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DIPL 6507NA Water Politics of the 21st Century

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DIPL6507NA - WATER POLITICS OF 21ST CENTURY

WATER POLITICS AND RESOURCES

Regional Conflicts and World Security

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The risk of wars being fought over water is rising because of explosive global population growth and widespread complacency. The same way that we have had wars over oil resources water wars might, and very possibly, happen in critical areas of the world.

With the world's population growing at exponential rates there is extreme pressure on water supplies to provide drinking and agricultural water.

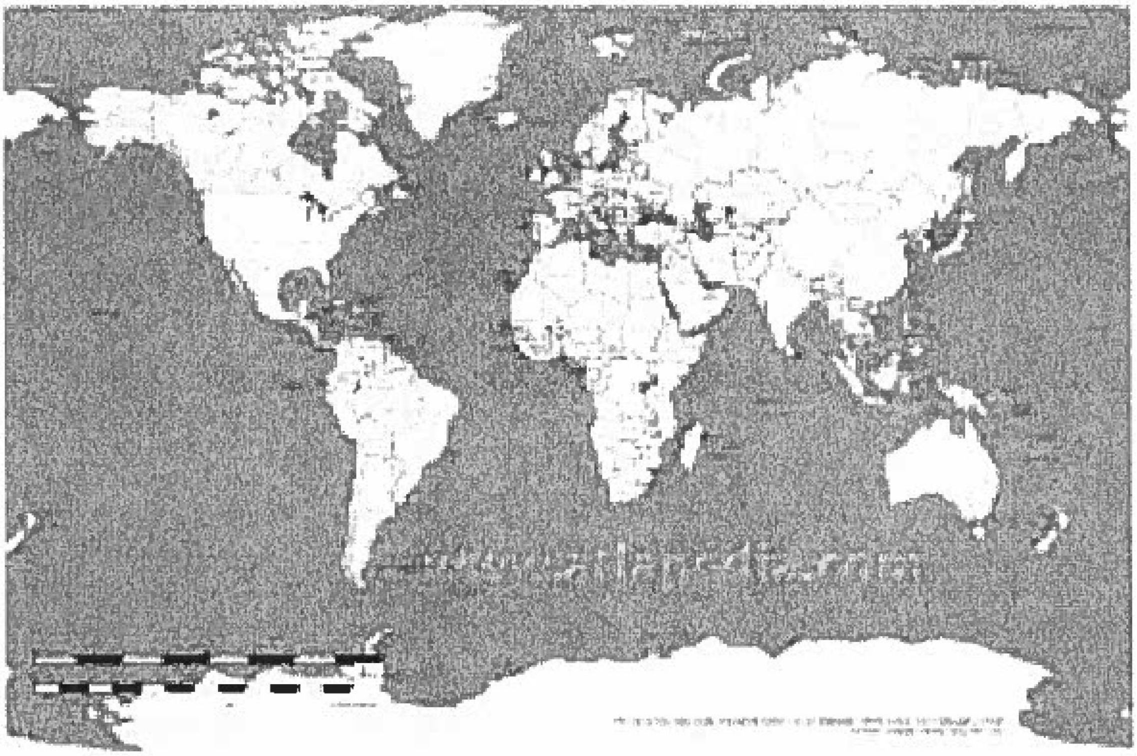
In 2025 we will have another two billion people to feed and 95 percent of these will be in urban areas. This requires sustained policies and investment in infrastructures. While it is estimated that each year about $80 billion is invested in the water sector, but this is needed to at least double over the next few years if a real global crisis is to be prevented.

The course focuses on the areas where supply and demand has reached a critical point and conflicts seem unavoidable.

The Water Problem:

- **Global Demand and Supply of Fresh Water.**
- **Critical Areas.**
- **Hydropolitics.**
- **Hydroeconomics.**
- **Hydroecologies.**
- **Future Prospects:**
  (The Geopolitics of water, Regional Conflicts and International Security).

Case Studies: (The Middle East, Africa, Central and South Asia....)



The Global Water Problem

Over the past century our water consumption increased tenfold. According to the World Health Organization, 1.1 billion people have no access to clean drinking water, while some 2.4 billion lack proper sanitary provision.

