OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as "developed", "industrialized" and "developing" are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

Distr.
RESTRICTED

ISED/R.53
22 January 1996

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

ORIGINAL: ENGLISH

INDUSTRY, SUSTAINABLE DEVELOPMENT AND WATER PROGRAMME FORMULATION

DOCUMENTS COLLECTION
00437 26.02.95
VIC LIBRARY

XP/GLO/96/062

Technical report: Global assessment of the use of freshwater resources for industrial and commercial purposes*

Based on the work of Mr. K. Strzepek and Ms. P. Bowling

Backstopping Officer: G. Ramsay, Chemical Industries Branch

---

* This document has not been edited.

V.96 80342

ABSTRACT

This UNIDO project is part of a UN comprehensive assessment of global freshwater resources, which includes analyses of agricultural, commercial, domestic, and industrial uses. The study described herein focuses on industrial and commercial uses of water. Water for industrial purposes is used in manufacturing, mining, and for electrical cooling. The goal of the study is a forecast of industrial and commercial water use to 2025 at a national level to identify nations, regions, or continents that may be facing critical situations with regard to industrial and commercial water management. To deal with the uncertainties of technological and economic conditions in the year 2025, a scenario approach was used. Combinations of five economic-development, three energy-growth, and two water-use technology scenarios were analyzed along with two different manufacturing-sector structures. Also examined were industrial pollution loadings, specifically with respect to four pollutant measures: biological oxygen demand, chemical oxygen demand, suspended solids, and total dissolved solids.

This detailed analysis confirms previous simpler analyses that industry and service will be the fastest growing water-use sectors, with increases between 2.7 and 5.0 times 1990 use and growth at a rate much faster than the population growth rate. The analysis suggests that in certain rapidly industrializing areas, there will be greater than ten-fold increases in manufacturing and commercial water use over 1990 levels. This study emphasizes the need for major research and development efforts to establish water-efficient and reduced-pollution technologies and appropriate water and environmental management institutions. The main conclusion of this study is that current trends in industrial and commercial development and water use are not environmentally sustainable.

SUMMARY

Global industrial water use in the year 2025 is estimated to increase from 2.7 to 3.2 times 1990 use depending on the economic development scenario assumed. Industrial water use is defined as freshwater withdrawals for the manufacturing and mining sectors and for cooling water used for thermal electrical generation. Manufacturing/mining industries water use in 2025 is estimated to increase from 2.3 to 3.6 times 1990 levels, while electrical cooling water use is projected to increase about 2.8 times. In 1990, industrial water accounted for 23 percent of all freshwater withdrawals and 7 percent of the stable renewable freshwater supply. The projected increases will lead to industrial water use accounting for 15 percent of the global freshwater supply. Commercial water use, defined as water withdrawn for public purposes (e.g. retail establishments, parks, and golf courses; does not include domestic (primarily household) water use), is estimated to increase globally from 2.1 to 5.0 times 1990 levels. With the UN forecasting a 60 percent increase in global population by 2025, which will lead to an increase in domestic water demand and increased pressure for greater agricultural production (and thus increased agricultural water use), global water resources will become more vulnerable.

The world's water resources in 1990 were classified as being in a water surplus condition. However, current sectoral water forecasts suggest that global resources in 2025 will move to a water stress condition. Industrial water use has the greatest impact in this vulnerability shift, as industry strives to grow faster than population to improve standard of living. While the global water-use estimates are a matter of concern, equally alarming is the fact that major industrial water pollutant loads in 2025 are estimated to increase from 3.4 to 4.8 times 1990 levels. Regional results point to Asia as a crisis area for industrial and commercial water usage and environmental management (pollution loads) with increases of up to 7 times, 14 times, and 19 times 1990 levels, respectively. The Middle East, Latin America, and Africa are also of great concern with increases over 1990 levels of up to 5 times in industrial water use and 10 times in industrial pollution loads.

ratio of 2025/1990 values	Development Scenario	
Economic Growth:	IPCC	Crisis
Industrial Water Use	3.2	2.7
Manufacturing/Mining	3.6	2.3
Electric Cooling	2.8	
Biological Oxygen Demand	4.8	3.5
Chemical Oxygen Demand	4.8	3.4
Suspended Solids	4.7	3.4
Total Dissolved Solids	4.8	3.4
Commercial Water Use	5.0	2.1

An alternative "water-efficient" scenario based on the trends in water use and manufacturing technologies in the USA over the past 30 years shows 29 and 21 percent decreases in global industrial water use for the IPCC and crisis development scenarios, respectively, and from as much as 71 percent to as little as 7 percent in regional decreases. The water-efficient scenario points to areas which are facing acute problems, as well as to areas which could greatly benefit from instituting water recycling. This analysis emphasizes the need for major research and development efforts to establish water-efficient and reduced-pollution technologies and appropriate water and environmental management institutions.

The main conclusion of this study is that current trends in industrial and commercial development and water use are not environmentally sustainable.

METHODOLOGY FOR THE INDUSTRIAL WATER USE MODEL

The main uses of water in industry are those of the manufacturing, mining, and electrical power generation sectors. These uses can be described by the equation

$$IWU = \alpha M_a + M_i + \beta E \qquad (1)$$

where IWU ≡ total industrial water use (km^3/yr),
M_a ≡ contribution from the manufacturing sector (km^3/yr),
M_i ≡ contribution from the mining sector (km^3/yr),
E ≡ contribution from electrical power generation (GWh), and
α, β are proportionality coefficients (to be explained later).

For the purpose of this study, industrial water use was divided into two parts: manufacturing and mining industries, and thermal electric cooling. Two different but related methodologies were used to forecast these two components of industrial water use.

The basis of the methodology is the engineering or water requirement approach, which assumes that each type of economic activity has a "water requirement," and that water use is the product of the level of economic activity and the water requirement. Therefore, to perform a forecast of water use in 2025, forecasts of economic activity and the water requirements in 2025 are needed:

$$\text{Water Use}_{2025} = (\text{Activity}_{2025}) \times (\text{Water Use/Activity})_{2025} \qquad (2)$$

The Activity_{2025} is provided by economic development scenarios. However, the $(\text{Water Use/Activity})_{2025}$ must be estimated by a water resources analyst. For this analysis, the water requirement parameter was obtained from historical data, $(\text{WaterUse/Activity})_{1990}$. While realizing that economic, institutional, and technical factors may lead to changes in these values, this analysis used the 1990 values to show the impact of continuing with current industrial water use and environmental management practices. In reality, these values probably will decrease, but likely not enough to change the insights from these results.

Manufacturing

This assessment has made use of the INDSTAT3 database of the United Nations Industrial Development Organization (UNIDO) to obtain industrial output data for as many countries as possible, broken down into the 28 manufacturing sectors specified by the International Standard Industrial Classification (ISIC) codes (UNIDO, 1995a). This breakdown is described in Table 1.

Table 1. *Manufacturing ISIC code descriptions*

ISIC code	Description of sector
311	Food products
313	Beverages
314	Tobacco
321	Textiles
322	Wearing apparel, except footwear
323	Leather products
324	Footwear, except rubber or plastic
331	Wood products, except furniture
332	Furniture, except metal
341	Paper and products
342	Printing and publishing
351	Industrial chemicals
352	Other chemicals
353	Petroleum refineries
354	Misc. petroleum and coal products
355	Rubber products
356	Plastic products
361	Pottery, china, earthenware
362	Glass and products
369	Other non-metallic mineral products
371	Iron and steel
372	Non-ferrous metals
381	Fabricated metal products
382	Machinery, except electrical
383	Machinery electric
384	Transport equipment
385	Professional and scientific equipment
390	Other manufactured products

Source: UNIDO, 1995b.

Since data on water use for manufacturing are scarce, a method of estimating water use from available data had to be developed. Water use data are obtainable for the United States, so the method employed in this assessment involves using these data and relating each country's industrial production output to that of the United States.

The U.S. data were given for 1982 in water intake (gallons) per employee by manufacturing sector (Nissan and Williams, 1987). Unfortunately, the sectors were divided up by SIC code, not ISIC code, and these two classification systems do not correlate exactly. A reasonable matching system was developed, but some error was introduced into the model by the lack of direct correlation.

The U.S. data were converted from intake per employee to intake per dollar output by using employee and output data from the UNIDO INDSTAT3 database for the U.S. in 1982 (UNIDO, 1995a). By having production output data for many countries, the manufacturing water intakes could be calculated. However, it was assumed that using the water intake per dollar output ratios from the U.S. data would skew water-use estimates in other countries because of differences in technologies and efficiencies of water use. Therefore, a set of comparison factors, or α's, was introduced to attempt to correct for this difference. The α's, in effect, represent the level of industrial technology in each country as compared to that of the U.S. in 1982.

REGIONAL ALPHAS

The Central Planning Bureau (CPB) of the Netherlands has used a collection of nine regions to classify the nations of the world for use in producing their forecasts (CPB, 1992; see description of development scenarios later under "Forecasting"). This study used a *modified* version of the CPB regions for the purpose of assigning α's, because certain countries did not well fit the mold of their assigned regions. It was not obvious beyond an intuitive sense what the values of these alphas should be. The model was calibrated using the dataset from Gleick (1993), the opinions of the authors on the comparative level of technology in various countries, and some degree of trial and error. After many iterations, the preliminary values for α given in Table 2 were obtained.

Table 2. *Modified CPB regions and corresponding comparison factors (α) (preliminary values)*

Region	α *
Africa	0.9
Canada	0.6
Dynamic Asian Economies	1.0
Finland	0.8
Italy	0.7
Japan	0.7
Latin America	0.7
Middle East	0.8
North America	0.9
New Market Economies	1.2
Rest of Asia	0.9
South Africa	0.8
United States	0.6
Western Europe	0.8

* Note: α = 1.0 would indicate industrial technology similar to that of the United States in 1982.

Mining

The data for mining industries were obtained in much the same manner as the manufacturing data. The values for the United States' water use and number of employees in mining came from the *1982 Census of Mineral Industries* (Bureau of the Census, 1985). Using those numbers as a ratio (water use per employee) and multiplying the ratio by the number of employees in mining in other countries (United Nations, 1993), the water use in other countries could be estimated. Unfortunately, the data for mining is considerably less prevalent than other data sought in this project, and so this particular dataset has many holes. However, the portion of the population employed in mining industries was found to be less than two percent for all countries with available data. Because the contribution of the mining sector to the total industrial water use is small, a proportionality coefficient was not used for this term.

Electrical Power Generation

Detailed data on electricity production came from the International Energy Agency (Kousnetzoff, 1995). A conversion factor (β) was needed to relate water usage and electricity production.

Once preliminary values for α had been obtained, industrial water use data from Gleick (1993) could be used to determine values for β. Solving equation (1) for β gives:

$$\beta = \frac{IWU_{Gleick} - \alpha M_a - M_i}{E} \qquad (3)$$

This process gave reasonable data for many countries, but in some cases the numerator of equation (2) gave a negative number, due to the combined use of Gleick's dataset and our estimated values. In these cases, a "minimum β" was used. The minimum β was determined from data for New Mexico, an arid western state which employs exclusively the efficient cooling technologies of water towers and pond evaporation (Carr *et al.*, 1990). It was assumed that there would be no β values substantially lower than New Mexico's, but to allow room for extremely efficient technologies, the minimum β was set at two-thirds the New Mexico value.

Manufacturing Revisited

Once the individual parts described above had been calculated, a "back"-calculation for α was performed in order to see how good the calibration had been. It was decided that further adjustments needed to be made to some of the α's. For those countries where the minimum β had been employed, the α obtained from that β was used. In some cases, this process gave an α far below what was believed to be appropriate. In this situation, an α of 0.5 was assigned, except for Israel and South Africa, where it is believed that an α as low as 0.25 is more appropriate. All other countries with adequate datasets (67 countries) used the preliminary regional α assignments. Table 3 lists the countries in each of the three newly-assigned α categories.

Table 3. *Changes in comparison factor (α) assignment after model calibration*

Category	Countries affected
α determined from minimum β	Algeria, Ireland, Kenya, Qatar, Sweden, Venezuela, Zambia
α assigned as 0.5	Australia, Cyprus, Denmark, Jamaica, Jordan, Malta, New Zealand, Saudi Arabia, Singapore, South Korea, Sudan, Uruguay, Zimbabwe
α assigned as 0.25	Israel, South Africa

Water-Efficient Technologies

As nations become more industrialized, the effort to find more efficient technologies becomes more pronounced. In order to capture the effect that water recycling within industry may have on future water use, a recycling scenario was developed as an alternative model run.

From Carr *et al.* (1990), water discharge data for five manufacturing sectors and the mining industry over a thirty-year period (1954-1983) and sixteen-year period (1968-1983), respectively, were available for the United States (see Figure 1). It was possible to determine the average annual rates of decline in water discharged for these sectors. For all unspecified manufacturing sectors, the average of the five rates was used. The manufacturing and mining growth rates are given in Table 4. These growth rates were applied to the initial water intake/employee values for the U.S., to produce the water use per employee values given in Table 5.

Table 4. *Annual growth rates used in the recycling scenario for manufacturing and mining.*

Sector(s)	Average annual growth rate (%)
Chemicals and allied products	-5.6
Paper and allied products	-3.5
Petroleum refining	-3.8
Steel processing	-2.6
Food processing	-2.9
All other manufacturing sectors	-3.7 (average of previous five)
Mining industry	-2.3

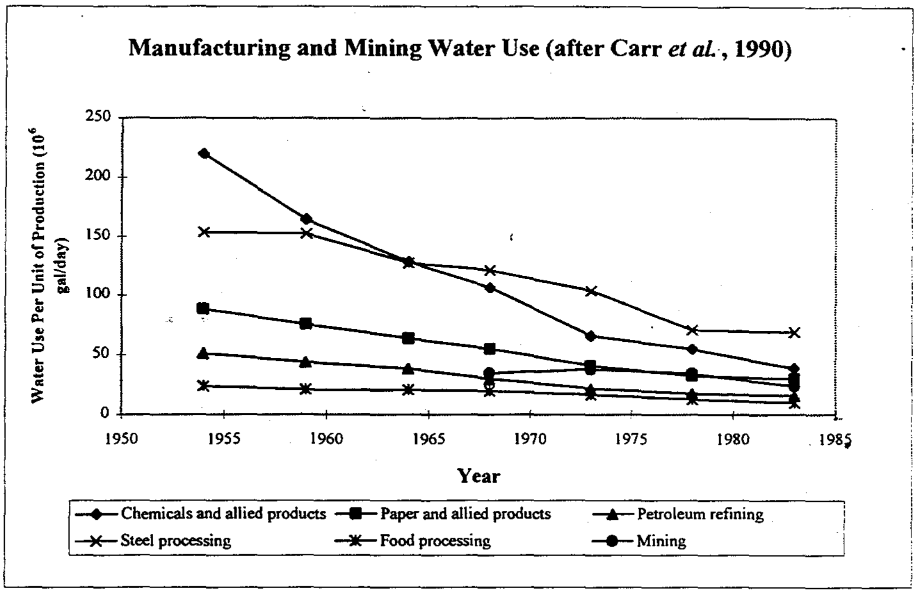

Figure 1. *Water use in five manufacturing sectors and the mining industry for a thirty-year period in the United States. (Source: Carr et al., 1990)*

Table 5. *Reduction in annual water use per employee in the recycling scenario*

	Water Use (gal/yr/employee)		
ISIC	Standard Scenario	Recycling Scenario	Percentage Decrease
311 / 313	448,000	161,324	64
314	96,700	25,967	73
321 / 322 / 324	183,300	49,221	73
323	32,300	8,673	73
331	136,700	36,708	73
332	7,700	2,068	73
341	3,130,500	891,987	72
351 / 352	3,997,500	531,134	87
353 / 354	5,594,000	1,446,651	74
355 / 356	111,000	29,807	73
361 / 362 / 369	294,200	79,001	73
371 / 372	3,063,400	1,200,660	61
381	46,100	12,379	73
382	60,300	16,192	73
383	39,100	10,499	73
384	94,600	25,403	73
385	49,000	13,158	73
mining (km^3/yr/empl)	4.27×10^{-6}	1.87×10^{-6}	56

Structural Manufacturing Shift

It is likely that there will be a structural shift within the industrial sector of the economy, but it is difficult to determine the nature of such a change. The standard model run used in the analysis assumed a structure similar to that in 1990. Another scenario (Raskin, Hansen, and Margolis, 1995) provides projections for the type of structural change expected and has been incorporated into this analysis as the structural shift run.

Developed by the Stockholm Environment Institute (Raskin, Hansen, and Margolis, 1995), the structural shift run projects the percentage of GDP contributed by certain manufacturing subsectors (iron and steel, non-ferrous metals, non-metallic minerals, paper and pulp, chemicals, and a miscellaneous "other" category) into the future. The basis for these projections is the observation that growth rates of material consumption in advanced industrial countries have leveled off in recent decades. For non-OECD regions, development in material-intensive industrial subsectors is assumed to converge toward OECD patterns. (For further explanation, see Raskin, Hansen, and Margolis, 1995.)

Summary of Industrial Water Use Scenarios

Each model run was performed on the five economic scenarios (to be explained in detail later). There were four model runs: standard, water-efficient, structural shift, and water-efficient structural shift.

METHODOLOGY FOR THE COMMERCIAL WATER USE MODEL

Water for commercial purposes is defined here as that withdrawn for public (but not domestic) use, i.e. water for commercial establishments and public services such as restaurants, retail stores, parks, and golf courses. Data about the commercial use of water are very often combined with those for domestic water use, and collectively they are referred to as the latter. In this paper, the combination of domestic and commercial water use will be termed *municipal water use*.

A separate model was developed for the analysis of commercial water use. Since data on commercial water use were not readily available, it was decided to use municipal water use data from Gleick (1993) and determine water use in the domestic sector, thereby indirectly obtaining values for commercial water use.

From Saunders and Warford (1976) and the United Nations (1976), data were acquired on the average urban and rural domestic water uses by world region, using a modified version of the regions from Saunders and Warford (1976). Using weighted averages of minimum and maximum values—and, for urban use, house connections and public standposts—, single values for rural and urban domestic water use per capita by region were determined. These values are given in Table 6.