BASICS

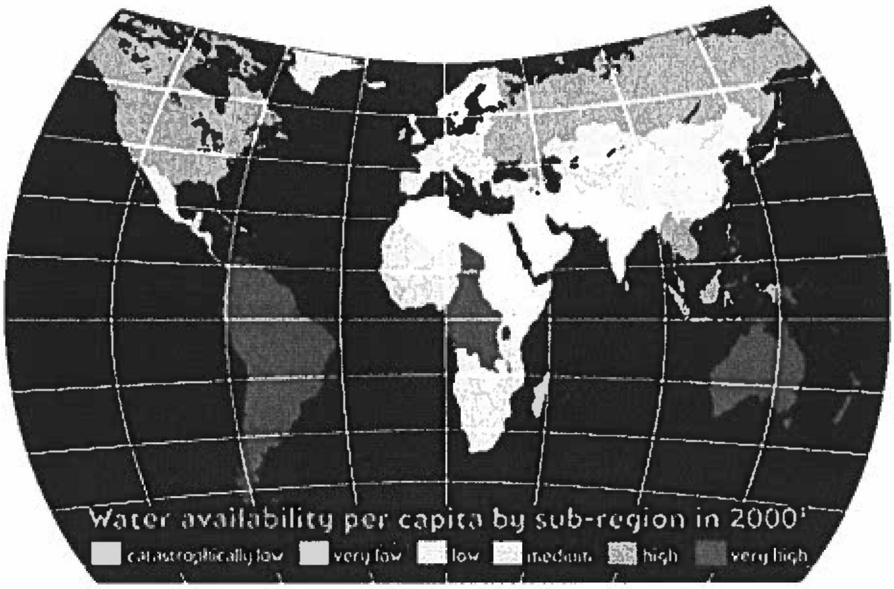
- On our blue planet 97.5% of the water is saltwater, unfit for human use.

- The majority of freshwater is beyond our reach, locked into polar snow and ice.

- Less than 1% of freshwater is usable, amounting to only 0.01% of the Earth's total water.

- Even this would be enough to support the world's population three times over, if used with care.

- However, water – like population – isn't distributed evenly. Asia has the greatest annual availability of fresh-water and Australia the lowest. But when population is taken into account the picture looks very different.



Water Supply of the World

The fresh water supply of the world actually available for human use in lakes and rivers and the accessible ground water amounts to only about one-third of 1% of the world's total water supply. The Antarctic Icecap is the largest supply of fresh water, nearly 2% of the world's total of fresh and salt water. As can be seen from the table below, the amount of water in our atmosphere is over ten times as much as the water in all the rivers flowing on the surface of the earth.

	Surface area (sq mi)	Volume (cu mi)	Percentage of total[1]
Salt water			
The oceans	139,500,000	317,000,000	97.2%
Inland seas and saline lakes	270,000	25,000	0.008
Fresh water			
Freshwater lakes	330,000	30,000	0.009
All rivers (average level)	—	300	0.0001
Antarctic Icecap	6,000,000	6,300,000	1.9
Arctic Icecap and glaciers	900,000	680,000	0.21
Water in the atmosphere	197,000,000	3,100	0.001
Ground water within half a mile from surface	—	1,000,000	0.31
Deep-lying ground water	—	1,000,000	0.31
Total (rounded)	—	**326,000,000**	**100.00**

1. All figures are estimated. *Source:* Department of the Interior, Geological Survey.

The Hydrological Cycle

The total volume of global water, constantly moves between the atmosphere, the lithosphere and the hydrosphere, a system that is called the world hydrological cycle. Figure 1 describes the components of the system, with inputs, outputs, flow regulators and storages.

The main inputs to the surface hydrological cycle are from precipitation. The main outputs are by evaporation and transpiration. Storage occurs in the oceans, the cryosphere (ice-covered areas of the world) and the groundwater. Between the input of water and its output, extensive movements take place, keeping it in permanent balance.

The routes that the water reaching the ground may take before being returned to the atmosphere are shown in figure 2. The pathway followed in any particular instance depends to a great extent upon the area and the form in which precipitation occurs. In the higher latitudes and in many mountain areas, for example, the main input is in the form of snow. This may accumulate over time, slowly being compressed into ice. As ice it may slowly move under gravitational forces as a glacier or ice sheet. Eventually the water is released by melting, to form streams and rivers which then flow to the sea.

In more temperate areas the route taken by the water is more complex, but the processes of transfer are much more rapid. Most of the precipitation occurs as rainfall and this either collects on the ground surface or soaks into the soil. The water which remains on the surface tends to flow over the land as runoff. This rapidly reaches the streams and is then carried to the sea. It takes water about three days to travel from the source to the mouth of the Thames, a distance of some 350 km and about eight weeks for it to pass the 6300 km length of the Mississippi. Thus the streams represent one of the most dynamic, important – and also sensitive – routes by which these transfers of water from land to the oceans occur.

The water which soaks into the ground travels more slowly. Some of it flows gradually through the soil and ultimately emerges as seepage water in springs or in stream banks. Some of it drains down-wards into the bedrock and forms groundwater, where it may be stored for many years before emerging again at the surface.

THE WORLD OCEAN

We use the term *world ocean* to refer to the combined ocean bodies and seas of the globe. Let us consider some statistics that emphasize the enormous extent and bulk of this great saltwater layer. The world ocean covers about 71 percent of the global surface; its average depth is about 3800 meters (12,500 ft), when shallow seas are included with the deep main ocean basins. The total volume of the world ocean is about 1.4 billion cu km (317 million cu mi), a quantity just over 97 percent of the world's free water. Of the small remaining volume, about 2 percent is locked up in the ice sheets of Antarctica and Greenland, and about 1 percent is represented by fresh water stored on the lands. These figures show the extent of the *Hydrosphere*, a general term for the total free water of the earth, in all three of its states (gas, liquid, and solid).

The importance of the oceans to humans is felt in a wide range of dimensions and scales.

- One environmental role played by the oceans is climatic. The huge water mass of the ocean stores a large quantity of heat which, in contrast to land masses, is gained or lost very slowly. Thus effectively moderate the seasonal extremes of temperature over much of the earth's surface.
- The oceans supply water vapor to the atmosphere and are the basic source of all rain that falls on the lands. This rainfall, the source of our freshwater supplies, originates from the ocean surface by a natural distillation of salt water.
- The oceans sustain a vast and complex assemblage of marine life forms, both plant and animal. This organic production provides humans with a modest but important share of their food.
- Throughout history the oceans have served as trackless surfaces of transport of people and the commodities that sustain their civilizations.
- The zone of contact between oceans and lands is a unique environment of the life layer. People, during history, have used, and modified, coastal zones in various ways, ranging from commercial and/or military ports and bases to industrial, food processing, and recreational facilities.
- People extract sweet water by desalinization of Sea water, dump the largest proportion of their wastes and pollutants into oceans and fight each other to gain access to, even a small, coastal land.

Oceans and Seas

Name	Area		Average depth		Greatest known depth		Place of greatest known depth
	sq. mi.	sq. km	ft.	M	ft.	M	
Pacific Ocean	60,060,700	155,557,000	13,215	4,028	36,198	11,033	Mariana Trench
Atlantic Ocean	29,637,900	76,762,000	12,880	3,926	30,246	9,219	Puerto Rico Trench
Indian Ocean	26,469,500	68,556,000	13,002	3,963	24,460	7,455	Sunda Trench
Southern Ocean[1]	7,848,300	20,327,000	13,100–16,400	4,000–5,000	23,736	7,235	South Sandwich Trench
Arctic Ocean	5,427,000	14,056,000	3,953	1,205	18,456	5,625	77°45'N; 175°W
Mediterranean Sea[2]	1,144,800	2,965,800	4,688	1,429	15,197	4,632	Off Cape Matapan, Greece
Caribbean Sea	1,049,500	2,718,200	8,685	2,647	22,788	6,946	Off Cayman Islands
South China Sea	895,400	2,319,000	5,419	1,652	16,456	5,016	West of Luzon
Bering Sea	884,900	2,291,900	5,075	1,547	15,659	4,773	Off Buldir Island
Gulf of Mexico	615,000	1,592,800	4,874	1,486	12,425	3,787	Sigsbee Deep
Okhotsk Sea	613,800	1,589,700	2,749	838	12,001	3,658	146°10'E; 46°50'N
East China Sea	482,300	1,249,200	617	188	9,126	2,782	25°16'N; 125°E
Hudson Bay	475,800	1,232,300	420	128	600	183	Near entrance
Japan Sea	389,100	1,007,800	4,429	1,350	12,276	3,742	Central Basin
Andaman Sea	308,000	797,700	2,854	870	12,392	3,777	Off Car Nicobar Island
North Sea	222,100	575,200	308	94	2,165	660	Skagerrak
Red Sea	169,100	438,000	1,611	491	7,254	2,211	Off Port Sudan
Baltic Sea	163,000	422,200	180	55	1,380	421	Off Gotland

1. A decision by the International Hydrographic Organization in spring 2000 delimited a fifth world ocean. 2. Includes Black Sea and Sea of Azov.