It is believed that the majority of available data on domestic water use represents relatively safe drinking water, since many times the use of unsafe water due to lack of access is not easily quantified. Therefore, the rural and urban populations with access to safe water (data from STI, 1994 and United Nations Demographic Yearbook) were used in combination with the domestic water use per capita ratios to obtain domestic water use by country (km^3/yr). For countries that were lacking the data on population with safe access, regional averages were used.

Table 6. *Values for rural and urban domestic use of safe freshwater (liters/capita/day)*

Region	Rural use	Urban use
Africa	19.0	42.0
Algeria, Morocco, Turkey	33.5	53.2
Asia	56.7	189.0
Central and South America	106.0	90.6
Eastern Europe	85.0	200.0
Eastern Mediterranean	53.5	69.3
Europe	67.4	128.8
Middle East	43.0	95.5
USA, Canada, Australia, New Zealand, Japan	47.5	190.0
Southeast Asia	42.0	53.4
Western Pacific	49.5	85.4

By subtracting these estimates for domestic water use from municipal water use (Gleick, 1993), commercial water use for each country (with available data) was obtained. In some cases, the initial domestic use estimate ended up greater than the municipal value, resulting in a negative value for commercial water use. For Africa, calibration of the domestic use per capita ratios resulted in changes in the weighting factors used to determine those ratios. In other cases, when one country was far off the others in its region, it was removed from the dataset. Once these changes were implemented, the base dataset for commercial water use was ready to be used in forecasting.

FORECASTING

Because several different data sources were used to obtain information for this analysis, the categorization of nations into regions varies somewhat between scenarios. To see in what region a specific country is listed for a particular scenario, see Appendix 1.

Economic Development Scenarios

CENTRAL PLANNING BUREAU OF THE NETHERLANDS

Mid- to long-term global economic forecasts are very rare, and therefore the use of arbitrary growth rates for a long-term economic forecast is often necessary. However, the Central Planning Bureau of the Netherlands undertook a comprehensive, internally consistent mid- to long-term forecast of global economic activity (CPB, 1992).

This analysis divided the globe into nine major economic zones and produced four forecasts based upon a range of assumptions and expert judgment about future trends in each of these zones. There was an internally consistent population forecast to accompany each scenario. However, population projections were made on a regional, not national, scale. In comparing the CPB regional projections to national projections, the UN medium variant forecast was the closest match. While the GNP forecasts were regional, they were assumed to be applicable for all countries in the region. In addition, the growth rates were assumed constant across all sectors in the economy. The four scenarios with their basic assumptions are listed below, and GNP growth rates are given in Table 7a.

CPB Global Shift

- strong American GNP scenario (3.4%)
- strong U.S. recovery, Japan and the Far East become more free-market
- Europe favors stability and risk-aversion
- CEE fails economic reconstruction, backlash in the CIS
- Africa delinked, Latin America has stable growth

CPB European Renaissance

- strong EU growth (2.9%)
- U.S. decline and loss of leadership
- EU thrives and includes CEE, CIS delayed breakthrough
- Japan and Far East have slowed growth
- Africa benefits from Europe, Latin American crisis

CPB Balanced Growth

- optimistic GNP (3.6%)
- Japan, Europe, North America have 3% growth
- strong Latin American and Africa growth
- continued strong Asian growth
- optimistic CEE and former USSR growth at 2.7%

- GNP rate is related to the population growth

CPB Global Crisis

- pessimistic GNP scenarios
- a closed Japan, slowing of the U.S., lagging European development
- rise of the Far East, CEE hit hard, and nationalistic former USSR
- mounting tensions and antagonistic trading blocks
- after severe crisis begins slow recovery
- Africa AIDS, Latin America forgotten

Table 7a. *GNP Growth Rates for the CPB Long-Term Economic Forecasts*

	Global Shift	EU Renaiss.	Global Balance	Global Crisis	
Region	1990-2025	1990-2025	1990-2025	1990-2015	2015-2025
Africa	2.9%	4.0%	4.9%	2.3%	3.0%
Dynamic Asian Economies[1]	7.3%	6.2%	7.0%	5.0%	5.5%
Japan	4.3%	3.7%	3.1%	3.0%	3.0%
Latin America	4.3%	2.8%	5.6%	3.0%	4.0%
Middle East	3.6%	3.5%	3.2%	2.1%	1.8%
North America	3.4%	1.8%	3.0%	1.7%	2.3%
New Market Economies[2]	0.2%	2.3%	2.7%	-0.4%	2.5%
Rest of Asia	6.5%	4.9%	6.1%	4.2%	5.0%
Western Europe	1.9%	2.8%	3.2%	1.8%	2.3%

[1] *Dynamic Asian Economies* include: Hong Kong, Indonesia, Malaysia, Philippines, Singapore, South Korea, Taiwan, Thailand

[2] *New Market Economies* include: Albania, Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovak Republic, and Former USSR

STOCKHOLM ENVIRONMENT INSTITUTE SCENARIO

The fifth economic development scenario used in the analysis was based on economic growth rate projections from the IPCC. This scenario was developed by the Stockholm Environment Institute and termed the "Conventional Development Scenario" (Raskin, Hansen, and Margolis, 1995). The rates with their corresponding regions are given in Table 7b. Assumptions that led to the CDS are described below.

- global population reaches ten billion by the year 2050;
- almost all of the population growth (about 95%) is in developing countries, with rapid urbanization;

- global economy, with most rapid growth rates in developing countries, expands 4.5-fold;
- in industrial areas, a gradual structural shift in the economy towards service, expansion of production and consumption, and continued improvements in water-use efficiency for equipment are assumed;
- developing regions are projected to exhibit economies and technologies patterned after those in industrial countries.

Table 7b. *Regional growth rates in the Conventional Development Scenario*

Region	Growth Rate (1990-2025)
Africa	4.1%
China+	5.2%
Latin America	3.2%
Middle East	4.1%
North America	2.6%
Eastern Europe	2.3%
Western Europe	2.3%
Former USSR	2.3%
OECD Pacific	2.4%
South and East Asia	4.5%

Manufacturing and Mining Forecasts

For forecasting the manufacturing and mining sectors, the methodology of Strzepek *et al.* (1995) was followed. Base values of GNP were obtained from WRI (1992), and each of the scenarios was forecast for the year 2025. The forecasts were presented as growth rates specified by regions. In employing the economic forecast of the Stockholm Environment Institute (1995), GDP was used in place of GNP in the following equations because that was the measure used in their forecast.

From these growth rates, the forecast GNPs (in million USD) could be calculated for each scenario using the equation:

$$G_f = G_b * (1+r)^n \qquad (4)$$

where $G_f \equiv$ forecast GNP
$G_b \equiv$ base GNP
$r \equiv$ growth rate expressed as a decimal (e.g. 2% is 0.02)
$n \equiv$ number of years for forecast

For the current task, n = 35 was used (2025 forecast from 1990 base).

Next, the ratio of base manufacturing/mining use to base "industrial" GNP ($MMU_b/IGNP_b$) was obtained from

$$\frac{MMU_b}{IGNP_b} = \frac{MMU_b}{G_b * (G_{ind})} \tag{5}$$

where $G_{ind} \equiv$ distribution of GNP to industry.

The industrial GNP for each scenario, $IGNP_s$, was obtained by multiplying the distribution of GNP to industry by the GNP forecast for that scenario.

$$IGNP_s = I\% * GNP_s \tag{6}$$

The last step was a simple multiplication to arrive at forecast manufacturing/mining water use:

$$MMU_f = \frac{MMU_b}{IGNP_b} * IGNP_s \tag{7}$$

Electricity Production Forecast

Data for thermal electricity production were available for a collection of regions from the Stockholm Environment Institute (Raskin, Hansen, and Margolis, 1995). From these data, electricity production growth rates (shown in Table 8) could be calculated and then applied to base values from the International Energy Agency (Kousnetzoff, 1995) to obtain a forecast E_f using the equation

$$E_f = E_b * (1 + r)^n \tag{8}$$

Table 8. *Raskin and Margolis (1995) Long-Term Energy Growth Forecasts (growth rate calculations by authors)*

Global Region	Annual Growth (%)
Africa	4.28
China+	5.05
Eastern Europe	2.45
Former Soviet Union	2.37
Latin America	3.64
Middle East	4.04
North America	1.38
OECD-Pacific	1.66
South and East Asia	4.16
Western Europe	1.44

Commercial Water Use Forecast

Data were available on the percentage contribution of the service (commercial) sector to the GDP in 1990 with projections for 2050 in a regional breakdown (Raskin, Hansen, and Margolis, 1995). By interpolation, the same parameter could be estimated for the year 2025. The estimates for future commercial water use could then be obtained by multiplying the base commercial water use by the ratio of the service-sector GDPs:

$$CWU_{2025} = CWU_{1990} * \left(\frac{SGDP_{2025}}{SGDP_{1990}} \right) \qquad (9)$$

It was assumed that the same sectoral percentages would apply to GNP, which was the economic measure used in projecting future commercial water use under the CPB scenarios.

STUDY FINDINGS

Industrial Water Use

Estimates of global industrial water use in the year 2025 are reported in Tables 9a-b for the standard and structural shift model runs, respectively. Global industrial water use is estimated to increase from 2.6 to 3.2 times that of 1990 for these runs, depending on the economic development scenario. Table 9c gives the results for the standard model run, separated into the manufacturing/mining and electrical cooling water components. In 2025, global manufacturing and mining industries water use is estimated to increase from 2.3 to 3.6 times 1990 levels, while global electrical cooling water use increases 2.8 times.

The estimate of (standard run) total industrial water use in the Dynamic Asian Economies in 2025 is 6.5 times that of the 1990 level under the Global Shift scenario, and even 3.8 times that of 1990 for the Global Crisis scenario (Table 9b). These estimates are comprised of increases in manufacturing and mining water use of 11.8 and 5.8 times 1990 levels for Global Shift and Global Crisis scenarios, respectively, and electrical cooling increases of 2.2 times 1990 levels (Table 9c). Competing demands for water resources appears to signal the potential for an industrial water use crisis in this region in 2025.

Even more alarming are the results of the pollution analysis for the Dynamic Asian Economies (see the section on Pollution Analysis for tabular results). This region is clearly facing the greatest threat to Ecologically Sustainable Industrial Development. Other regions are forecast to be facing critical, if not crisis, situations in 2025. The Middle East, Latin America, Rest of Asia, and Africa are of great concern with increases over 1990 levels of 3 to 5 times in water use and 3 to 10 times pollution loadings.

Table 9a. *Forecast industrial water use (2025) with standard model run. Results are given as the ratios of 2025 to 1990 water use estimates.*

Region	Global Shift	EU Renaissance	Global Balance	Global Crisis	Conv. Developmt.
Africa	3.3	4.0	4.7	3.1	4.0
DAE	6.5	4.9	6.0	3.8	2.2
Japan	4.3	3.5	2.9	2.8	2.2
Latin America	3.9	2.9	5.4	3.2	3.1
Middle East	3.7	3.7	3.5	3.2	3.9
North America	2.4	2.2	2.3	2.2	2.2
NME	2.4	2.7	2.8	2.4	5.3
Rest of Asia	5.3	4.4	5.1	4.2	4.2
Western Europe	2.9	3.2	3.4	2.9	4.3
WORLD	**3.0**	**2.9**	**3.1**	**2.7**	**3.2**

Table 9b. *Forecast industrial water use (2025) with structural shift model run. Results are given as the ratios of 2025 to base 1990 water use estimates.*

Region	Global Shift	EU Renaissance	Global Balance	Global Crisis	Conv. Developmt.
Africa	2.9	3.6	4.3	2.7	3.7
DAE	5.6	4.2	5.1	3.3	2.0
Japan	4.2	3.4	2.8	2.7	2.2
Latin America	3.8	2.8	5.2	3.1	2.6
Middle East	1.8	1.8	1.7	1.4	2.0
North America	2.5	2.2	2.4	2.2	2.3
NME	2.5	2.9	3.0	2.5	14.3
Rest of Asia	5.7	4.6	5.4	4.4	4.5
Western Europe	2.4	2.7	2.8	2.5	2.6
WORLD	**2.9**	**2.7**	**3.0**	**2.6**	**3.2**

Sensitivity Analysis of Electrical Power Generation Sector

The model has been run with two alternate scenarios for electrical cooling water growth. These scenarios were generated in the IIASA Energy Study as low and high energy growth (Anderer *et al.*, 1981) about 20 years before the IPCC energy growth estimates which have been used as the principle energy growth scenario in this analysis. It had been assumed that the true growth in this sector would fall somewhere between the high and low extremes. In reality, the growth has been even faster than the high rate, and consequently the stress that this sector puts on water supply has been steadily increasing. Table 10 shows the electrical energy component of forecasts for industrial water use under the IPCC, IIASA high, and IIASA low scenarios. It can be seen that the IPCC energy growth scenario projects higher water-use ratios for the world and for all regions except the Dynamic Asian Economies.

Table 9c. *Forecast industrial water use with the standard model run, separated into the manufacturing/mining and electrical cooling water components. Results are given as the ratios of 2025 to base 1990 water use estimates.*

	Manufacturing/Mining Component					Electrical Cooling Component
Region	Global Shift	EU Renaiss.	Global Balance	Global Crisis	Conv. Devlpmt.	
Africa	2.7	3.9	5.3	2.4	4.1	4.0
DAE	11.8	8.2	10.7	5.8	2.2	2.2
Japan	4.4	3.6	2.9	2.8	2.2	2.2
Latin Amer.	4.4	2.6	6.7	3.1	3.0	3.3
Middle East	3.4	3.3	3.0	2.0	4.1	3.8
North Amer.	3.2	1.9	2.8	1.9	2.4	2.2
NME	1.1	2.2	2.5	1.2	5.9	2.8
Rest of Asia	9.1	5.3	7.9	4.6	4.8	4.0
West. Europe	1.9	2.6	3.0	2.0	4.7	3.8
WORLD	**3.3**	**2.9**	**3.6**	**2.3**	**3.6**	**2.8**

Table 10. *Electrical cooling component of forecast industrial water use under the IPCC, IIASA high, and IIASA low scenarios. Results are given as the ratios of 2025 to 1990 water use estimates.*

Region	IPCC	IIASA high	IIASA low
Africa	4.0	3.1	2.1
DAE	2.2	3.1	2.1
Japan	2.2	1.7	1.3
Latin America	3.3	2.4	1.8
Middle East	3.8	3.3	2.2
North America	2.2	1.4	1.1
NME	2.8	1.9	1.5
Rest of Asia	4.0	2.8	1.9
Western Europe	3.8	1.7	1.3
WORLD	**2.8**	**1.8**	**1.4**

Water-Efficient Technologies

The regional results of industrial water use under the water-efficient scenario are given in Tables 11a-b for standard and structural shift model runs, respectively. Results of the water-efficient and standard industrial runs are compared for selected areas and presented in Figures 2-5. In order to use recycled water in production, it is necessary to increase water treatment within a plant. Effluents will most likely become more concentrated unless additional treatment is implemented. However, the model presented here does not provide a clear measure of the possible changes in pollutants because of the methodology used to forecast pollutant loadings.

Table 11a. *Forecast industrial water use with water-efficient technology under standard model run . Results are given as the ratios of 2025 to 1990 water use estimates.*

Region	Global Shift	EU Renaissance	Global Balance	Global Crisis	Conv. Developmt.
Africa	2.2	2.4	2.7	2.2	2.5
DAE	2.7	2.3	2.6	2.0	1.5
Japan	1.2	1.0	0.9	0.8	0.7
Latin America	2.0	1.7	2.4	1.8	1.8
Middle East	2.9	2.9	2.8	2.7	2.8
North America	2.0	1.9	2.0	1.9	1.9
NME	2.3	2.4	2.4	2.3	4.2
Rest of Asia	3.6	3.4	3.5	3.3	3.3
Western Europe	2.2	2.3	2.3	2.2	2.5
WORLD	**2.2**	**2.2**	**2.2**	**2.1**	**2.3**

Table 11b. *Forecast industrial water use with water-efficient technology under structural shift model run. Results are given as the ratios of 2025 to 1990 water use estimates.*

Region	Global Shift	EU Renaissance	Global Balance	Global Crisis	Conv. Developmt.
Africa	1.8	2.0	2.2	1.7	2.0
DAE	2.3	2.0	2.2	1.7	1.3
Japan	1.1	1.0	0.8	0.8	0.6
Latin America	1.9	1.6	2.3	1.7	1.6
Middle East	1.1	1.1	1.1	1.0	1.4
North America	2.0	1.9	2.0	1.9	1.9
NME	2.3	2.4	2.5	2.3	11.0
Rest of Asia	3.7	3.4	3.6	3.3	3.4
Western Europe	2.0	2.1	2.1	2.0	2.0
WORLD	**2.1**	**2.1**	**2.2**	**2.0**	**2.5**

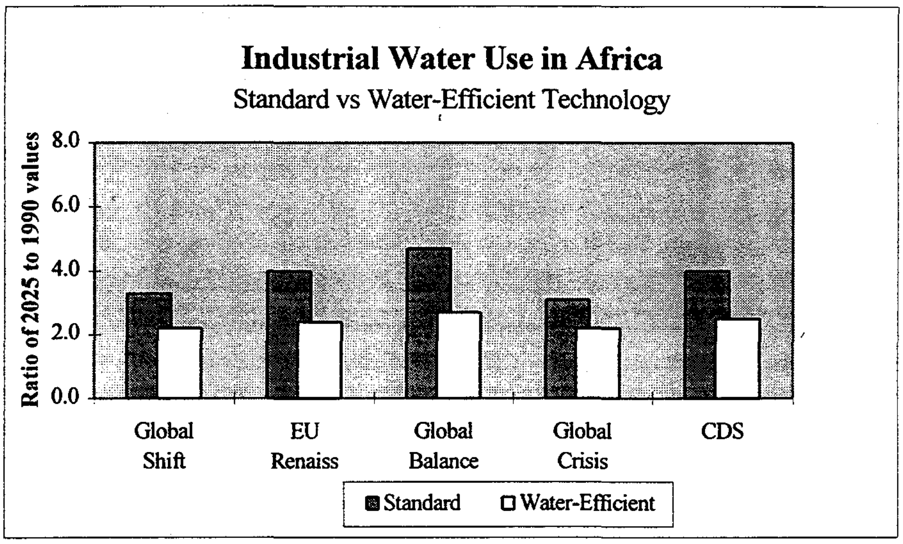

Figure 2. *A comparison of water use under the standard and water-efficient model runs for Africa.*