Territorial Waters

Territorial waters are all waters within the jurisdiction, recognized in international law, of a country. Certain waters by their situation are controlled by one nation; these include wholly enclosed inland seas, lakes, and rivers. Control of boundary lakes and rivers extends to the middle of the navigable channel, but agreements to share the use of such waters and of waters that flow through several countries (e.g., the Rhine, the Danube) are common. When waters are almost completely bordered by one country, but lie along an international navigation route (e.g., the Bosporus), treaties often make them available to all ships.

Since the 18th cent coastal states have been held to have jurisdiction over unenclosed waters for 3 nautical mi (3.45 mi/5.55 km) from the low water line, a measure originally derived from the distance of a cannon shot. In the case of a bay up to 24 mi (39 km) wide, a line drawn from one enclosing point to the other marked the outer limit of territorial jurisdiction. A broader zone of jurisdiction to combat smuggling has long been claimed by various states, as by the United States during prohibition.

Merchant ships of all flags have the right of "innocent passage" in a nation's territorial waters; the rights of nonbelligerent foreign warships in this zone, and the extent of the jurisdiction of the coastal nation's courts over ships passing through and incidents in the zone, have long been matters of debate. Fishing and mineral extraction within the zone are entirely within the control of the coastal nation. In the 20th cent., coastal nations progressively widened their claims over offshore waters, especially in the face of competition from foreign fishing fleets and in anticipation of rich oil, gas, and mineral finds on the continental shelf. The UN-sponsored Law of the Sea Treaty, which went into effect in 1994, codified territorial waters of 12 nautical mi (13.8 mi/22.2 km) and an exclusive economic zone of 200 nautical mi (230 mi/370 km). In 1999, U.S. agencies were empowered by presidential proclamation to enforce American law up to 24 miles (39 km) offshore, doubling the previous limit.

The Columbia Electronic Encyclopedia,

Large Lakes of the World

	Area		Length		Maximum depth	
Name and location	sq. mi.	km	mi.	km	ft.	M
Caspian Sea, Azerbaijan-Russia-Kazakhstan-Turkmenistan-Iran1	152,239	394,299	745	1,199	3,104	946
Superior, U.S.-Canada	31,820	82,414	383	616	1,333	406
Victoria, Tanzania-Uganda	26,828	69,485	200	322	270	82
Huron, U.S.-Canada	23,010	59,596	247	397	750	229
Michigan, U.S.	22,400	58,016	321	517	923	281
Aral, Kazakhstan-Uzbekistan	13,000	33,800	266	428	223	68
Tanganyika, Tanzania-Congo	12,700	32,893	420	676	4,708	1,435
Baikal, Russia	12,162	31,500	395	636	5,712	1,741
Great Bear, Canada	12,000	31,080	232	373	270	82
Nyasa, Malawi-Mozambique-Tanzania	11,600	30,044	360	579	2,316	706
Great Slave, Canada	11,170	28,930	298	480	2,015	614
Chad,2 Chad-Niger-Nigeria	9,946	25,760	—	—	23	7
Erie, U.S.-Canada	9,930	25,719	241	388	210	64
Winnipeg, Canada	9,094	23,553	264	425	204	62
Ontario, U.S.-Canada	7,520	19,477	193	311	778	237
Balkhash, Kazakhstan	7,115	18,428	376	605	87	27
Ladoga, Russia	7,000	18,130	124	200	738	225
Onega, Russia	3,819	9,891	154	248	361	110
Titicaca, Bolivia-Peru	3,141	8,135	110	177	1,214	370
Nicaragua, Nicaragua	3,089	8,001	110	177	230	70
Athabaska, Canada	3,058	7,920	208	335	407	124
Rudolf, Kenya	2,473	6,405	154	248	—	—
Reindeer, Canada	2,444	6,330	152	245	—	—
Eyre, South Australia	2,4003	6,216	130	209	varies	Varies
Issyk-Kul, Kyrgyzstan	2,394	6,200	113	182	2,297	700
Urmia,2 Iran	2,317	6,001	81	130	49	15
Torrens, South Australia	2,200	5,698	130	209	—	—
Vänern, Sweden	2,141	5,545	87	140	322	98
Winnipegosis, Canada	2,086	5,403	152	245	59	18
Mobutu Sese Seko, Uganda	2,046	5,299	100	161	180	55
Nettilling, Baffin Island, Canada	1,950	5,051	70	113	—	—
Nipigon, Canada	1,870	4,843	72	116	—	—
Manitoba, Canada	1,817	4,706	140	225	22	7
Great Salt, U.S.	1,800	4,662	75	121	15–25	5–8
Kioga, Uganda	1,700	4,403	50	80	about 30	9

Paraná	Confluence of Paranaiba and Grande rivers	Río de la Plata	2,795	4,498
Irtish	Altai Mts., Russia	Ob River	2,758	4,438
Zaire (Congo)	Confluence of Lualab and Luapula rivers, Congo	Atlantic Ocean	2,716	4,371
Heilong (Amur)	Confluence of Shilka (Russia) and Argun (Manchuria) rivers	Tatar Strait	2,704	4,352
Lena	Baikal Mts., Russia	Arctic Ocean	2,652	4,268
Mackenzie	Head of Finlay River, British Columbia, Canada	Beaufort Sea (Arctic Ocean)	2,635	4,241
Niger	Guinea	Gulf of Guinea	2,600	4,184
Mekong	Tibetan highlands	South China Sea	2,500	4,023
Mississippi	Lake Itasca, Minnesota	Gulf of Mexico	2,348	3,779
Missouri	Confluence of Jefferson, Gallatin, and Madison rivers, Montana	Mississippi River	2,315	3,726
Volga	Valdai plateau, Russia	Caspian Sea	2,291	3,687
Madeira	Confluence of Beni and Maumoré rivers, Bolivia–Brazil boundary	Amazon River	2,012	3,238
Purus	Peruvian Andes	Amazon River	1,993	3,207
São Francisco	Southwest Minas Gerais, Brazil	Atlantic Ocean	1,987	3,198
Yukon	Junction of Lewes and Pelly rivers, Yukon Territory, Canada	Bering Sea	1,979	3,185
St. Lawrence	Lake Ontario	Gulf of St. Lawrence	1,900	3,058
Rio Grande	San Juan Mts., Colorado	Gulf of Mexico	1,885	3,034
Brahmaputra	Himalayas	Ganges River	1,800	2,897
Indus	Himalayas	Arabian Sea	1,800	2,897
Danube	Black Forest, Germany	Black Sea	1,766	2,842
Euphrates	Confluence of Murat Nehri and Kara Su rivers, Turkey	Shatt-al-Arab	1,739	2,799
Darling	Central part of Eastern Highlands, Australia	Murray River	1,70	2,73

NOTE: area more than 1,700 sq. mi.
1. The Caspian Sea is called "sea" because the Romans, finding it salty, named it *Mare Caspium.* Many geographers, however, consider it a lake because it is land-locked.
2. Figures represent high-water data.
3. Varies with the rainfall of the wet season. It has been reported to dry up almost completely on occasion.

Principal Rivers of the World

Looked at on a global scale the distribution of rivers is seen to be very unequal. Some of the continents receive large amounts of rainfall and experience plenty of surface runoff; others are relatively dry and water runoff is rare. The areas having most surface runoff are those with high rates of precipitation and low rates of evaporation. South America has the largest value, mainly because much of the continent lies in the humid tropics. The temperate latitude continents of Europe, Asia and North America have high amount of surface water. Africa and the Middle East, on the other hand, have low ratio of runoff to evaporation because of the areas of desert and the smaller proportion of the surface under tropical rain system. The driest continent is Australia, where large permanent rivers are scarce. Antarctica is rather an unknown quantity.