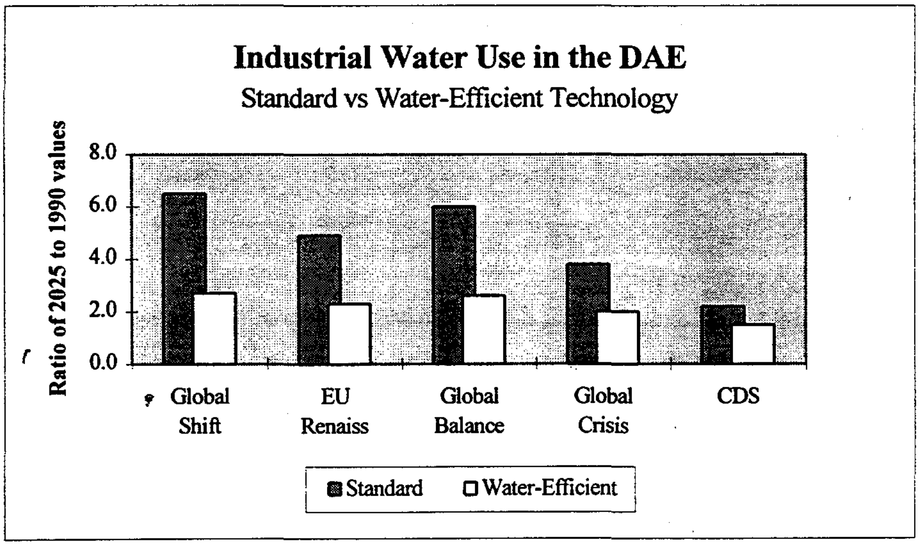

Figure 3. *A comparison of water use under the standard and water-efficient model runs for the Dynamic Asian Economies.*

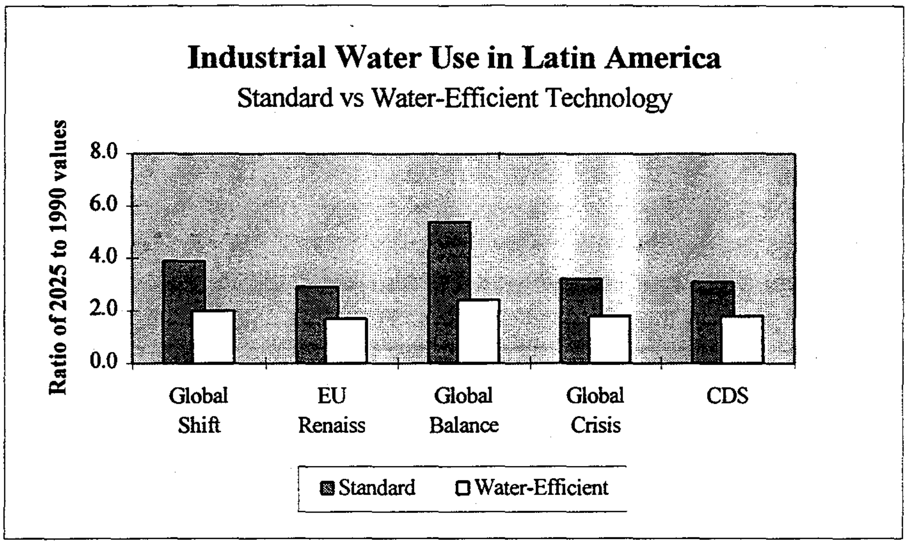

Figure 4. *A comparison of water use under the standard and water-efficient model runs for Latin America.*

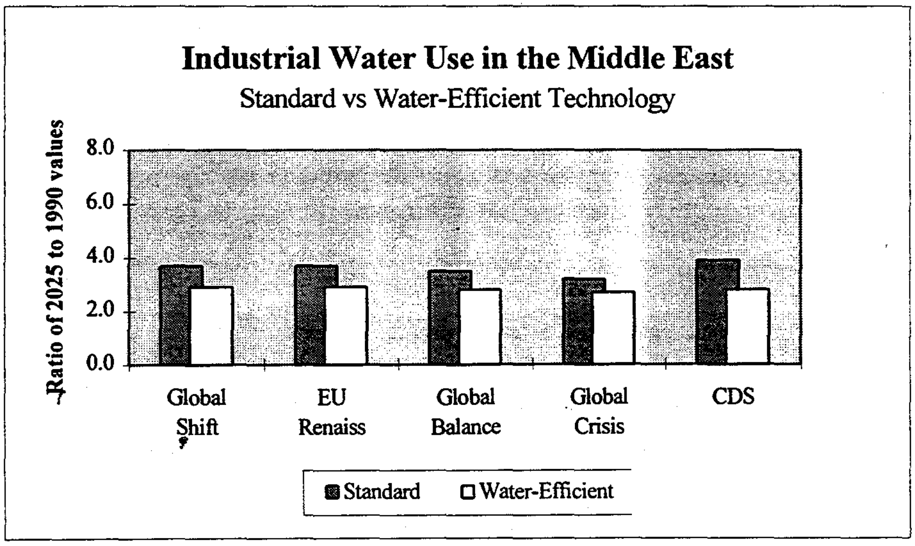

Figure 5. *A comparison of water use under the standard and water-efficient model runs for the Middle East.*

Commercial Water Use

Regional and global results for the commercial water use forecast are given in Table 12. Similar to industrial water use results, commercial water use increases are greatest in the Asian regions, with increases of up to 13.6 times and 13.0 times 1990 levels in the Dynamic Asian Economies and Rest of Asia, respectively, under the Global Shift scenario.

Table 12. *Forecast commercial water use (2025). Results are given as the ratios of 2025 to 1990 water use estimates.*

Region	Global Shift	EU Renaissance	Global Balance	Global Crisis	Conv. Developmt.
Africa	3.2	4.6	6.2	2.8	4.8
DAE	13.6	9.5	12.3	6.7	2.6
Japan	5.0	4.1	3.4	3.3	2.6
Latin America	5.0	3.0	7.8	3.6	3.5
Middle East	4.0	3.9	3.5	2.3	4.8
North America	3.7	2.2	3.3	2.2	2.6
NME	1.3	2.6	3.0	1.4	6.8
Rest of Asia	13.0	7.7	11.4	6.6	8.5
Western Europe	2.1	2.8	3.2	2.1	5.0
WORLD	**4.4**	**3.3**	**4.6**	**2.8**	**3.5**

Pollutant Analysis

Forecasting pollutant loads is virtually impossible, since as industrialization takes place, much legislation for clean waters also occurs. It is difficult to imagine what the state of the world's water might be 35 years from now. However, in an attempt to capture a measure of the potential loadings, a methodology for projecting pollutant loads was developed.

Water pollution from industrial effluents varies greatly with the type of industry. Data giving approximate pollutant concentration per amount of industrial product for many industries were available from Gleick (1993). Because worldwide production data by industrial sub-sector is difficult to find, it was decided to use United States data and develop a ratio which could be applied to other countries. U.S. production data were obtained from UNIDO's Commodity Balance Statistics Database (UNIDO, 1993) and analyzed to determine industrial freshwater pollutant loadings for a specific year. Each country's base pollution (1990) could then be determined by multiplying its production in a given industrial sub-sector by the sector's U.S. pollution ratio. To obtain the forecast pollutant loads, these base ratios were multiplied by the previously forecast industrial water use values. This procedure assumes industrial pollution amounts similar to those of the United States in 1982 (the year from which the sectoral pollution ratios were derived). In reality, if legislation is enforced and new legislation put into effect, the situation could be better than it appears by this analysis. However, left as is, the situation greatly worsens.

The measures of pollution used in this study were biological oxygen demand, chemical oxygen demand, suspended solids, and total dissolved solids. Regional results of the pollution analysis follow in Tables 13a-d.

Results are alarming for this analysis. It is estimated that in the Dynamic Asian Economies under the Global Shift scenario, biological pollution loading, suspended solids, and total dissolved solids will increase 18.5, 16.8, and 17.2 times 1990 levels, respectively. The Rest of Asia grouping is also of great concern with increases over 1990 levels of between 5 and 10 times in pollution loadings.

Table 13a. *Biological oxygen demand (BOD) analysis under standard scenario. Results are given as the ratio of 2025 to 1990 values.*

Region	Global Shift	EU Renaissance	Global Balance	Global Crisis	Conv. Developmt.
Africa	3.6	5.2	7.1	3.1	5.4
DAE	18.5	12.9	16.8	9.1	3.5
Japan	6.2	5.1	4.2	4.0	3.2
Latin America	6.4	3.9	9.9	4.5	4.4
Middle East	5.8	5.6	5.0	3.4	6.9
North America	6.0	3.5	5.2	3.5	4.3
NME	0.9	1.9	2.1	1.0	4.9
Rest of Asia	10.1	5.9	8.8	5.1	5.4
Western Europe	2.5	3.4	3.9	2.5	6.1
WORLD	**5.2**	**4.1**	**5.3**	**3.5**	**4.8**

Table 13b. *Chemical oxygen demand (COD) analysis under standard scenario. Results are given as the ratio of 2025 to 1990 values.*

Region	Global Shift	EU Renaissance	Global Balance	Global Crisis	Conv. Developmt.
Africa	3.7	5.3	7.1	3.2	5.4
DAE	17.8	12.4	16.1	8.7	3.4
Japan	6.2	5.1	4.1	4.0	3.2
Latin America	6.4	3.9	9.9	4.6	4.4
Middle East	5.5	5.4	4.9	3.3	6.6
North America	5.9	3.4	5.1	3.5	4.2
NME	1.0	1.9	2.2	1.1	4.9
Rest of Asia	9.8	5.8	8.6	5.0	5.2
Western Europe	2.5	3.4	3.9	2.6	6.0
WORLD	**5.2**	**4.1**	**5.4**	**3.4**	**4.8**

Table 13c. *Suspended solids (SS) analysis under standard scenario. Results are given as the ratio of 2025 to 1990 values.*

Region	Global Shift	EU Renaissance	Global Balance	Global Crisis	Conv. Developmt.
Africa	3.7	5.2	7.0	3.2	5.4
DAE	16.8	11.8	15.2	8.3	3.3
Japan	6.0	5.0	4.1	3.9	3.1
Latin America	6.3	3.8	9.6	4.5	4.4
Middle East	5.6	5.4	5.0	3.5	6.6
North America	5.6	3.3	4.9	3.4	4.1
NME	1.4	2.1	2.3	1.4	5.0
Rest of Asia	8.7	5.5	7.8	4.9	5.1
Western Europe	2.6	3.4	3.9	2.6	5.9
WORLD	**4.9**	**4.0**	**5.1**	**3.4**	**4.7**

Table 13d. *Total dissolved solids (TDS) analysis under standard scenario. Results are given as the ratio of 2025 to 1990 values.*

Region	Global Shift	EU Renaissance	Global Balance	Global Crisis	Conv. Developmt.
Africa	3.8	5.5	7.4	3.3	5.6
DAE	17.2	12.0	15.6	8.5	3.3
Japan	6.2	5.1	4.2	4.0	3.2
Latin America	6.4	3.8	9.8	4.5	4.4
Middle East	6.0	5.8	5.2	3.5	7.2
North America	5.9	3.4	5.2	3.5	4.3
NME	0.9	1.9	2.1	1.0	4.9
Rest of Asia	10.0	5.9	8.7	5.0	5.1
Western Europe	2.5	3.4	3.9	2.6	6.1
WORLD	**5.0**	**4.0**	**5.2**	**3.4**	**4.8**

NEEDS FOR FURTHER RESEARCH

There are many parameters in this model that used average data and many countries for which there were no end results because of a lack of data. There is a great need for accurate data collection, and for concomitant standards for such data collection. Better data will allow for greater accuracy in modeling and will supply forecasters with more substantial historical bases on which to establish future scenarios. Better modeling accuracy will aid management and planning and seek to prevent the crises that may occur due to continued stress on the world's water supply.

While data on water use, particularly in the developing countries, is lacking, there is an even greater source of uncertainty in this analysis—forecasts of technological change and economic development. There is a need for globally-consistent national and regional forecasts of economic growth and economic sectoral adjustments. Since industrial water use is very much linked to the sub-sectoral make-up of the industrial sector, additional national forecasts of the changes in industrial structure are needed. Commercial water use, driven by growth in the service sector, also needs an accurate forecast. With electrical cooling being a very important part of industrial water use, future energy-use scenarios consistent with economic-growth scenarios are needed.

Water efficient technologies will be adopted only when economic or institutional forces drive water users to conserve. There is much need for research on the use of economic instruments for efficient water management in developing countries and the establishment and operation of water management institutions to implement water management policy.

CONCLUSIONS

Global water resources vulnerability in 2025 are forecast to move to a water stress condition from a water surplus condition in 1990. Water used in industry has the greatest impact in this vulnerability shift. Both global water-use estimates and pollutant load projections are cause for great concern.

Industrial pollution loadings are an issue for environmental reasons and for what economists term "externalities." Biological pollution loadings lead to reduced dissolved oxygen (DO) levels in lakes, streams, and coastal waters. Many species of aquatic life need high DO levels to survive. In addition, high biological pollution levels lead to poor water quality and public health hazards. Suspended solid (SS) loadings, while not a direct public health hazard, affect the aesthetic quality of water bodies and must be removed by water treatment plants which provide potable water supply. This removal of additional SS increases the operational costs of water treatment plants. Finally, total dissolved solids in irrigation water greatly impact the yields obtained from agricultural crops. In many areas brackish water supplies are virtually useless for irrigation as a result of upstream pollution loadings.

Urban centers appear to be the focal point for water management crises in the 20th century with the growth of mega-cities, mostly in the developing world. The local water resource vulnerability to demand/supply balance will be critical. With urbanization and population growth jointly increasing municipal water needs and wastewater generation, and industrialization with its thirst for water occurring in urban areas, the water demand of urban areas is going to increase to many times the national levels, leading to the need for comprehensive supply and water/wastewater infrastructure development coupled with demand management and conservation measures to avoid economic and public health problems.

The results presented in this study are based on 1990 water use and manufacturing technology. Actual conditions in 2025 will be much different than 1990. However, the results do point to the fact that industrial and commercial water use and environmental management are aspects of integrated water resources development and management that cannot continue with current trends and technologies and which are not ecologically sustainable. Major research and development efforts need to be instituted to explore water-efficient and reduced-pollution technologies, along with the establishment of appropriate water and environmental management institutions targeted to achieving *Ecologically Sustainable Industrial Development.*

REFERENCES

Anderer, J., A. McDonald, and N. Nakicenovic. 1981. *Energy in a Finite World, Paths to a Sustainable Future.* Report by the Energy Systems Program Group of the International Institute for Applied Systems Analysis, W. Häfele, Program Leader. Cambridge, Massachusetts: Ballinger Publishing Company.

Bureau of the Census. 1985. *1982 Census of Mineral Industries, Water Use in Mineral Industries* Series. Washington, D.C.: U.S. Department of Commerce.

Bureau of the Census. 1986. *Statistical Abstract of the United States 1986, 106th Edition.* Washington, D.C.: U.S. Department of Commerce.

Carmichael, J. B., and K. M. Strzepek. 1987. *Industrial Water Use and Treatment Practices.* UNIDO. London: Cassell Tycooly.

Carr, J. E., E. B. Chase, R. W. Paulson, and D. W. Moody (compilers) - United States Geological Survey. 1990. *National Water Summary 1987--Hydrologic Events and Water Supply and Use.* USGS Water-Supply Paper 2350. U.S. Government Printing Office.

Central Planning Bureau (CPB) of the Netherlands (Centraal Planbureau). 1992. *Scanning the Future, A long-term scenario study of the world economy 1990-2015.* The Hague: Sdu Publishers.

Gleick, P. H. 1993. *Water in Crisis: A Guide to the World's Fresh Water Resources.* New York: Oxford University Press.

Kousnetzoff, N. 1995. Head of Non-OECD Energy Statistics, Energy Statistics Division, International Energy Agency. Personal communication.

Nissan, E., and D. C. Williams, Jr. 1987. *County-level Projections for Industrial Water Demand in Mississippi.* Technical Completion Report, Project No. G1234-02. Water Resources Research Institute, Mississippi State University. Submitted to U.S. Department of the Interior. U.S. Department of Commerce, National Technical Information Service.

Raskin, P., and R. Margolis. 1995. *Global Energy in the 21st Century: Patterns, Projections and Problems.* POLESTAR Series Report No. 3. Stockholm, Sweden: Stockholm Environment Institute.

Raskin, P., E. Hansen, and R. Margolis. 1995. *Water and Sustainability: A Global Outlook.* POLESTAR Series Report No. 4. Stockholm, Sweden: Stockholm Environment Institute.

Saunders, R. J., and J. J. Warford. 1976. *Village Water Supply: Economic and Policy in the Developing World.* Baltimore, London: The Johns Hopkins University Press.

Software Toolworks, Inc. 1994. *The Software Toolworks World Atlas, Version 5.0.0.*

Strzepek, K. M., J. D. Niemann, L. Somlyódy, and S. Kulshreshtha. 1995. *A Global Assessment of National Water Resources Vulnerabilities: Sensitivities, Assumptions, and Driving Forces.* International Institute for Applied Systems Analysis (IIASA) Working Paper. Forthcoming. Laxenburg, Austria: IIASA.

United Nations. 1976. *The Demand for Water: Procedures and Methodologies for Projecting Water Demands in the Context of Regional and National Planning, Natural Resources.* Water Series No. 3, ST/ESA/38. New York: United Nations Publications.

United Nations. 1993. *Industrial Statistics Yearbook 1991.* Volume I: General Industrial Statistics. New York: United Nations.

UNIDO (United Nations Industrial Development Organization), Industrial Statistics Branch. 1993. *UNIDO Commodity Balance Statistics Database 1993.*

UNIDO, Industrial Statistics Branch. 1995a. *UNIDO Industrial Statistics Database 1995, 3-Digit Level of ISIC Code.*

UNIDO, Industrial Statistics Branch. 1995b. INDSTAT3 User's Guide. Vienna: UNIDO.