			Approx. length	
River	**Source**	**Outflow**	**mi.**	**km**
Nile	Tributaries of Lake Victoria, Africa	Mediterranean Sea	4,180	6,690
Amazon	Glacier-fed lakes, Peru	Atlantic Ocean	3,912	6,296
Mississippi-Missouri-Red Rock	Source of Red Rock, Montana	Gulf of Mexico	3,710	5,970
Chang Jiang (Yangtze)	Tibetan plateau, China	China Sea	3,602	5,797
Ob	Altai Mts., Russia	Gulf of Ob	3,459	5,567
Huang Ho (Yellow)	Eastern part of Kunlan Mts., West China	Gulf of Chihli	2,900	4,667
Yenisei	Tannu-Ola Mts., western Tuva, Russia	Arctic Ocean	2,800	4,506

			2	9
Zambezi	11°21'S, 24°22'E, Zambia	Mozambique Channel	1,700	2,736
Tocantins	Goiás, Brazil	Pará River	1,677	2,699
Murray	Australian Alps, New South Wales	Indian Ocean	1,609	2,589
Nelson	Head of Bow River, western Alberta, Canada	Hudson Bay	1,600	2,575
Paraguay	Mato Grosso, Brazil	Paraná River	1,584	2,549
Ural	Southern Ural Mts., Russia	Caspian Sea	1,574	2,533
Ganges	Himalayas	Bay of Bengal	1,557	2,506
Amu Darya (Oxus)	Nicholas Range, Pamir Mts., Turkmenistan	Aral Sea	1,500	2,414
Japurá	Andes, Colombia	Amazon River	1,500	2,414
Salween	Tibet, south of Kunlun Mts.	Gulf of Martaban	1,500	2,414
Arkansas	Central Colorado	Mississippi River	1,459	2,348
Colorado	Grand County, Colorado	Gulf of California	1,450	2,333
Dnieper	Valdai Hills, Russia	Black Sea	1,419	2,284
Ohio-Allegheny	Potter County, Pennsylvania	Mississippi River	1,306	2,102
Irrawaddy	Confluence of Nmai and Mali rivers, northeast Burma	Bay of Bengal	1,300	2,092
Orange	Lesotho	Atlantic Ocean	1,300	2,092
Orinoco	Serra Parima Mts., Venezuela	Atlantic Ocean	1,281	2,062
Pilcomayo	Andes Mts., Bolivia	Paraguay River	1,242	1,999
Xi Jiang (Si Kiang)	Eastern Yunnan Province, China	China Sea	1,236	1,989
Columbia	Columbia Lake, British Columbia, Canada	Pacific Ocean	1,232	1,983
Don	Tula, Russia	Sea of Azov	1,223	1,968

Sungari	China–North Korea boundary	Amur River	1,215	1,955
Saskatchewan	Canadian Rocky Mts.	Lake Winnipeg	1,205	1,939
Peace	Stikine Mts., British Columbia, Canada	Great Slave River	1,195	1,923
Tigris	Taurus Mts., Turkey	Shatt-al-Arab	1,180	1,899

Water Supply and Demand

If you think of the earth as a Noah's Ark, a life-friendly speck floating through the sterile immensities of space, you will appreciate that its passenger capacity is limited.

Some scientists have tried to set a numerical limit, suggesting that a population of around two billion people would be the "ideal" for human well being. Many religious leaders argue that no limit is necessary, because (they believe) providence will ensure that, however numerous we are, nobody will go short.

However, experience suggests that we have to accept a trade-off between growing numbers and quality of life.

Human Access to Water Supplies, by Region, 2000

Region	Percent served		
	Urban	Rural	Total
Global	94%	71%	82%
Africa	85	47	81
Asia	93	75	81
Latin America/Caribbean	93	62	85
Oceania	98%	63%	88%
Europe	100	87	96
North America	100	100	100

The Ark, in other words, will sail on. But it will sink lower in the water, and life for many on board will be increasingly wretched.

Just few of the most urgent pressures it faces show how precarious its voyage is becoming.

Food

A US conservation group says the world's impending water shortage could reduce global food supplies by more than 10%.

The group, the Worldwatch Institute, based in Washington DC, says the shortage could lead not only to hunger but also to civil unrest and war.

Sandra Postel is the author of a book published by the institute on the water crisis, entitled: "Pillar of Sand: Can the Irrigation Miracle Last?