World Bank. 1992. *World Development Report 1992, Development and the Environment.* New York, Oxford: Oxford University Press.

World Resources Institute. 1992. *World Resources 1992-93. A Guide to the Global Environment. Toward Sustainable Development.* New York, Oxford: Oxford University Press.

APPENDICES

Appendix 1: *List of Classifications By Nation*

Appendix 2: *Industrial Water Use Forecasts By Nation*

Appendix 3: *Commercial Water Use Forecasts By Nation*

Appendix 4: *Biological Oxygen Demand (BOD) Forecasts By Nation*

Appendix 5: *Chemical Oxygen Demand (COD) Forecasts By Nation*

Appendix 6: *Suspended Solids (SS) Forecasts By Nation*

Appendix 7: *Total Dissolved Solids (TDS) Forecasts By Nation*

Appendix 8: *Water Use Forecasts for Water-Efficient Industrial Technology*

◆ ◆ ◆

Appendix 1

List of Classifications
By Nation

◆ ◆ ◆

Country	Region[1]				α	β
	used in CPB economic forecasts[2]	*IPCC electrical energy & CDS econ. forecasts*[3]	*used in commercial water forecasts*[4]	*IIASA electrical energy forecasts*[5]		
Afghanistan	Rest of Asia	ME	Asia	AF/SEA		
Albania	NME	EEur	EEur	SU/EE		2.00E-06
Algeria	Middle East	Africa	AMT	ME/NAf	0.45	2.00E-06
American Samoa						
Andorra			Europe			
Angola	Africa	Africa	Africa	AF/SEA		4.49E-04
Antigua and Barbuda	Latin America					
Argentina	Latin America	LA	CSA	LA	0.70	9.24E-05
Australia	NAM	OECDP	NAM	WE/JANZ	0.50	2.00E-06
Austria	Western Europe	WE	Europe	WE/JANZ	0.80	1.85E-05
Bahamas	Latin America			LA		
Bahrain	Middle East	ME		ME/NAf		3.09E-05
Bangladesh	Rest of Asia	SEA	SEA	AF/SEA	0.90	1.21E-05
Barbados	Latin America	LA				
Belgium	Western Europe	WE	Europe	WE/JANZ	0.80	6.36E-05
Belize	Latin America	LA	CSA	LA		
Benin	Africa	Africa	Africa	AF/SEA	0.90	2.61E-03
Bermuda	Latin America					
Bhutan			SEA			
Bolivia	Latin America	LA	CSA	LA	0.70	3.11E-05
Botswana	Africa	Africa	Africa	AF/SEA		
Brazil	Latin America	LA	CSA	LA	0.70	8.19E-05
British Virgin Islands	Latin America					
Brunei	Rest of Asia		WPac	AF/SEA		
Bulgaria	NME	EEur	EEur	SU/EE	1.20	1.37E-04
Burkina Faso	Africa	Africa	Africa			
Burma	Rest of Asia	SEA	SEA	AF/SEA		8.52E-05
Burundi	Africa	Africa	Africa	AF/SEA		
Cambodia	Rest of Asia	SEA	SEA	C/CPA		
Cameroon	Africa	Africa	Africa	AF/SEA	0.90	3.09E-04
Canada	NAM	NAM	NAM	NAM	0.63	1.90E-04
Cape Verde	Africa	Africa		AF/SEA		

Country	**Region**[1]				α	β
	used in CPB economic forecasts[2]	*IPCC electrical energy & CDS econ. forecasts*[3]	*used in commercial water forecasts*[4]	*IIASA electrical energy forecasts*[5]		
Central African Republic	Africa	Africa	Africa	AF/SEA		
Chad	Africa	Africa	Africa	AF/SEA		
Chile	Latin America	LA	CSA	LA	0.70	2.88E-06
China	Rest of Asia	China+	Asia	C/CPA	0.90	3.70E-05
Colombia	Latin America	LA	CSA	LA	0.70	4.64E-05
Comoros	Africa	Africa		AF/SEA		
Congo	Africa	Africa	Africa	AF/SEA	0.90	7.97E-04
Cook Islands	Rest of Asia					
Costa Rica	Latin America	LA	CSA	LA		
Cuba	Latin America	LA	CSA	LA	0.70	3.36E-06
Cyprus	Western Europe	ME	EMed	WE/JANZ	0.50	2.00E-06
Czechoslovakia	NME	EEur	EEur	SU/EE	1.20	3.18E-05
Denmark	Western Europe	WE	Europe	WE/JANZ	0.50	2.00E-06
Djibouti	Africa	Africa	Africa			
Dominica	Latin America					
Dominican Republic	Latin America	LA	CSA	LA		
Ecuador	Latin America	LA	CSA	LA	0.70	3.61E-05
Egypt	Middle East	Africa	Africa	ME/NAf	0.80	6.71E-05
El Salvador	Latin America	LA	CSA	LA		
Equatorial Guinea	Latin America	Africa	Africa			
Ethiopia	Africa	Africa	Africa	AF/SEA	0.90	4.89E-04
Falkland Islands			CSA			
Fiji	Rest of Asia	OECDP				
Finland	Western Europe	WE	Europe	WE/JANZ	0.76	3.03E-06
France	Western Europe	WE	Europe	WE/JANZ	0.80	4.00E-05
French Guiana	Latin America		CSA			
French Polynesia	Rest of Asia					
Gabon	Africa	Africa	Africa	AF/SEA	0.90	2.44E-05
Gambia	Africa	Africa	Africa	AF/SEA		
Germany East	Western Europe			SU/EE		
Germany West	Western Europe			WE/JANZ		
Germany	Western Europe	WE	Europe	WE/JANZ	0.80	2.75E-05

Country	**Region**[1]				α	β
	used in CPB economic forecasts[2]	*IPCC electrical energy & CDS econ. forecasts*[3]	*used in commercial water forecasts*[4]	*IIASA electrical energy forecasts*[5]		
Ghana	Africa	Africa		AF/SEA	0.90	1.66E-04
Greece	Western Europe	WE	Europe	WE/JANZ	0.80	3.44E-05
Greenland			Europe			
Grenada	Latin America					
Guadeloupe	Latin America			LA		
Guam	Rest of Asia					
Guatemala	Latin America	LA	CSA	LA	0.70	1.27E-04
Guinea	Africa	Africa	Africa	AF/SEA		
Guinea-Bissau	Africa	Africa	Africa	AF/SEA		
Guyana	Latin America	LA	CSA	LA		
Haiti	Latin America	LA	CSA	LA		
Honduras	Latin America	LA	CSA	LA		
Hong Kong	DAE			AF/SEA		
Hungary	NME	EEur	EEur	SU/EE	1.20	6.26E-05
Iceland	Western Europe	WE	Europe	WE/JANZ	0.80	3.15E-03
India	Rest of Asia	SEA	Asia	AF/SEA	0.90	4.65E-05
Indonesia	DAE	SEA	WPac	AF/SEA	1.00	2.49E-05
Iran	Middle East	ME	ME	ME/NAf	0.80	3.24E-05
Iraq	Middle East	ME	ME	ME/NAf	0.80	8.15E-05
Ireland	Western Europe	WE	Europe	WE/JANZ	0.66	2.00E-06
Israel	Middle East	ME	EMed	WE/JANZ	0.25	2.00E-06
Italy	Western Europe	WE	Europe	WE/JANZ	0.70	3.98E-05
Ivory Coast	Africa	Africa	Africa	AF/SEA		
Jamaica	Latin America	LA		LA	0.50	2.00E-06
Japan	Japan	OECDP	NAM	WE/JANZ	0.70	2.19E-06
Jordan	Middle East	ME	EMed	ME/NAf	0.50	2.00E-06
Kenya	Africa	Africa	Africa	AF/SEA	0.64	2.00E-06
Kiribati	Rest of Asia					
Kuwait	Middle East	ME	ME	ME/NAf	0.80	6.41E-06
Laos	Rest of Asia	China+	Asia	C/CPA		
Lebanon	Middle East	ME	EMed	ME/NAf		9.80E-06
Lesotho	Africa	Africa	Africa	AF/SEA		

Country	**Region**[1]				α	β
	used in CPB economic forecasts[2]	*IPCC electrical energy & CDS econ. forecasts*[3]	*used in commercial water forecasts*[4]	*IIASA electrical energy forecasts*[5]		
Liberia	Africa	Africa	Africa	AF/SEA		
Libya	Middle East	Africa	Africa	ME/NAf	0.80	1.57E-05
Liechtenstein			Europe			
Luxembourg	Western Europe	WE	Europe	WE/JANZ		
Macao				AF/SEA		
Madagascar	Africa	Africa	Africa	AF/SEA		
Malawi	Africa	Africa	Africa	AF/SEA		
Malaysia	DAE	SEA	WPac	AF/SEA	1.00	7.13E-05
Maldives	Rest of Asia					
Mali	Africa	Africa	Africa	AF/SEA		
Malta	Western Europe	WE		AF/SEA	0.50	2.00E-06
Martinique	Latin America			LA		
Mauritania	Africa	Africa	Africa	AF/SEA		
Mauritius	Africa	Africa		AF/SEA		
Mexico	Latin America	LA	CSA	LA	0.70	1.68E-05
Monaco			Europe			
Mongolia	Rest of Asia	China+	Asia	C/CPA		
Montserrat						
Morocco	Middle East	Africa	AMT	AF/SEA	0.80	1.47E-05
Mozambique	Africa	Africa	Africa	AF/SEA	0.90	3.95E-04
Namibia	Africa	Africa	Africa	AF/SEA		
Nauru	Rest of Asia					
Nepal	Rest of Asia	SEA	SEA	AF/SEA	0.90	5.04E-04
Netherlands	Western Europe	WE	Europe	WE/JANZ	0.80	7.11E-05
Netherlands Antilles				LA		
New Caledonia	Rest of Asia					
New Zealand	NAM	OECDP	NAM	WE/JANZ	0.50	2.00E-06
Nicaragua	Latin America	LA	CSA	LA		
Niger	Africa	Africa	Africa	AF/SEA		
Nigeria	Africa	Africa	Africa	AF/SEA	0.90	4.05E-05
North Korea	Rest of Asia	China+	Asia	C/CPA		1.04E-04
Norway	Western Europe	WE	Europe	WE/JANZ	0.80	7.77E-04

Country	**Region**[1]				α	β
	used in CPB economic forecasts[2]	*IPCC electrical energy & CDS econ. forecasts*[3]	*used in commercial water forecasts*[4]	*IIASA electrical energy forecasts*[5]		
Oman	Middle East	ME	ME	ME/NAf		
Pakistan	Rest of Asia	SEA		AF/SEA	0.90	3.60E-05
Palestine						
Panama	Latin America	LA	CSA	LA	0.70	2.70E-04
Papua New Guinea	Rest of Asia	SEA	WPac	AF/SEA		
Paraguay	Latin America	LA	CSA	LA	0.70	1.11E-03
Peru	Latin America	LA	CSA	LA	0.70	8.68E-05
Philippines	DAE	SEA	WPac	AF/SEA	1.00	3.20E-04
Poland	NME	EEur	EEur	SU/EE	1.20	5.05E-05
Portugal	Western Europe	WE	Europe	WE/JANZ	0.80	1.35E-04
Puerto Rico	Latin America			LA		
Qatar	Middle East	ME	ME	ME/NAf	0.46	2.00E-06
Reunion	Africa			AF/SEA		
Romania	NME	EEur	EEur	SU/EE	1.20	1.47E-04
Rwanda	Africa	Africa	Africa	AF/SEA		
Samoa						
Sao Tome and Principe	Africa					
Saudi Arabia	Middle East	ME	ME	ME/NAf	0.50	2.00E-06
Senegal	Africa	Africa	Africa	AF/SEA	0.90	1.15E-05
Seychelles	Africa					
Sierra Leone	Africa	Africa	Africa	AF/SEA		
Singapore	DAE	SEA		AF/SEA	0.50	2.00E-06
Solomon Islands	Rest of Asia	OECDP				
Somalia	Africa	Africa	Africa	AF/SEA		
South Africa	NAM	Africa	Africa	WE/JANZ	0.25	2.00E-06
South Korea	DAE	SEA	Asia	AF/SEA	0.50	2.00E-06
Spain	Western Europe	WE	Europe	WE/JANZ	0.80	4.86E-05
Sri Lanka	Rest of Asia	SEA	Asia	AF/SEA	0.90	1.49E-04
St. Kitts-Nevis	Latin America					
St. Lucia	Latin America					
St. Vincent/Grenadines	Latin America					
Sudan	Africa	Africa	Africa	AF/SEA	0.50	2.00E-06

Country	Region[1]				α	β
	used in CPB economic forecasts[2]	*IPCC electrical energy & CDS econ. forecasts*[3]	*used in commercial water forecasts*[4]	*IIASA electrical energy forecasts*[5]		
Suriname	Latin America	LA	CSA	LA		
Swaziland	Africa	Africa	Africa	AF/SEA		
Sweden	Western Europe	WE	Europe	WE/JANZ	0.67	2.00E-06
Switzerland	Western Europe	WE	Europe	WE/JANZ		9.33E-05
Syria	Middle East	ME	EMed	ME/NAf	0.80	1.65E-05
Taiwan	DAE		WPac	AF/SEA		
Tanzania	Africa	Africa	Africa	AF/SEA		
Thailand	DAE	SEA	SEA	AF/SEA	1.00	2.12E-05
Togo	Africa	Africa	Africa	AF/SEA		
Tonga	Rest of Asia					
Trinidad and Tobago	Latin America	LA		LA	0.70	4.56E-06
Tunisia	Middle East	Africa	Africa	AF/SEA	0.80	9.51E-06
Turkey	Western Europe	WE	AMT	WE/JANZ	0.80	2.47E-05
U.S. Virgin Islands	Latin America					
Uganda	Africa	Africa	Africa	AF/SEA		
United Arab Emirates	Middle East	ME		ME/NAf	0.80	2.34E-06
United Kingdom	Western Europe	WE	Europe	WE/JANZ	0.80	3.46E-05
United States	NAM	NAM	NAM	NAM	0.55	7.74E-05
Uruguay	Latin America	LA	CSA	LA	0.50	2.00E-06
USSR	NME	USSR	Asia	SU/EE	1.20	6.06E-05
Venezuela	Latin America	LA	CSA	LA	0.48	2.00E-06
Vietnam	Rest of Asia	China+	SEA	C/CPA		2.07E-04
West Bank			EMed			
Western Sahara	Middle East		Africa	AF/SEA		
Yemen South				ME/NAf		
Yemen North				ME/NAf		
Yemen	Middle East	ME	ME	ME/NAf	0.80	3.08E-05
Yugoslavia	Western Europe	WE	EEur	WE/JANZ	0.80	7.36E-05
Zaire	Africa	Africa	Africa	AF/SEA	0.90	1.03E-03
Zambia	Africa	Africa	Africa	AF/SEA	0.83	2.00E-06
Zimbabwe	Africa	Africa	Africa	AF/SEA	0.50	2.00E-06

NOTES:
[1] AF/SEA = Africa and South/SE Asia
AMT = Algeria, Morocco, and Turkey
C/CPA = China and Centrally Planned Asian Economies
China+ = China, North Korea, Laos, Mongolia, and Vietnam
CSA = Central and South America
DAE = Dynamic Asian Economies
EEur = Eastern Europe
EMed = Eastern Mediterranean
LA = Latin America
ME = Middle East
ME/NAf = Middle East and Northern Africa
NAM = North America
NME = New Market Economies
OECDP = OECD Pacific
SEA = Southeast Asia (or South and East Asia for Raskin *et al.* scenarios)
SU/EE = Soviet Union and Eastern Europe
WE = Western Europe
WE/JANZ = Western Europe, Japan, Australia, New Zealand, and South Africa
WPac = Western Pacific
[2] CPB, 1992
[3] Raskin *et al.*, 1995
[4] Saunders and Warford, 1976
[5] Anderer *et al.*, 1981

◆ ◆ ◆

Appendix 2

Industrial Water Use Forecasts By Nation

◆ ◆ ◆

Industrial Water Use

Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Afghanistan										
Albania										
Algeria	3.6	3.5	3.3	2.6	4.1	4.4	4.3	4.0	3.1	5.0
American Samoa										
Angola										
Antigua and Barbuda										
Argentina	3.5	3.1	4.2	3.2	3.2	3.5	3.1	4.2	3.2	3.0
Australia	3.1	1.9	2.7	2.0	2.2	2.9	1.8	2.6	1.9	2.1
Austria	2.2	2.8	3.1	2.2	4.6	1.5	1.9	2.1	1.6	1.7
Bahamas										
Bahrain										
Bangladesh	6.1	4.0	5.4	3.5	2.2	6.1	4.0	5.5	3.6	2.2
Barbados										
Belgium	3.1	3.4	3.5	3.1	4.2	2.8	2.9	3.0	2.8	2.8
Belize										
Benin	3.8	4.0	4.2	3.7	4.0	3.9	4.1	4.4	3.8	4.2
Bermuda										
Bolivia	3.8	3.0	4.8	3.2	3.1	3.5	2.8	4.4	3.0	2.6
Botswana										
Brazil	4.2	2.7	6.1	3.1	3.1	4.0	2.6	5.9	3.0	2.3
British Virgin Islands										
Brunei										
Bulgaria	4.5	4.7	4.7	4.5	5.2	4.5	4.6	4.7	4.5	4.9
Burkina Faso										
Burma										
Burundi										
Cambodia										
Cameroon	3.1	4.0	4.9	2.9	4.1	3.6	4.7	6.0	3.3	4.9
Canada	2.4	2.2	2.3	2.2	2.2	2.5	2.2	2.4	2.2	2.3
Cape Verde										
Central African Republic										
Chad										

Industrial Water Use

Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Chile	4.3	2.6	6.7	3.1	3.0	4.1	2.5	6.3	2.9	2.1
China	6.2	5.1	5.9	4.9	5.3	6.9	5.5	6.5	5.3	5.8
Colombia	3.8	3.0	4.9	3.2	3.1	4.0	3.1	5.2	3.3	2.9
Comoros										
Congo	3.0	4.0	5.0	2.7	4.1					
Cook Islands										
Costa Rica										
Cuba	4.1	2.8	5.9	3.1						
Cyprus	2.3	2.8	3.1	2.3		2.4	3.0	3.3	2.4	2.4
Czechoslovakia	3.6	4.0	4.1	3.6	5.4	3.6	4.0	4.1	3.6	4.8
Denmark	2.1	2.8	3.1	2.2	4.6	1.7	2.1	2.4	1.7	1.9
Djibouti										
Dominica										
Dominican Republic										
Ecuador	3.9	2.9	5.2	3.2	3.1	4.1	3.1	5.6	3.4	2.9
Egypt	3.9	3.9	3.9	3.8	4.0					
El Salvador										
Equatorial Guinea										
Ethiopia	3.6	4.0	4.4	3.4	4.0	3.8	4.3	4.9	3.7	4.4
Fiji										
Finland	2.1	2.7	3.1	2.1	4.6	1.3	1.7	1.9	1.4	1.5
France	3.0	3.3	3.5	3.0	4.2	2.7	2.9	3.0	2.7	2.8
French Guiana										
French Polynesia										
Gabon	3.2	4.0	4.8	3.0	4.0	3.6	4.6	5.7	3.4	4.7
Gambia										
Germany	2.7	3.1	3.4	2.7	4.3	2.3	2.6	2.7	2.3	2.4
Ghana	2.9	4.0	5.1	2.7	4.1	3.3	4.5	5.9	3.0	4.7
Greece	3.1	3.4	3.5	3.1	4.2	2.9	3.1	3.2	2.9	3.1
Grenada										
Guadeloupe										
Guam										

Industrial Water Use
Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Guatemala	3.6	3.1	4.2	3.2	3.2	3.6	3.1	4.2	3.2	3.0
Guinea										
Guinea-Bissau										
Guyana										
Haiti										
Honduras										
Hong Kong										
Hungary	3.7	4.1	4.2	3.8	5.3	3.7	4.1	4.2	3.7	4.4
Iceland	2.6	3.0	3.3	2.6		2.2	2.6	2.8	2.3	2.4
India	3.7	2.9	3.4	2.7	2.2	3.5	2.8	3.3	2.6	2.2
Indonesia	7.2	5.3	6.6	4.1	2.2					
Iran	3.6	3.5	3.3	2.8	3.9	3.5	3.4	3.3	2.8	3.0
Iraq	3.7	3.7	3.7	3.6						
Ireland	2.0	2.7	3.1	2.1	4.6	1.5	1.9	2.2	1.5	1.8
Israel	3.5	3.4	3.2	2.4	4.0	3.6	3.5	3.3	2.5	2.8
Italy	2.8	3.2	3.4	2.8	4.3	2.5	2.7	2.8	2.5	2.6
Ivory Coast										
Jamaica	4.2	2.7	6.4	3.1	3.0	4.3	2.7	6.4	3.1	2.7
Japan	4.3	3.5	2.9	2.8	2.2	4.2	3.4	2.8	2.7	2.2
Jordan	3.5	3.4	3.1	2.2	4.0	3.5	3.3	3.1	2.2	3.2
Kenya	2.7	3.9	5.3	2.4	4.1					
Kiribati										
Kuwait	3.6	3.6	3.5	3.2	3.8					
Laos										
Lebanon										
Lesotho										
Liberia										
Libya	4.0	3.9	3.9	3.9		4.0	4.0	4.0	3.9	4.1
Luxembourg										
Macao										
Madagascar										
Malawi										

Industrial Water Use

Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Malaysia	5.6	4.4	5.2	3.5	2.2	5.4	4.2	5.0	3.4	2.2
Maldives										
Mali										
Malta	2.5	3.0	3.3	2.5		2.5	2.9	3.2	2.5	2.4
Martinique										
Mauritania										
Mauritius										
Mexico	4.0	2.8	5.6	3.2	3.1	4.0	2.8	5.6	3.1	2.6
Mongolia										
Montserrat										
Morocco	3.7	3.6	3.4	2.8	4.0					
Mozambique	3.9	4.0	4.0	3.9	4.0	4.0	4.0	4.1	4.0	4.0
Namibia										
Nauru										
Nepal	4.8	3.4	4.4	3.1	2.2	4.5	3.2	4.2	3.0	2.2
Netherlands	3.1	3.4	3.5	3.1	4.2	2.9	3.0	3.1	2.9	2.9
Netherlands Antilles										
New Caledonia										
New Zealand	3.2	1.9	2.8	1.9	2.2	3.7	2.2	3.2	2.2	2.6
Nicaragua										
Niger										
Nigeria	3.4	4.0	4.6	3.2	4.0	3.8	4.6	5.5	3.6	4.7
North Korea										
Norway	2.4	2.9	3.2	2.4	4.5	1.9	2.2	2.4	1.9	2.2
Oman										
Pakistan	4.0	3.0	3.7	2.8	2.2	3.9	3.0	3.6	2.8	2.2
Palestine										
Panama	3.5	3.1	4.0	3.2	3.2					
Papua New Guinea										
Paraguay	3.3	3.2	3.5	3.2	3.2	3.3	3.2	3.5	3.2	3.2
Peru	3.8	2.9	5.1	3.2	3.1	3.8	2.9	5.1	3.2	2.7
Philippines	3.6	3.1	3.4	2.7	2.2	3.6	3.1	3.4	2.7	2.2

Industrial Water Use

Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Poland	3.7	4.1	4.2	3.7	5.4	3.6	4.0	4.1	3.7	4.7
Portugal	3.6	3.7	3.7	3.6	4.0					
Puerto Rico										
Qatar	3.5	3.4	3.2	2.4		3.3	3.2	3.0	2.3	2.3
Reunion										
Romania	4.1	4.3	4.4	4.1	5.3	4.0	4.3	4.4	4.1	4.8
Rwanda										
Samoa										
Sao Tome and Principe										
Saudi Arabia	3.5	3.5	3.3	2.6	3.9	3.5	3.5	3.3	2.6	2.8
Senegal	3.0	4.0	5.0	2.7	4.1	3.5	4.6	6.0	3.1	4.8
Seychelles										
Sierra Leone										
Singapore	10.8	7.6	9.8	5.4	2.2	11.1	7.8	10.1	5.6	2.3
Solomon Islands										
Somalia										
South Africa	3.3	2.1	2.9	2.1	4.1	3.5	2.2	3.1	2.2	4.3
South Korea	11.2	7.8	10.1	5.6	2.2	10.6	7.4	9.6	5.3	2.1
Spain	3.0	3.3	3.5	3.0	4.2	2.7	2.9	3.0	2.7	2.9
Sri Lanka	3.9	3.0	3.6	2.8	2.2	3.9	3.0	3.6	2.8	2.2
St. Kitts-Nevis										
St. Lucia										
St. Vincent and the Grenadi										
Sudan	2.9	4.0	5.1	2.7		3.6	4.9	6.3	3.2	5.0
Suriname										
Swaziland										
Sweden	2.1	2.7	3.1	2.1	4.6	1.3	1.7	1.9	1.3	1.5
Switzerland										
Syria	3.6	3.5	3.4	3.0	3.9	3.6	3.5	3.4	3.0	3.1
Taiwan										
Tanzania										
Thailand	6.2	4.7	5.7	3.7	2.2	6.1	4.7	5.7	3.7	2.2

Industrial Water Use

Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Togo										
Tonga										
Trinidad and Tobago	4.0	2.8	5.7	3.1	3.1	4.2	2.9	5.9	3.3	2.9
Tunisia	3.6	3.6	3.4	2.7	4.0	4.4	4.3	4.0	3.2	5.0
Turkey	2.6	3.0	3.3	2.6	4.4	2.3	2.6	2.8	2.3	2.8
U.S. Virgin Islands										
Uganda										
United Arab Emirates	3.6	3.5	3.4	2.9	3.9	3.3	3.2	3.1	2.7	2.8
United Kingdom	2.9	3.2	3.4	2.9	4.3	2.5	2.8	2.9	2.5	2.7
United States	2.4	2.2	2.3	2.2	2.2	2.4	2.2	2.4	2.2	2.3
Uruguay	4.3	2.6	6.6	3.1	3.0	4.8	2.9	7.3	3.4	2.5
USSR	2.0	2.2	2.3	2.0		2.1	2.5	2.6	2.1	2.8
Venezuela	4.3	2.7	6.4	3.1	3.0	4.1	2.6	6.1	3.0	2.2
Vietnam										
Western Sahara										
Yemen	3.7	3.7	3.6	3.5	3.7					
Yugoslavia	3.2	3.4	3.5	3.2	4.1	3.0	3.1	3.2	3.0	3.3
Zaire	3.9	4.0	4.0	3.9	4.0					
Zambia	2.7	3.9	5.3	2.4	4.1	3.6	5.2	7.0	3.1	5.4
Zimbabwe	2.8	3.9	5.2	2.5	4.1	3.0	4.2	5.6	2.7	4.4

Appendix 3

Commercial Water Use Forecasts By Nation

Commercial Water Use

Ratio of forecast (2025) to base (1990) values

Country	Global Shift	EU Renaissance	Global Balance	Global Crisis	CDS
Afghanistan					
Albania					
Algeria	4.0	3.9	3.5	2.3	4.8
Andorra					
Angola	3.2	4.6	6.2	2.8	4.8
Argentina	5.0	3.0	7.8	3.6	3.5
Australia	3.7	2.2	3.3	2.2	2.6
Austria	2.1	2.8	3.2	2.1	5.0
Bangladesh					
Belgium	2.1	2.8	3.2	2.1	5.0
Belize					
Benin	3.2	4.6	6.2	2.8	4.8
Bhutan					
Bolivia					
Botswana	3.2	4.6	6.2	2.8	4.8
Brazil	5.0	3.0	7.8	3.6	3.5
Brunei					
Bulgaria	1.2	2.6	2.9	1.3	6.8
Burkina Faso					
Burma					
Burundi	3.2	4.6	6.2	2.8	4.8
Cambodia					
Cameroon	3.2	4.6	6.2	2.8	4.8
Canada	3.7	2.2	3.3	2.2	2.6
Central African Republic					
Chad	3.2	4.6	6.2	2.8	4.8
Chile	5.0	3.0	7.8	3.6	3.5
China	13.0	7.7	11.4	6.6	8.5
Colombia	5.0	3.0	7.8	3.6	3.5
Congo	3.2	4.6	6.2	2.8	4.8
Costa Rica					
Cuba	5.0	3.0	7.8	3.6	
Cyprus					
Czechoslovakia	1.2	2.6	2.9	1.3	6.8
Denmark	2.1	2.8	3.2	2.1	5.0
Djibouti					
Dominican Republic	5.0	3.0	7.8	3.6	3.5
Ecuador	5.0	3.0	7.8	3.6	3.5
Egypt	4.0	3.9	3.5	2.3	4.8
El Salvador	5.0	3.0	7.8	3.6	3.5
Equatorial Guinea	3.2	4.6	6.2	2.8	
Ethiopia	3.2	4.6	6.2	2.8	4.8
Falkland Islands					
Finland	2.1	2.8	3.2	2.1	5.0
France	2.1	2.8	3.2	2.1	5.0
French Guiana					

Commercial Water Use

Ratio of forecast (2025) to base (1990) values

Country	Global Shift	EU Renaissance	Global Balance	Global Crisis	CDS
Gabon	3.2	4.6	6.2	2.8	4.8
Gambia					
Germany					
Greece	2.1	2.8	3.2	2.1	5.0
Greenland					
Guatemala					
Guinea	3.2	4.6	6.2	2.8	4.8
Guinea-Bissau					
Guyana	5.0	3.0	7.8	3.6	
Haiti					
Honduras					
Hungary					
Iceland	2.1	2.8	3.2	2.1	
India					
Indonesia	13.6	9.5	12.3	6.7	2.6
Iran	4.0	3.9	3.5	2.3	4.7
Iraq	4.0	3.9	3.5	2.3	
Ireland	2.1	2.8	3.2	2.1	5.0
Israel	4.0	3.9	3.5	2.3	4.7
Italy					
Ivory Coast	3.2	4.6	6.2	2.8	4.8
Japan	5.0	4.1	3.4	3.3	2.6
Jordan	4.0	3.9	3.5	2.3	4.7
Kenya	3.2	4.6	6.2	2.8	4.8
Kuwait					
Laos	13.0	7.7	11.4	6.6	8.5
Lebanon					
Lesotho	3.2	4.6	6.2	2.8	4.8
Liberia	3.2	4.6	6.2	2.8	
Libya					
Liechtenstein					
Luxembourg	2.1	2.8	3.2	2.1	
Madagascar					
Malawi	3.2	4.6	6.2	2.8	4.8
Malaysia	13.6	9.5	12.3	6.7	2.6
Mali	3.2	4.6	6.2	2.8	4.8
Mauritania	3.2	4.6	6.2	2.8	4.8
Mexico	5.0	3.0	7.8	3.6	3.5
Monaco					
Mongolia					
Morocco	4.0	3.9	3.5	2.3	4.8
Mozambique	3.2	4.6	6.2	2.8	4.8
Namibia					
Nepal					
Netherlands	2.1	2.8	3.2	2.1	5.0
New Zealand	3.7	2.2	3.3	2.2	2.6

Commercial Water Use

Ratio of forecast (2025) to base (1990) values

Country	Global Shift	EU Renaissance	Global Balance	Global Crisis	CDS
Nicaragua	5.0	3.0	7.8	3.6	
Niger	3.2	4.6	6.2	2.8	4.8
Nigeria	3.2	4.6	6.2	2.8	4.8
North Korea	13.0	7.7	11.4	6.6	
Norway	2.1	2.8	3.2	2.1	5.0
Oman					
Panama	5.0	3.0	7.8	3.6	3.5
Papua New Guinea					
Paraguay	5.0	3.0	7.8	3.6	3.5
Peru	5.0	3.0	7.8	3.6	3.5
Philippines	13.6	9.5	12.3	6.7	2.6
Poland	1.2	2.6	2.9	1.3	6.8
Portugal	2.1	2.8	3.2	2.1	5.0
Qatar					
Romania	1.2	2.6	2.9	1.3	6.8
Rwanda	3.2	4.6	6.2	2.8	4.8
Saudi Arabia					
Senegal	3.2	4.6	6.2	2.8	4.8
Sierra Leone	3.2	4.6	6.2	2.8	4.8
Somalia					
South Africa	3.8	2.2	3.3	2.2	4.8
South Korea					
Spain	2.1	2.8	3.2	2.1	5.0
Sri Lanka					
Sudan	3.2	4.6	6.2	2.8	
Suriname	5.0	3.0	7.8	3.6	
Swaziland	3.2	4.6	6.2	2.8	
Sweden	2.1	2.8	3.2	2.1	5.0
Switzerland	2.1	2.8	3.2	2.1	5.0
Syria	4.0	3.9	3.5	2.3	4.7
Taiwan					
Tanzania	3.2	4.6	6.2	2.8	4.8
Thailand	13.6	9.5	12.3	6.7	2.6
Togo	3.2	4.6	6.2	2.8	4.8
Tunisia	4.0	3.9	3.5	2.3	4.8
Turkey	2.1	2.8	3.2	2.1	5.0
Uganda	3.2	4.6	6.2	2.8	4.8
United Kingdom	2.1	2.8	3.2	2.1	5.0
United States	3.7	2.2	3.3	2.2	2.6
Uruguay					
USSR	1.3	2.6	3.0	1.4	
Venezuela	5.0	3.0	7.8	3.6	3.5
Vietnam	13.0	7.7	11.4	6.6	
West Bank					
Western Sahara					
Yemen					

Commercial Water Use Ratio of forecast (2025) to base (1990) values					
Country	Global Shift	EU Renaissance	Global Balance	Global Crisis	CDS
Yugoslavia	2.1	2.8	3.2	2.1	5.0
Zaire	3.2	4.6	6.2	2.8	4.8
Zambia	3.2	4.6	6.2	2.8	4.8
Zimbabwe	3.2	4.6	6.2	2.8	4.8

◆ ◆ ◆ ◆ ◆ ◆

Appendix 4

Biological Oxygen Demand (BOD) Forecasts By Nation

◆ ◆ ◆ ◆ ◆ ◆

Biological Oxygen Demand (BOD)

Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Afghanistan										
Albania										
Algeria	7.6	7.4	6.7	4.5	9.0	10.1	9.8	8.8	5.9	12.1
American Samoa										
Angola										
Antigua and Barbuda										
Argentina	6.2	3.8	9.6	4.4	4.3	6.2	3.8	9.6	4.4	3.2
Australia	6.4	3.7	5.6	3.8	4.4	6.0	3.5	5.2	3.6	4.1
Austria	2.4	3.3	3.8	2.5	5.8	1.5	2.1	2.4	1.5	1.7
Bahamas										
Bahrain										
Bangladesh	10.1	5.9	8.8	5.1	2.5	10.1	6.0	8.9	5.1	2.5
Barbados										
Belgium	2.4	3.3	3.8	2.5	5.8	1.4	2.0	2.2	1.5	1.6
Belize										
Benin	3.0	4.4	5.9	2.6	4.5	3.7	5.4	7.3	3.3	5.7
Bermuda										
Bolivia	6.2	3.8	9.6	4.4	4.3	5.3	3.2	8.2	3.8	2.7
Botswana										
Brazil	6.2	3.8	9.6	4.4	4.3	6.0	3.6	9.2	4.2	3.0
British Virgin Islands										
Brunei										
Bulgaria	0.9	1.9	2.1	1.0	4.9	0.9	1.8	2.0	0.9	1.8
Burkina Faso										
Burma										
Burundi										
Cambodia										
Cameroon	3.0	4.4	5.9	2.6	4.5	3.9	5.6	7.6	3.4	5.9
Canada	5.1	2.9	4.4	3.0	3.5	5.8	3.4	5.1	3.5	4.0
Cape Verde										
Central African Republic										
Chad										

Biological Oxygen Demand (BOD)

Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Chile	6.2	3.8	9.6	4.4	4.3	5.9	3.5	9.1	4.2	3.0
China	10.1	5.9	8.8	5.1	6.5	12.7	7.5	11.1	6.4	8.4
Colombia	6.2	3.8	9.6	4.4	4.3	6.7	4.1	10.4	4.8	3.4
Comoros										
Congo	3.0	4.4	5.9	2.6	4.5					
Cook Islands										
Costa Rica										
Cuba	6.2	3.8	9.6	4.4						
Cyprus	3.9	5.3	6.0	3.9		4.2	5.7	6.5	4.3	4.8
Czechoslovakia	0.9	1.9	2.1	1.0	4.9	0.8	1.7	1.9	0.9	1.7
Denmark	3.9	5.3	6.0	3.9	9.3	2.8	3.8	4.3	2.8	3.2
Djibouti										
Dominica										
Dominican Republic										
Ecuador	6.2	3.8	9.6	4.4	4.3	7.0	4.2	10.8	5.0	3.6
Egypt	4.3	4.2	3.8	2.5	5.1					
El Salvador										
Equatorial Guinea										
Ethiopia	3.0	4.4	5.9	2.6	4.5	3.9	5.6	7.6	3.4	5.9
Fiji										
Finland	2.5	3.5	4.0	2.6	6.1	1.5	2.0	2.3	1.5	1.7
France	2.4	3.3	3.8	2.5	5.8	1.5	2.1	2.4	1.6	1.8
French Guiana										
French Polynesia										
Gabon	3.0	4.4	5.9	2.6	4.5	3.8	5.5	7.4	3.3	5.8
Gambia										
Germany	2.4	3.3	3.8	2.5	5.8	1.5	2.0	2.3	1.5	1.7
Ghana	3.0	4.4	5.9	2.6	4.5	3.6	5.2	7.0	3.1	5.4
Greece	2.4	3.3	3.8	2.5	5.8	1.8	2.4	2.8	1.8	2.0
Grenada										
Guadeloupe										
Guam										

Biological Oxygen Demand (BOD)

Ratio of forecast (2025) to base (1990) values

	Standard Scenario					*Structural Shift Scenario*				
Country	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Guatemala	6.2	3.8	9.6	4.4	4.3	6.2	3.7	9.6	4.4	3.2
Guinea										
Guinea-Bissau										
Guyana										
Haiti										
Honduras										
Hong Kong										
Hungary	0.9	1.9	2.1	1.0	4.9	0.8	1.7	2.0	0.9	1.7
Iceland	2.4	3.3	3.8	2.5		1.8	2.5	2.8	1.8	2.1
India	10.0	5.9	8.8	5.1	2.5	9.0	5.3	7.9	4.5	2.2
Indonesia	11.8	8.2	10.7	5.8	2.2					
Iran	4.3	4.2	3.8	2.5	5.1	4.1	4.0	3.6	2.4	2.7
Iraq	4.3	4.2	3.8	2.5						
Ireland	2.9	4.0	4.6	3.0	7.1	2.0	2.7	3.1	2.0	2.3
Israel	13.8	13.3	12.0	8.0	16.3	14.5	14.0	12.6	8.4	9.3
Italy	2.8	3.7	4.3	2.8	6.6	1.7	2.4	2.7	1.8	2.0
Ivory Coast										
Jamaica	8.7	5.3	13.5	6.2	6.0	8.8	5.3	13.6	6.2	4.5
Japan	6.2	5.1	4.2	4.0	3.2	6.1	5.0	4.0	3.9	3.1
Jordan	6.9	6.7	6.0	4.0	8.2	6.8	6.6	5.9	4.0	4.4
Kenya	4.3	6.2	8.4	3.7	6.4					
Kiribati										
Kuwait	4.3	4.2	3.8	2.5	5.1					
Laos										
Lebanon										
Lesotho										
Liberia										
Libya	4.3	4.2	3.8	2.6		5.5	5.3	4.8	3.2	6.5
Luxembourg										
Macao										
Madagascar										
Malawi										

Biological Oxygen Demand (BOD)

Ratio of forecast (2025) to base (1990) values

	Standard Scenario					*Structural Shift Scenario*				
Country	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Malaysia	11.8	8.2	10.7	5.8	2.2	11.0	7.7	10.0	5.4	2.1
Maldives										
Mali										
Malta	3.9	5.3	6.0	3.9		3.7	5.0	5.8	3.8	4.3
Martinique										
Mauritania										
Mauritius										
Mexico	6.2	3.8	9.6	4.4	4.3	6.2	3.7	9.6	4.4	3.2
Mongolia										
Montserrat										
Morocco	4.3	4.2	3.8	2.5	5.1					
Mozambique	3.0	4.4	5.9	2.6	4.5	4.1	5.9	8.0	3.5	6.2
Namibia										
Nauru										
Nepal	10.1	5.9	8.8	5.1	2.5	9.3	5.4	8.1	4.7	2.3
Netherlands	2.4	3.3	3.8	2.5	5.8	1.5	2.1	2.4	1.5	1.8
Netherlands Antilles										
New Caledonia										
New Zealand	6.4	3.7	5.6	3.8	4.4	7.6	4.4	6.6	4.5	5.2
Nicaragua										
Niger										
Nigeria	3.0	4.4	5.9	2.6	4.5	4.1	5.9	8.0	3.5	6.2
North Korea										
Norway	2.4	3.3	3.8	2.5	5.8	1.5	2.1	2.4	1.5	1.7
Oman										
Pakistan	10.0	5.9	8.8	5.1	2.5	9.3	5.5	8.2	4.7	2.3
Palestine										
Panama	6.2	3.8	9.6	4.4	4.3					
Papua New Guinea										
Paraguay	6.2	3.8	9.6	4.4	4.3	6.1	3.7	9.4	4.3	3.1
Peru	6.2	3.8	9.6	4.4	4.3	6.2	3.7	9.5	4.4	3.2
Philippines	11.8	8.2	10.7	5.8	2.2	11.6	8.1	10.5	5.7	2.2

Biological Oxygen Demand (BOD)
Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Poland	0.9	1.9	2.1	1.0	4.9	0.8	1.6	1.8	0.9	1.6
Portugal	2.4	3.3	3.8	2.5	5.8					
Puerto Rico										
Qatar	7.5	7.2	6.5	4.4		6.7	6.5	5.9	3.9	4.4
Reunion										
Romania	0.9	1.9	2.1	1.0	4.9	0.8	1.7	1.9	0.9	1.7
Rwanda										
Samoa										
Sao Tome and Principe										
Saudi Arabia	6.9	6.6	6.0	4.0	8.1	6.9	6.6	6.0	4.0	4.4
Senegal	3.0	4.4	5.9	2.6	4.5	3.9	5.7	7.7	3.4	6.0
Seychelles										
Sierra Leone										
Singapore	23.5	16.4	21.3	11.6	4.4	24.3	16.9	22.0	11.9	4.6
Solomon Islands										
Somalia										
South Africa	12.9	7.5	11.2	7.6	16.3	17.7	10.3	15.5	10.5	22.7
South Korea	23.5	16.4	21.3	11.6	4.4	22.2	15.5	20.1	10.9	4.2
Spain	2.4	3.3	3.8	2.5	5.8	1.5	2.1	2.4	1.6	1.8
Sri Lanka	10.1	5.9	8.8	5.1	2.5	10.1	5.9	8.8	5.1	2.5
St. Kitts-Nevis										
St. Lucia										
St. Vincent/Grenadines										
Sudan	5.4	7.9	10.7	4.7		6.9	10.1	13.6	6.1	10.6
Suriname										
Swaziland										
Sweden	2.9	3.9	4.5	2.9	6.9	1.6	2.2	2.5	1.7	1.9
Switzerland										
Syria	4.3	4.2	3.8	2.5	5.1	4.2	4.1	3.7	2.5	2.7
Taiwan										
Tanzania										
Thailand	11.8	8.2	10.7	5.8	2.2	11.6	8.1	10.5	5.7	2.2

Biological Oxygen Demand (BOD)

Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Togo										
Tonga										
Trinidad and Tobago	6.2	3.8	9.6	4.4	4.3	6.9	4.2	10.6	4.9	3.5
Tunisia	4.3	4.2	3.8	2.5	5.1	5.7	5.6	5.0	3.3	6.9
Turkey	2.4	3.3	3.8	2.5	5.8	1.6	2.2	2.5	1.7	1.9
U.S. Virgin Islands										
Uganda										
United Arab Emirates	4.3	4.2	3.8	2.5	5.1	3.6	3.5	3.1	2.1	2.3
United Kingdom	2.4	3.3	3.8	2.5	5.8	1.5	2.1	2.4	1.5	1.7
United States	5.8	3.4	5.1	3.5	4.0	6.3	3.7	5.5	3.8	4.4
Uruguay	8.7	5.3	13.5	6.2	6.0	9.7	5.8	14.9	6.9	4.9
USSR	0.9	1.8	2.1	1.0		1.7	3.5	4.0	1.8	7.5
Venezuela	9.1	5.5	14.1	6.5	6.3	8.6	5.2	13.3	6.1	4.4
Vietnam										
Western Sahara										
Yemen	4.3	4.2	3.8	2.5	5.1					
Yugoslavia	2.4	3.3	3.8	2.5	5.8	1.5	2.1	2.4	1.5	1.7
Zaire	3.0	4.4	5.9	2.6	4.5					
Zambia	3.3	4.8	6.5	2.9	4.9	4.3	6.3	8.5	3.8	6.6
Zimbabwe	5.4	7.9	10.7	4.7	8.2	7.2	10.5	14.2	6.3	11.0

◆ ◆ ◆ ◆ ◆

Appendix 5

Chemical Oxygen Demand (COD) Forecasts By Nation

◆ ◆ ◆ ◆ ◆

Chemical Oxygen Demand (COD)

Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Afghanistan										
Albania										
Algeria	7.5	7.2	6.6	4.4	8.8	9.9	9.5	8.6	5.8	11.8
American Samoa										
Angola										
Antigua and Barbuda										
Argentina	6.2	3.8	9.6	4.4	4.3	6.2	3.8	9.6	4.4	3.2
Australia	6.3	3.7	5.5	3.8	4.4	5.9	3.4	5.1	3.5	4.1
Austria	2.4	3.3	3.8	2.5	5.8	1.5	2.1	2.4	1.5	1.8
Bahamas										
Bahrain										
Bangladesh	9.8	5.8	8.6	5.0	2.5	9.9	5.9	8.7	5.0	2.5
Barbados										
Belgium	2.4	3.3	3.8	2.5	5.8	1.5	2.0	2.3	1.5	1.7
Belize										
Benin	3.0	4.4	5.9	2.6	4.5	3.7	5.4	7.3	3.3	5.7
Bermuda										
Bolivia	6.2	3.8	9.6	4.4	4.3	5.3	3.2	8.1	3.8	2.7
Botswana										
Brazil	6.2	3.8	9.6	4.4	4.3	6.0	3.6	9.2	4.2	3.0
British Virgin Islands										
Brunei										
Bulgaria	1.1	2.0	2.3	1.2	4.9	1.1	1.9	2.2	1.1	1.9
Burkina Faso										
Burma										
Burundi										
Cambodia										
Cameroon	3.0	4.4	5.9	2.6	4.5	3.9	5.6	7.6	3.4	5.9
Canada	5.0	2.9	4.4	3.0	3.5	5.8	3.3	5.0	3.4	4.0
Cape Verde										
Central African Republic										
Chad										

Chemical Oxygen Demand (COD)

Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Chile	6.2	3.8	9.6	4.4	4.3	5.9	3.5	9.0	4.2	3.0
China	9.8	5.9	8.6	5.1	6.5	12.4	7.4	10.9	6.3	8.2
Colombia	6.2	3.8	9.6	4.4	4.3	6.7	4.1	10.3	4.8	3.4
Comoros										
Congo	3.0	4.4	5.9	2.6	4.5					
Cook Islands										
Costa Rica										
Cuba	6.2	3.7	9.5	4.4						
Cyprus	3.9	5.2	6.0	3.9		4.2	5.7	6.5	4.3	4.8
Czechoslovakia	1.3	2.1	2.4	1.3	4.9	1.2	2.0	2.2	1.2	2.0
Denmark	3.9	5.2	6.0	3.9	9.3	2.8	3.8	4.3	2.8	3.2
Djibouti										
Dominica										
Dominican Republic										
Ecuador	6.2	3.8	9.6	4.4	4.3	7.0	4.2	10.8	5.0	3.6
Egypt	4.3	4.2	3.8	2.6	5.0					
El Salvador										
Equatorial Guinea										
Ethiopia	3.0	4.4	5.9	2.6	4.5	3.9	5.6	7.6	3.4	5.9
Fiji										
Finland	2.6	3.5	4.0	2.6	6.1	1.5	2.0	2.3	1.5	1.7
France	2.4	3.3	3.8	2.5	5.8	1.6	2.1	2.4	1.6	1.8
French Guiana										
French Polynesia										
Gabon	3.0	4.4	5.9	2.6	4.5	3.8	5.5	7.4	3.3	5.8
Gambia										
Germany	2.4	3.3	3.8	2.5	5.8	1.5	2.1	2.4	1.6	1.8
Ghana	3.0	4.4	5.9	2.6	4.5	3.6	5.2	7.0	3.1	5.4
Greece	2.4	3.3	3.8	2.5	5.8	1.8	2.4	2.8	1.8	2.1
Grenada										
Guadeloupe										
Guam										

Chemical Oxygen Demand (COD)

Ratio of forecast (2025) to base (1990) values

	Standard Scenario					*Structural Shift Scenario*				
Country	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Guatemala	6.2	3.8	9.6	4.4	4.3	6.2	3.7	9.5	4.4	3.2
Guinea										
Guinea-Bissau										
Guyana										
Haiti										
Honduras										
Hong Kong										
Hungary	1.0	1.9	2.2	1.1	4.9	1.0	1.8	2.1	1.0	1.8
Iceland	2.4	3.3	3.8	2.5		1.8	2.5	2.8	1.8	2.1
India	9.6	5.7	8.5	4.9	2.4	8.6	5.1	7.6	4.4	2.2
Indonesia	11.6	8.1	10.5	5.7	2.2					
Iran	4.3	4.2	3.8	2.5	5.1	4.1	4.0	3.6	2.4	2.7
Iraq	4.3	4.1	3.8	2.6						
Ireland	2.9	4.0	4.5	3.0	7.0	2.0	2.7	3.1	2.0	2.3
Israel	13.5	13.1	11.8	7.9	16.0	14.2	13.7	12.4	8.3	9.2
Italy	2.8	3.7	4.3	2.8	6.6	1.8	2.4	2.7	1.8	2.0
Ivory Coast										
Jamaica	8.6	5.2	13.3	6.1	6.0	8.7	5.3	13.4	6.2	4.5
Japan	6.2	5.1	4.1	4.0	3.2	6.0	4.9	4.0	3.9	3.1
Jordan	6.8	6.6	5.9	4.0	8.0	6.7	6.5	5.9	4.0	4.4
Kenya	4.3	6.2	8.4	3.7	6.4					
Kiribati										
Kuwait	4.1	4.0	3.7	2.9	4.7					
Laos										
Lebanon										
Lesotho										
Liberia										
Libya	4.2	4.1	3.8	2.8		5.2	5.1	4.7	3.4	6.1
Luxembourg										
Macao										
Madagascar										
Malawi										

Chemical Oxygen Demand (COD)

Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Malaysia	11.6	8.1	10.5	5.7	2.2	10.9	7.6	9.9	5.4	2.1
Maldives										
Mali										
Malta	3.9	5.2	5.9	3.9		3.7	5.0	5.7	3.8	4.2
Martinique										
Mauritania										
Mauritius										
Mexico	6.2	3.7	9.5	4.4	4.3	6.2	3.7	9.5	4.4	3.2
Mongolia										
Montserrat										
Morocco	4.3	4.2	3.8	2.5	5.1					
Mozambique	3.0	4.4	5.9	2.7	4.5	4.1	5.9	7.9	3.6	6.1
Namibia										
Nauru										
Nepal	10.1	5.9	8.8	5.1	2.5	9.2	5.4	8.1	4.7	2.3
Netherlands	2.4	3.3	3.8	2.5	5.8	1.6	2.1	2.4	1.6	1.8
Netherlands Antilles										
New Caledonia										
New Zealand	6.4	3.7	5.6	3.8	4.4	7.6	4.4	6.6	4.5	5.2
Nicaragua										
Niger										
Nigeria	3.0	4.4	5.9	2.7	4.5	4.1	5.9	7.9	3.6	6.2
North Korea										
Norway	2.4	3.3	3.8	2.5	5.8	1.5	2.1	2.4	1.5	1.7
Oman										
Pakistan	9.7	5.8	8.5	4.9	2.5	9.0	5.3	7.9	4.6	2.3
Palestine										
Panama	6.2	3.8	9.6	4.4	4.3					
Papua New Guinea										
Paraguay	6.2	3.8	9.6	4.4	4.3	6.1	3.7	9.4	4.3	3.1
Peru	6.2	3.8	9.6	4.4	4.3	6.2	3.7	9.5	4.4	3.2
Philippines	11.6	8.1	10.6	5.7	2.2	11.5	8.0	10.4	5.7	2.2

Chemical Oxygen Demand (COD)

Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Poland	1.2	2.1	2.3	1.2	4.9	1.1	1.8	2.1	1.1	1.8
Portugal	2.4	3.3	3.8	2.5	5.8					
Puerto Rico										
Qatar	7.2	7.0	6.3	4.3		6.5	6.3	5.7	3.9	4.3
Reunion										
Romania	1.0	2.0	2.2	1.1	4.9	1.0	1.8	2.0	1.0	1.8
Rwanda										
Samoa										
Sao Tome and Principe										
Saudi Arabia	6.6	6.4	5.8	4.0	7.7	6.6	6.3	5.8	4.0	4.4
Senegal	3.0	4.4	5.9	2.6	4.5	3.9	5.7	7.7	3.4	6.0
Seychelles										
Sierra Leone										
Singapore	23.1	16.1	21.0	11.4	4.4	23.9	16.7	21.6	11.7	4.5
Solomon Islands										
Somalia										
South Africa	12.2	7.2	10.7	7.4	15.3	16.6	9.8	14.6	10.0	21.3
South Korea	23.2	16.2	21.0	11.4	4.4	21.9	15.3	19.8	10.8	4.2
Spain	2.4	3.3	3.8	2.5	5.8	1.6	2.1	2.4	1.6	1.8
Sri Lanka	10.0	5.9	8.8	5.0	2.5	10.0	5.9	8.8	5.0	2.5
St. Kitts-Nevis										
St. Lucia										
St. Vincent/Grenadines										
Sudan	5.4	7.8	10.6	4.7		6.9	10.0	13.5	6.0	10.5
Suriname										
Swaziland										
Sweden	2.9	3.9	4.5	2.9	6.8	1.7	2.3	2.6	1.7	1.9
Switzerland										
Syria	4.3	4.2	3.8	2.5	5.1	4.2	4.1	3.7	2.5	2.7
Taiwan										
Tanzania										
Thailand	11.6	8.1	10.5	5.7	2.2	11.5	8.0	10.4	5.6	2.2