Heavy reliance on irrigation"

She says: "Without increasing water productivity in irrigation, major food-producing regions will not have enough water to sustain crop production."

"Some 40% of the world's food comes from irrigated cropland, and we're betting on that share to increase to feed a growing population."

Postel says in the book that one threat to the productivity of irrigation is excessive pumping of groundwater from subterranean aquifers.

Soil Erosion

The area available for producing grain for each person alive today has fallen by half since 1950, to 0.12 hectares. So farmers are turning to increasingly marginal land on hillsides and in tropical forests.

The immediate result is deforestation which can make flooding more frequent and more severe. The longer-term consequence is the impoverishment of the soil itself. And the soil, in many countries, is being eroded by wind and water, leaving even less productive land.

The European Environment Agency describes soil loss on the continent through erosion and development as "worryingly high".

Water

By 2050, the amount of fresh water available per person will be about 25% of the 1950 figure. For Example one of China's two main rivers, the Yellow River, has run dry for part of each year since 1985. In 1997, it failed to reach the sea on 226 days.

On every continent, water tables are dropping - under the north China plain, which produces nearly 40% of the Chinese grain harvest, the fall averages 1.5 meters a year.

Underground water reserves in many countries are being used faster than they are replenished. Earlier research by Worldwatch illustrated the scale of the problem:

- Between 1991 and 1996, the water table beneath the north China plain fell by an average of 1.5 meters a year.

- Almost everywhere in India, the water table is falling at between one and three meters annually.
- Mexico City is sinking because of the amount of water being pumped out from beneath its foundations.

Cities

At present almost 50% of the world's people are living in cities.
They go there, often, not because they have much real hope of a better life, but to escape rural desperation.
Population growth there means ever-smaller plots of land for succeeding generations, till there is too little left for survival.
But city life is polluted and unhealthy, and ultimately unsustainable, sucking in resources from far away and spewing out wastes for disposal somewhere.

Further threats

There are plenty of other problems for the Ark's passengers to worry about:

- fish catches from the world's oceans have reached - or passed - their sustainable limits.
- human activities, notably farming and industry, are changing the climate.
- we are driving other species to extinction at an unnatural rate.
- the growth of demand for energy looks impossible to meet without new, sustainable technologies.
- there is a growing problem in every country of waste disposal.

Two further problems are the growing diversion of irrigation water for use in cities, and the build-up of salinity in the soil.
There is an annual "water deficit" of about 160 billion cubic meters - enough to produce nearly 10% of the world's grain. Countries which are short of water are buying more and more on the world grain market.
Jordan imports 91% of its supplies from abroad, Israel 87%, Saudi Arabia 50% and Egypt 40%. The number of people living in countries suffering from water shortages is expected to rise from 470m today to 3bn by 2025.
One region that relies heavily on irrigation is north-east Africa. There, Worldwatch says, competition for the waters of the Nile will get fiercer.
The total population of Ethiopia, Sudan and Egypt stands at 157m today. By 2050 it is projected to reach 388m.

Changing strategies

Postel says the world needs a "blue revolution" to double water productivity in the next 30 years. She says drip irrigation systems, which deliver water

straight to the plant's roots, can cut water use by from 30-70%. They also raise crop yields significantly, and are in use in the US, Europe and Asia.
Farmers in Texas have improved their water efficiency to more than 90% by using efficient sprinklers. And Malaysian rice farmers have cut water wastage by almost half by planning irrigation better, shoring up canals, and sowing seeds directly in the field rather than transplanting seedlings.

Grain imports

Fresh water is also becoming increasingly unusable because of pollution. But given increasing populations, Worldwatch identifies one way of easing demands for water - importing grain.
Agriculture is by far the biggest user of water in Africa accounting for 88% of water use. It takes about 1,000 tones of water to produce every tone of grain.
Worldwatch says that already the water needed to produce the annual combined imports of grain by the Middle East and North Africa is equivalent to the annual flow of the Nile.
Importing grain is much easier than importing water, but for poorer countries in Africa it may not be an option.
For this reason the UN proposes monitoring worldwide reserves of drinking water and establishing agreements for the use of water.