Chemical Oxygen Demand (COD)

Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Togo										
Tonga										
Trinidad and Tobago	6.1	3.7	9.4	4.4	4.3	6.8	4.1	10.4	4.8	3.5
Tunisia	4.3	4.2	3.8	2.6	5.1	5.7	5.5	5.0	3.4	6.8
Turkey	2.4	3.3	3.8	2.5	5.8	1.7	2.2	2.6	1.7	1.9
U.S. Virgin Islands										
Uganda										
United Arab Emirates	4.1	4.0	3.7	2.9	4.7	3.6	3.5	3.3	2.6	2.7
United Kingdom	2.4	3.3	3.8	2.5	5.8	1.6	2.1	2.4	1.6	1.8
United States	5.7	3.4	5.0	3.4	4.0	6.2	3.6	5.4	3.7	4.3
Uruguay	8.7	5.3	13.4	6.2	6.0	9.7	5.8	14.9	6.9	4.9
USSR	1.0	1.9	2.1	1.0		1.7	3.5	3.9	1.9	7.2
Venezuela	9.0	5.5	13.9	6.4	6.2	8.6	5.2	13.2	6.1	4.4
Vietnam										
Western Sahara										
Yemen	4.3	4.1	3.8	2.6	5.0					
Yugoslavia	2.4	3.3	3.8	2.5	5.8	1.5	2.1	2.4	1.6	1.8
Zaire	3.0	4.4	5.9	2.6	4.5					
Zambia	3.3	4.8	6.5	2.9	4.9	4.3	6.3	8.5	3.8	6.6
Zimbabwe	5.4	7.7	10.4	4.7	8.0	7.1	10.2	13.7	6.2	10.7

◆◆◆◆◆

Appendix 6

Suspended Solids (SS) Forecasts
By Nation

◆◆◆◆◆

Suspended Solids (SS)
Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Afghanistan										
Albania										
Algeria	7.0	6.8	6.2	4.4	8.1	9.0	8.7	7.9	5.5	10.6
American Samoa										
Angola										
Antigua and Barbuda										
Argentina	6.1	3.7	9.3	4.4	4.2	6.1	3.7	9.3	4.4	3.2
Australia	5.9	3.5	5.2	3.6	4.1	5.5	3.3	4.8	3.4	3.9
Austria	2.4	3.3	3.8	2.5	5.8	1.6	2.1	2.4	1.6	1.8
Bahamas										
Bahrain										
Bangladesh	9.0	5.4	7.9	4.7	2.4	9.0	5.4	7.9	4.7	2.4
Barbados										
Belgium	2.5	3.3	3.8	2.5	5.7	1.6	2.1	2.3	1.6	1.8
Belize										
Benin	3.0	4.4	5.9	2.6	4.5	3.7	5.4	7.3	3.3	5.7
Bermuda										
Bolivia	6.0	3.7	9.2	4.3	4.2	5.2	3.2	7.8	3.7	2.7
Botswana										
Brazil	6.2	3.8	9.6	4.4	4.3	5.9	3.6	9.2	4.2	3.0
British Virgin Islands										
Brunei										
Bulgaria	1.8	2.5	2.8	1.8	4.9	1.8	2.5	2.7	1.8	2.5
Burkina Faso										
Burma										
Burundi										
Cambodia										
Cameroon	3.0	4.4	5.9	2.6	4.5	3.9	5.6	7.6	3.4	5.9
Canada	4.9	2.9	4.3	3.0	3.4	5.6	3.3	4.9	3.4	3.9
Cape Verde										
Central African Republic										
Chad										

Suspended Solids (SS)

Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Chile	6.2	3.7	9.5	4.4	4.3	5.8	3.5	9.0	4.2	3.0
China	9.0	5.7	8.0	5.1	6.2	11.1	7.0	9.8	6.1	7.7
Colombia	6.1	3.7	9.4	4.4	4.3	6.6	4.0	10.1	4.7	3.4
Comoros										
Congo	3.0	4.4	5.9	2.6	4.5					
Cook Islands										
Costa Rica										
Cuba	6.0	3.7	9.1	4.3						
Cyprus	3.8	5.1	5.8	3.9		4.1	5.5	6.2	4.2	4.7
Czechoslovakia	2.3	2.9	3.1	2.3	5.0	2.2	2.8	3.0	2.3	2.8
Denmark	3.9	5.2	5.9	3.9	9.0	2.8	3.8	4.3	2.9	3.2
Djibouti										
Dominica										
Dominican Republic										
Ecuador	6.1	3.7	9.4	4.4	4.3	6.9	4.2	10.6	4.9	3.6
Egypt	4.2	4.1	3.8	2.9	4.8					
El Salvador										
Equatorial Guinea										
Ethiopia	3.0	4.4	5.9	2.6	4.5	3.9	5.6	7.6	3.4	5.9
Fiji										
Finland	2.6	3.5	4.0	2.6	6.0	1.6	2.1	2.4	1.6	1.8
France	2.5	3.3	3.8	2.6	5.7	1.7	2.2	2.5	1.8	1.9
French Guiana										
French Polynesia										
Gabon	3.1	4.4	5.8	2.7	4.5	3.8	5.4	7.2	3.4	5.6
Gambia										
Germany	2.5	3.3	3.8	2.6	5.7	1.7	2.2	2.5	1.7	1.9
Ghana	3.0	4.4	5.9	2.6	4.5	3.6	5.2	7.0	3.1	5,4
Greece	2.5	3.3	3.8	2.6	5.7	2.0	2.5	2.9	2.0	2.2
Grenada										
Guadeloupe										
Guam										

Suspended Solids (SS) Ratio of forecast (2025) to base (1990) values										
	Standard Scenario					*Structural Shift Scenario*				
Country	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Guatemala	6.1	3.7	9.4	4.4	4.3	6.1	3.7	9.4	4.4	3.2
Guinea										
Guinea-Bissau										
Guyana										
Haiti										
Honduras										
Hong Kong										
Hungary	1.5	2.3	2.6	1.6	4.9	1.5	2.2	2.4	1.5	2.2
Iceland	2.4	3.3	3.8	2.5		1.8	2.5	2.8	1.8	2.1
India	8.1	5.0	7.1	4.3	2.4	7.3	4.5	6.4	3.9	2.2
Indonesia	10.8	7.6	9.8	5.4	2.2					
Iran	4.3	4.1	3.8	2.6	5.0	4.1	4.0	3.6	2.5	2.7
Iraq	4.1	4.0	3.7	2.9						
Ireland	3.0	4.0	4.5	3.0	6.9	2.1	2.7	3.1	2.1	2.3
Israel	12.8	12.3	11.2	7.6	15.0	13.4	12.9	11.7	8.0	8.8
Italy	2.8	3.8	4.3	2.9	6.5	1.9	2.5	2.8	1.9	2.1
Ivory Coast										
Jamaica	8.3	5.1	12.6	5.9	5.8	8.3	5.1	12.7	6.0	4.4
Japan	6.0	5.0	4.1	3.9	3.1	5.9	4.8	4.0	3.8	3.0
Jordan	6.4	6.2	5.6	4.0	7.4	6.3	6.1	5.6	3.9	4.3
Kenya	4.3	6.2	8.4	3.7	6.4					
Kiribati										
Kuwait	4.0	3.9	3.7	3.2	4.3					
Laos										
Lebanon										
Lesotho										
Liberia										
Libya	4.1	4.0	3.9	3.5		4.4	4.4	4.2	3.8	4.8
Luxembourg										
Macao										
Madagascar										
Malawi										

Suspended Solids (SS)

Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Malaysia	10.9	7.7	9.9	5.5	2.2	10.3	7.2	9.3	5.1	2.1
Maldives										
Mali										
Malta	3.9	5.0	5.7	3.9		3.7	4.9	5.5	3.8	4.2
Martinique										
Mauritania										
Mauritius										
Mexico	6.1	3.7	9.3	4.4	4.2	6.0	3.7	9.2	4.3	3.2
Mongolia										
Montserrat										
Morocco	4.3	4.1	3.8	2.7	5.0					
Mozambique	3.1	4.3	5.7	2.8	4.5	4.1	5.7	7.5	3.6	5.9
Namibia										
Nauru										
Nepal	10.0	5.9	8.8	5.0	2.5	9.2	5.4	8.1	4.6	2.3
Netherlands	2.5	3.3	3.8	2.5	5.7	1.6	2.2	2.4	1.7	1.9
Netherlands Antilles										
New Caledonia										
New Zealand	6.3	3.7	5.5	3.8	4.4	7.4	4.3	6.5	4.4	5.1
Nicaragua										
Niger										
Nigeria	3.1	4.4	5.8	2.7	4.5	4.1	5.8	7.8	3.6	6.1
North Korea										
Norway	2.4	3.3	3.8	2.5	5.8	1.5	2.1	2.4	1.5	1.7
Oman										
Pakistan	8.1	5.0	7.2	4.4	2.4	7.6	4.7	6.7	4.1	2.3
Palestine										
Panama	6.2	3.7	9.5	4.4	4.3					
Papua New Guinea										
Paraguay	6.2	3.8	9.6	4.4	4.3	6.1	3.7	9.4	4.3	3.1
Peru	6.2	3.7	9.5	4.4	4.3	6.1	3.7	9.4	4.4	3.2
Philippines	11.2	7.8	10.1	5.6	2.2	11.0	7.7	10.0	5.5	2.2

Suspended Solids (SS)

Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Poland	2.0	2.7	2.9	2.1	5.0	1.9	2.5	2.7	2.0	2.5
Portugal	2.5	3.3	3.8	2.5	5.7					
Puerto Rico										
Qatar	6.1	5.9	5.5	4.1		5.6	5.5	5.1	3.9	4.1
Reunion										
Romania	1.5	2.3	2.6	1.6	4.9	1.5	2.2	2.4	1.5	2.2
Rwanda										
Samoa										
Sao Tome and Principe										
Saudi Arabia	5.6	5.4	5.0	3.9	6.3	5.5	5.4	5.0	3.9	4.1
Senegal	3.1	4.4	5.8	2.7	4.5	3.9	5.6	7.6	3.5	5.9
Seychelles										
Sierra Leone										
Singapore	20.6	14.5	18.7	10.3	4.1	21.2	14.9	19.3	10.6	4.3
Solomon Islands										
Somalia										
South Africa	11.0	6.7	9.7	6.9	13.7	14.8	8.9	13.0	9.1	18.7
South Korea	21.8	15.2	19.8	10.8	4.2	20.5	14.4	18.6	10.2	4.0
Spain	2.5	3.3	3.8	2.5	5.7	1.7	2.2	2.5	1.7	1.9
Sri Lanka	9.7	5.8	8.6	4.9	2.5	9.7	5.8	8.6	4.9	2.5
St. Kitts-Nevis										
St. Lucia										
St. Vincent/Grenadines										
Sudan	5.3	7.6	10.2	4.7		6.8	9.7	13.0	5.9	10.1
Suriname										
Swaziland										
Sweden	2.9	3.9	4.4	3.0	6.7	1.8	2.3	2.6	1.8	2.0
Switzerland										
Syria	4.2	4.1	3.8	2.7	4.9	4.1	4.0	3.7	2.6	2.9
Taiwan										
Tanzania										
Thailand	10.7	7.5	9.7	5.4	2.2	10.6	7.5	9.6	5.3	2.2

Suspended Solids (SS)

Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Togo										
Tonga										
Trinidad and Tobago	5.6	3.7	8.3	4.2	4.1	6.1	4.0	9.1	4.6	3.5
Tunisia	4.3	4.1	3.8	2.7	5.0	5.5	5.4	4.9	3.4	6.5
Turkey	2.5	3.3	3.8	2.6	5.7	1.8	2.4	2.7	1.8	2.0
U.S. Virgin Islands										
Uganda										
United Arab Emirates	3.9	3.9	3.7	3.2	4.3	3.6	3.6	3.5	3.0	3.1
United Kingdom	2.5	3.3	3.8	2.6	5.7	1.7	2.2	2.5	1.7	1.9
United States	5.4	3.3	4.8	3.3	3.8	5.9	3.5	5.2	3.6	4.1
Uruguay	8.6	5.2	13.3	6.2	6.0	9.6	5.8	14.8	6.8	4.9
USSR	1.3	2.0	2.1	1.3		1.9	3.2	3.5	2.0	6.1
Venezuela	8.6	5.3	13.1	6.2	6.0	8.2	5.0	12.4	5.9	4.3
Vietnam										
Western Sahara										
Yemen	4.2	4.1	3.8	2.7	4.8					
Yugoslavia	2.6	3.3	3.8	2.6	5.6	1.7	2.2	2.5	1.8	1.9
Zaire	3.1	4.4	5.9	2.7	4.5					
Zambia	3.3	4.8	6.5	2.9	4.9	4.3	6.3	8.5	3.8	6.6
Zimbabwe	5.2	7.3	9.6	4.6	7.5	6.7	9.5	12.6	5.9	9.9

◆ ◆ ◆ ◆ ◆

Appendix 7

Total Dissolved Solids (TDS) Forecasts By Nation

◆ ◆ ◆ ◆ ◆

Total Dissolved Solids (TDS)

Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Afghanistan										
Albania										
Algeria	7.6	7.4	6.7	4.5	9.0	10.1	9.7	8.8	5.9	12.1
American Samoa										
Angola										
Antigua and Barbuda										
Argentina	6.2	3.8	9.6	4.4	4.3	6.2	3.8	9.6	4.4	3.2
Australia	6.4	3.7	5.6	3.8	4.4	6.0	3.5	5.2	3.5	4.1
Austria	2.4	3.3	3.8	2.5	5.8	1.5	2.1	2.4	1.5	1.7
Bahamas										
Bahrain										
Bangladesh	10.0	5.9	8.8	5.0	2.5	10.1	5.9	8.8	5.1	2.5
Barbados										
Belgium	2.4	3.3	3.8	2.5	5.8	1.4	2.0	2.2	1.5	1.7
Belize										
Benin	3.0	4.4	5.9	2.6	4.5	3.7	5.4	7.3	3.3	5.7
Bermuda										
Bolivia	6.2	3.8	9.6	4.4	4.3	5.3	3.2	8.2	3.8	2.7
Botswana										
Brazil	6.2	3.8	9.6	4.4	4.3	6.0	3.6	9.2	4.2	3.0
British Virgin Islands										
Brunei										
Bulgaria	1.0	1.9	2.2	1.0	4.9	0.9	1.8	2.0	1.0	1.8
Burkina Faso										
Burma										
Burundi										
Cambodia										
Cameroon	3.0	4.4	5.9	2.6	4.5	3.9	5.6	7.6	3.4	5.9
Canada	5.1	2.9	4.4	3.0	3.5	5.8	3.4	5.1	3.4	4.0
Cape Verde										
Central African Republic										
Chad										

Total Dissolved Solids (TDS)

Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Chile	6.2	3.8	9.6	4.4	4.3	5.9	3.5	9.1	4.2	3.0
China	10.0	5.9	8.7	5.1	6.5	12.6	7.4	11.0	6.4	8.3
Colombia	6.2	3.8	9.6	4.4	4.3	6.7	4.1	10.4	4.8	3.4
Comoros										
Congo	3.0	4.4	5.9	2.6	4.5					
Cook Islands										
Costa Rica										
Cuba	6.2	3.8	9.6	4.4						
Cyprus	3.9	5.2	6.0	3.9		4.2	5.7	6.5	4.3	4.8
Czechoslovakia	1.0	1.9	2.2	1.1	4.9	0.9	1.8	2.0	1.0	1.8
Denmark	3.9	5.3	6.0	3.9	9.3	2.8	3.8	4.3	2.8	3.2
Djibouti										
Dominica										
Dominican Republic										
Ecuador	6.2	3.8	9.6	4.4	4.3	7.0	4.2	10.8	5.0	3.6
Egypt	4.3	4.2	3.8	2.5	5.1					
El Salvador										
Equatorial Guinea										
Ethiopia	3.0	4.4	5.9	2.6	4.5	3.9	5.6	7.6	3.4	5.9
Fiji										
Finland	2.5	3.5	4.0	2.6	6.1	1.5	2.0	2.3	1.5	1.7
France	2.4	3.3	3.8	2.5	5.8	1.6	2.1	2.4	1.6	1.8
French Guiana										
French Polynesia										
Gabon	3.0	4.4	5.9	2.6	4.5	3.8	5.5	7.4	3.3	5.8
Gambia										
Germany	2.4	3.3	3.8	2.5	5.8	1.5	2.1	2.4	1.5	1.7
Ghana	3.0	4.4	5.9	2.6	4.5	3.6	5.2	7.0	3.1	5.4
Greece	2.4	3.3	3.8	2.5	5.8	1.8	2.4	2.8	1.8	2.1
Grenada										
Guadeloupe										
Guam										

Total Dissolved Solids (TDS)

Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Guatemala	6.2	3.8	9.6	4.4	4.3	6.2	3.7	9.5	4.4	3.2
Guinea										
Guinea-Bissau										
Guyana										
Haiti										
Honduras										
Hong Kong										
Hungary	0.9	1.9	2.1	1.0	4.9	0.9	1.7	2.0	0.9	1.7
Iceland	2.4	3.3	3.8	2.5		1.8	2.5	2.8	1.8	2.1
India	9.9	5.9	8.7	5.0	2.5	8.9	5.2	7.8	4.5	2.2
Indonesia	11.7	8.2	10.6	5.8	2.2					
Iran	4.3	4.2	3.8	2.5	5.1	4.1	4.0	3.6	2.4	2.7
Iraq	4.3	4.2	3.8	2.5						
Ireland	2.9	4.0	4.6	3.0	7.1	2.0	2.7	3.1	2.0	2.3
Israel	13.7	13.3	12.0	8.0	16.3	14.4	13.9	12.6	8.4	9.3
Italy	2.8	3.7	4.3	2.8	6.6	1.8	2.4	2.7	1.8	2.0
Ivory Coast										
Jamaica	8.7	5.2	13.4	6.2	6.0	8.8	5.3	13.5	6.2	4.5
Japan	6.2	5.1	4.2	4.0	3.2	6.1	4.9	4.0	3.9	3.1
Jordan	6.9	6.6	6.0	4.0	8.1	6.8	6.6	5.9	4.0	4.4
Kenya	4.3	6.2	8.4	3.7	6.4					
Kiribati										
Kuwait	4.3	4.1	3.8	2.6	5.0					
Laos										
Lebanon										
Lesotho										
Liberia										
Libya	4.3	4.1	3.8	2.7		5.3	5.2	4.7	3.3	6.3
Luxembourg										
Macao										
Madagascar										
Malawi										

Total Dissolved Solids (TDS)

Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Malaysia	11.7	8.2	10.6	5.8	2.2	11.0	7.7	10.0	5.4	2.1
Maldives										
Mali										
Malta	3.9	5.2	6.0	3.9		3.7	5.0	5.8	3.8	4.3
Martinique										
Mauritania										
Mauritius										
Mexico	6.2	3.8	9.6	4.4	4.3	6.2	3.7	9.6	4.4	3.2
Mongolia										
Montserrat										
Morocco	4.3	4.2	3.8	2.5	5.1					
Mozambique	3.0	4.4	5.9	2.6	4.5	4.1	5.9	7.9	3.5	6.2
Namibia										
Nauru										
Nepal	10.1	5.9	8.8	5.1	2.5	9.3	5.4	8.1	4.7	2.3
Netherlands	2.4	3.3	3.8	2.5	5.8	1.5	2.1	2.4	1.6	1.8
Netherlands Antilles										
New Caledonia										
New Zealand	6.4	3.7	5.6	3.8	4.4	7.6	4.4	6.6	4.5	5.2
Nicaragua										
Niger										
Nigeria	3.0	4.4	5.9	2.6	4.5	4.1	5.9	8.0	3.6	6.2
North Korea										
Norway	2.4	3.3	3.8	2.5	5.8	1.5	2.1	2.4	1.5	1.7
Oman										
Pakistan	9.9	5.9	8.7	5.0	2.5	9.2	5.4	8.1	4.6	2.3
Palestine										
Panama	6.2	3.8	9.6	4.4	4.3					
Papua New Guinea										
Paraguay	6.2	3.8	9.6	4.4	4.3	6.1	3.7	9.4	4.3	3.1
Peru	6.2	3.8	9.6	4.4	4.3	6.2	3.7	9.5	4.4	3.2
Philippines	11.7	8.2	10.6	5.8	2.2	11.6	8.1	10.5	5.7	2.2

Total Dissolved Solids (TDS)

Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Poland	1.0	1.9	2.2	1.1	4.9	0.9	1.7	1.9	0.9	1.7
Portugal	2.4	3.3	3.8	2.5	5.8					
Puerto Rico										
Qatar	7.1	6.9	6.3	4.3		6.5	6.3	5.7	3.9	4.3
Reunion										
Romania	1.0	1.9	2.2	1.0	4.9	0.9	1.7	2.0	0.9	1.7
Rwanda										
Samoa										
Sao Tome and Principe										
Saudi Arabia	6.7	6.5	5.9	4.0	7.9	6.7	6.5	5.9	4.0	4.4
Senegal	3.0	4.4	5.9	2.6	4.5	3.9	5.7	7.7	3.4	6.0
Seychelles										
Sierra Leone										
Singapore	23.3	16.3	21.1	11.5	4.4	24.0	16.8	21.8	11.8	4.6
Solomon Islands										
Somalia										
South Africa	12.7	7.4	11.1	7.6	16.1	17.5	10.2	15.3	10.4	22.5
South Korea	23.4	16.3	21.2	11.5	4.4	22.1	15.4	20.0	10.8	4.2
Spain	2.4	3.3	3.8	2.5	5.8	1.6	2.1	2.4	1.6	1.8
Sri Lanka	10.1	5.9	8.8	5.1	2.5	10.0	5.9	8.8	5.1	2.5
St. Kitts-Nevis										
St. Lucia										
St. Vincent/Grenadines										
Sudan	5.4	7.9	10.6	4.7		6.9	10.1	13.6	6.1	10.5
Suriname										
Swaziland										
Sweden	2.9	3.9	4.5	2.9	6.9	1.6	2.2	2.5	1.7	1.9
Switzerland										
Syria	4.3	4.2	3.8	2.5	5.1	4.2	4.1	3.7	2.5	2.7
Taiwan										#N/A
Tanzania										
Thailand	11.7	8.2	10.6	5.8	2.2	11.6	8.1	10.5	5.7	2.2

Total Dissolved Solids (TDS)

Ratio of forecast (2025) to base (1990) values

Country	*Standard Scenario*					*Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Togo										
Tonga										
Trinidad and Tobago	6.2	3.7	9.5	4.4	4.3	6.9	4.2	10.6	4.9	3.5
Tunisia	4.3	4.2	3.8	2.5	5.1	5.7	5.5	5.0	3.4	6.9
Turkey	2.4	3.3	3.8	2.5	5.8	1.6	2.2	2.6	1.7	1.9
U.S. Virgin Islands										
Uganda										
United Arab Emirates	4.3	4.1	3.8	2.6	5.0	3.6	3.5	3.2	2.2	2.4
United Kingdom	2.4	3.3	3.8	2.5	5.8	1.5	2.1	2.4	1.5	1.7
United States	5.8	3.4	5.1	3.5	4.0	6.3	3.7	5.5	3.8	4.4
Uruguay	8.7	5.3	13.5	6.2	6.0	9.7	5.8	14.9	6.9	4.9
USSR	0.9	1.9	2.1	1.0		1.7	3.5	4.0	1.9	7.4
Venezuela	9.1	5.5	14.0	6.5	6.3	8.6	5.2	13.3	6.1	4.4
Vietnam										
Western Sahara										
Yemen	4.3	4.2	3.8	2.5	5.1					
Yugoslavia	2.4	3.3	3.8	2.5	5.8	1.5	2.1	2.4	1.5	1.7
Zaire	3.0	4.4	5.9	2.6	4.5					
Zambia	3.3	4.8	6.5	2.9	4.9	4.3	6.3	8.5	3.8	6.6
Zimbabwe	5.4	7.8	10.6	4.7	8.1	7.2	10.4	14.1	6.3	10.9

◆◆◆

Appendix 8

Water Use Forecasts for Water-Efficient Industrial Technology

◆◆◆

Water-Efficient Technologies Industrial Water Use

Ratio of forecast (2025) to base (1990) values

Country	*Water-Efficient Scenario*					*Water-Efficient Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Afghanistan										
Albania										
Algeria	2.0	2.0	1.9	1.7	2.1	2.2	2.2	2.1	1.8	2.4
American Samoa										
Angola										
Antigua and Barbuda										
Argentina	2.7	2.6	2.9	2.6	2.6	2.7	2.6	2.8	2.6	2.5
Australia	1.2	0.8	1.1	0.8	0.9	1.1	0.8	1.0	0.8	0.8
Austria	0.9	1.1	1.2	1.0	1.6	0.8	0.9	1.0	0.8	0.8
Bahamas										
Bahrain										
Bangladesh	2.2	1.7	2.1	1.6	1.3	2.2	1.7	2.1	1.6	1.3
Barbados										
Belgium	2.5	2.6	2.7	2.5	2.8	2.5	2.5	2.5	2.5	2.5
Belize										
Benin	3.5	3.5	3.6	3.5	3.5	3.5	3.6	3.6	3.5	3.6
Bermuda										
Bolivia	2.4	2.2	2.8	2.2	2.2	2.3	2.1	2.6	2.2	2.1
Botswana										
Brazil	1.5	1.1	2.1	1.3	1.2	1.4	1.1	1.9	1.2	1.0
British Virgin Islands										
Brunei										
Bulgaria	4.4	4.4	4.5	4.4	4.6	4.4	4.4	4.5	4.4	4.6
Burkina Faso										
Burma										
Burundi										
Cambodia										
Cameroon	1.8	2.1	2.4	1.7	2.1	2.0	2.3	2.7	1.9	2.3
Canada	2.0	1.9	2.0	1.9	2.0	2.0	1.9	2.0	1.9	2.0
Cape Verde										
Central African Republic										
Chad										

Water-Efficient Technologies Industrial Water Use

Ratio of forecast (2025) to base (1990) values

Country	*Water-Efficient Scenario*					*Water-Efficient Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Chile	1.5	0.9	2.2	1.1	1.0	1.3	0.8	2.0	1.0	0.7
China	4.3	4.0	4.2	4.0	4.1	4.5	4.1	4.4	4.1	4.2
Colombia	2.2	2.0	2.5	2.1	2.0	2.2	2.0	2.5	2.1	2.0
Comoros										
Congo	1.7	2.1	2.5	1.6	2.1					
Cook Islands										
Costa Rica										
Cuba	1.8	1.4	2.3	1.5						
Cyprus	1.1	1.3	1.4	1.1		1.2	1.3	1.4	1.2	1.1
Czechoslovakia	3.4	3.5	3.6	3.4	4.0	3.3	3.5	3.5	3.4	3.8
Denmark	0.8	1.0	1.0	0.8	1.4	0.7	0.8	0.9	0.7	0.8
Djibouti										
Dominica										
Dominican Republic										
Ecuador	2.1	1.9	2.5	1.9	1.9	2.2	1.9	2.6	2.0	1.9
Egypt	3.7	3.7	3.7	3.6	3.7					
El Salvador										
Equatorial Guinea										
Ethiopia	2.9	3.0	3.1	2.9	3.0	3.0	3.1	3.3	2.9	3.1
Fiji										
Finland	0.8	1.0	1.1	0.8	1.5	0.6	0.7	0.8	0.6	0.7
France	2.4	2.5	2.5	2.4	2.7	2.3	2.4	2.4	2.3	2.3
French Guiana										
French Polynesia										
Gabon	2.0	2.2	2.4	1.9	2.2	2.1	2.3	2.6	2.0	2.4
Gambia										
Germany	1.9	2.0	2.0	1.9	2.3	1.8	1.8	1.9	1.8	1.8
Ghana	1.4	1.8	2.1	1.3	1.8	1.6	1.9	2.4	1.4	2.0
Greece	2.5	2.6	2.7	2.5	2.9	2.5	2.5	2.6	2.5	2.6
Grenada										
Guadeloupe										
Guam										

Water-Efficient Technologies Industrial Water Use

Ratio of forecast (2025) to base (1990) values

Country	*Water-Efficient Scenario*					*Water-Efficient Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Guatemala	2.7	2.5	2.8	2.6	2.6	2.6	2.5	2.8	2.6	2.5
Guinea										
Guinea-Bissau										
Guyana										
Haiti										
Honduras										
Hong Kong										
Hungary	3.5	3.6	3.7	3.5	4.0	3.5	3.6	3.6	3.5	3.8
Iceland	1.7	1.9	1.9	1.7		1.6	1.7	1.8	1.6	1.7
India	2.3	2.1	2.2	2.0	1.9	2.2	2.0	2.1	2.0	1.9
Indonesia	2.7	2.2	2.6	1.9	1.4					
Iran	2.3	2.2	2.2	2.0	2.4	2.2	2.2	2.2	2.0	2.1
Iraq	3.5	3.5	3.5	3.5						
Ireland	0.6	0.7	0.8	0.6	1.1	0.5	0.6	0.7	0.5	0.6
Israel	1.6	1.5	1.5	1.3	1.7	1.6	1.6	1.5	1.3	1.4
Italy	2.1	2.2	2.3	2.1	2.5	2.0	2.1	2.1	2.0	2.0
Ivory Coast										
Jamaica	1.7	1.2	2.5	1.3	1.3	1.7	1.2	2.5	1.3	1.2
Japan	1.2	1.0	0.9	0.8	0.7	1.1	1.0	0.8	0.8	0.6
Jordan	1.4	1.4	1.3	1.0	1.6	1.4	1.4	1.3	1.0	1.4
Kenya	0.7	1.1	1.4	0.6	1.1					
Kiribati										
Kuwait	3.0	3.0	3.0	2.8	3.1					
Laos										
Lebanon										
Lesotho										
Liberia										
Libya	3.8	3.8	3.8	3.8		3.8	3.8	3.8	3.8	3.8
Luxembourg										
Macao										
Madagascar										
Malawi										

Water-Efficient Technologies Industrial Water Use

Ratio of forecast (2025) to base (1990) values

Country	*Water-Efficient Scenario*					*Water-Efficient Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Malaysia	2.7	2.3	2.6	2.0	1.7	2.6	2.2	2.5	2.0	1.6
Maldives										
Mali										
Malta	1.6	1.7	1.8	1.6		1.6	1.7	1.8	1.6	1.5
Martinique										
Mauritania										
Mauritius										
Mexico	1.8	1.5	2.2	1.6	1.6	1.8	1.5	2.2	1.6	1.4
Mongolia										
Montserrat										
Morocco	2.0	2.0	1.9	1.8	2.1					
Mozambique	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
Namibia										
Nauru										
Nepal	2.3	1.9	2.2	1.9	1.6	2.2	1.9	2.1	1.8	1.6
Netherlands	2.6	2.6	2.6	2.6	2.8	2.5	2.5	2.6	2.5	2.5
Netherlands Antilles										
New Caledonia										
New Zealand	1.0	0.6	0.9	0.6	0.7	1.1	0.7	1.0	0.7	0.8
Nicaragua										
Niger										
Nigeria	2.4	2.6	2.7	2.4	2.6	2.5	2.7	2.9	2.5	2.7
North Korea										
Norway	1.4	1.5	1.6	1.4	2.0	1.2	1.3	1.4	1.2	1.3
Oman										
Pakistan	2.4	2.1	2.3	2.0	1.8	2.3	2.0	2.3	2.0	1.8
Palestine										
Panama	2.8	2.7	2.9	2.8	2.8					
Papua New Guinea										
Paraguay	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Peru	2.2	1.9	2.5	2.0	2.0	2.1	1.9	2.5	2.0	1.8
Philippines	2.4	2.3	2.4	2.2	2.0	2.4	2.3	2.4	2.2	2.0

Water-Efficient Technologies Industrial Water Use

Ratio of forecast (2025) to base (1990) values

Country	*Water-Efficient Scenario*					*Water-Efficient Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Poland	3.4	3.6	3.6	3.4	4.1	3.4	3.6	3.6	3.4	3.9
Portugal	3.4	3.4	3.4	3.4	3.5					
Puerto Rico										
Qatar	1.5	1.5	1.4	1.3		1.4	1.4	1.3	1.2	1.2
Reunion										
Romania	3.9	4.0	4.0	3.9	4.3	3.9	4.0	4.0	3.9	4.2
Rwanda										
Samoa										
Sao Tome and Principe										
Saudi Arabia	1.8	1.8	1.8	1.6	1.9	1.8	1.8	1.8	1.6	1.7
Senegal	1.4	1.7	2.0	1.4	1.7	1.5	1.8	2.2	1.5	1.9
Seychelles										
Sierra Leone										
Singapore	2.5	1.8	2.3	1.4	0.7	2.6	1.9	2.4	1.4	0.7
Solomon Islands										
Somalia										
South Africa	1.6	1.1	1.4	1.1	1.9	1.6	1.1	1.5	1.1	2.0
South Korea	3.3	2.3	3.0	1.7	0.7	2.9	2.1	2.7	1.5	0.7
Spain	2.4	2.5	2.5	2.4	2.7	2.3	2.4	2.4	2.3	2.4
Sri Lanka	2.3	2.0	2.2	2.0	1.8	2.3	2.0	2.2	2.0	1.8
St. Kitts-Nevis										
St. Lucia										
St. Vincent/Grenadines										
Sudan	1.3	1.6	1.9	1.2		1.5	1.8	2.2	1.4	1.9
Suriname										
Swaziland										
Sweden	0.8	1.0	1.1	0.8	1.5	0.6	0.7	0.7	0.6	0.6
Switzerland										
Syria	2.5	2.5	2.4	2.3	2.5	2.5	2.5	2.4	2.3	2.4
Taiwan										
Tanzania										
Thailand	2.7	2.3	2.6	2.0	1.6	2.6	2.2	2.5	2.0	1.5

Water-Efficient Technologies Industrial Water Use

Ratio of forecast (2025) to base (1990) values

Country	*Water-Efficient Scenario*					*Water-Efficient Structural Shift Scenario*				
	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.	Gbl Shift	EU Renaiss	Gbl Balance	Gbl Crisis	Conv. Devel.
Togo										
Tonga										
Trinidad and Tobago	2.1	1.7	2.7	1.8	1.8	2.1	1.7	2.7	1.8	1.7
Tunisia	2.0	1.9	1.9	1.7	2.0	2.1	2.1	2.0	1.8	2.3
Turkey	1.7	1.8	1.9	1.7	2.3	1.6	1.7	1.8	1.6	1.8
U.S. Virgin Islands										
Uganda										
United Arab Emirates	2.4	2.4	2.3	2.2	2.5	2.3	2.3	2.2	2.1	2.1
United Kingdom	2.2	2.2	2.3	2.2	2.5	2.1	2.1	2.2	2.1	2.1
United States	2.0	1.9	2.0	1.9	2.0	2.0	1.9	2.0	1.9	2.0
Uruguay	1.1	0.7	1.6	0.8	0.8	1.2	0.8	1.8	0.9	0.7
USSR	1.8	1.9	1.9	1.8		1.9	2.0	2.0	1.9	2.1
Venezuela	1.5	1.0	2.1	1.1	1.1	1.3	0.9	1.9	1.0	0.8
Vietnam										
Western Sahara										
Yemen	3.4	3.4	3.3	3.3	3.4					
Yugoslavia	2.7	2.8	2.8	2.7	3.0	2.6	2.7	2.7	2.6	2.8
Zaire	3.9	3.9	3.9	3.9	3.9					
Zambia	0.6	0.8	1.1	0.5	0.9	0.8	1.1	1.5	0.7	1.2
Zimbabwe	1.3	1.8	2.3	1.2	1.8	1.3	1.8	2.4	1.2	1.9