Spreading Deserts

Not only in Africa and the Middle East but in any region where humans are putting extra pressures on land and water resources, desertification is widespread. In Africa, many parts of south and south-west Asia and in Latin America natural vegetation still forms the main supplier of fuel, domestic uses, grazing (and over-grazing) cattle. Trees and brushes are continuously cut, making room for winds to erode the soil, turning it into deserts. This in turn result in further pressure on neighbouring land and water resources and expanded uncultivateable lands. Number of cases in Iran, Pakistan, Egypt and many other countries where sand hills and salt-covered former farmlands are closing to major cities is increasing dramatically. The following table is an indicator of the vastness of desert-lands across the globe.

Principal Deserts of the World

Deserts are arid regions, generally receiving less than ten inches of precipitation a year, or regions where the potential evaporation rate is twice as great as the precipitation.

The world's deserts are divided into four categories. **Subtropical deserts** are the hottest, with parched terrain and rapid evaporation. Although **cool coastal deserts** are located within the same latitudes as subtropical deserts, the average temperature is much cooler because of frigid offshore ocean currents. **Cold winter deserts** are marked by stark temperature differences from season to season, ranging from 100° F (38° C) in the summer to 10° F (−12° C) in the winter. **Polar regions** are also considered to be deserts because nearly all moisture in these areas is locked up in the form of ice.

Desert	Location	Size	Topography
SUBTROPICAL DESERTS			
Sahara	Morocco, Western Sahara, Algeria, Tunisia, Libya, Egypt, Mauritania, Mali, Niger, Chad, Ethiopia, Eritrea, Somalia	3.5 million sq. mi.	70% gravel plains, sand, and dunes. Contrary to popular belief, the desert is only 30% sand. The world's largest nonpolar desert gets its name from the Arabic word *Sahra'*, meaning desert
Arabian	Saudi Arabia, Kuwait, Qatar, United Arab Emirates, Oman, Yemen	1 million sq. mi.	Gravel plains, rocky highlands; one-fourth is the Rub al-Khali ("Empty Quarter"), the world's largest expanse of unbroken sand
Kalahari	Botswana, South Africa, Namibia	220,000 sq. mi.	Sand sheets, longitudinal dunes
Australian Desert			
Gibson	Australia (southern portion of the Western Desert)	120,000 sq. mi.	Sandhills, gravel, grass. These three regions of desert are collectively referred to as the Great Western Desert—otherwise known as "the Outback." Contains Ayers Rock, or Uluru, one of the world's largest monoliths
Great Sandy	Australia (northern portion of the Western Desert)	150,000 sq. mi.	
Great Victoria	Australia (southernmost portion of the Western Desert)	250,000 sq. mi.	
Simpson and Sturt Stony	Australia (eastern half of the continent)	56,000 sq. mi.	Simpson's straight, parallel sand dunes are the longest in the world—up to 125 mi. Encompasses the Stewart Stony Desert, named for the Australian

			explorer
Mojave	U.S.: Arizona, Colorado, Nevada, Utah, California	54,000 sq. mi.	Mountain chains, dry alkaline lake beds, calcium carbonate dunes
Sonoran	U.S.: Arizona, California; Mexico	120,000 sq. mi.	Basins and plains bordered by mountain ridges; home to the Saguaro cactus
Chihuahuan	Mexico; southwestern U.S.	175,000 sq. mi.	Shrub desert; largest in North America
Thar	India, Pakistan	175,000 sq. mi.	Rocky sand and sand dunes
COOL COASTAL DESERTS			
Namib	Angola, Namibia, South Africa	13,000 sq. mi.	Gravel plains
Atacama	Chile	54,000 sq. mi.	Salt basins, sand, lava; world's driest desert
COLD WINTER DESERTS			
Great Basin	U.S.: Nevada, Oregon, Utah	190,000 sq. mi.	Mountain ridges, valleys, 1% sand dunes
Colorado Plateau	U.S.: Arizona, Colorado, New Mexico, Utah, Wyoming	130,000 sq. mi.	Sedimentary rock, mesas, and plateaus—includes the Grand Canyon and is also called the "Painted Desert" because of the spectacular colors in its rocks and canyons
Patagonian	Argentina	260,000 sq. mi.	Gravel plains, plateaus, basalt sheets
Kara-Kum	Uzbekistan, Turkmenistan	135,000 sq. mi.	90% gray layered sand—name means "black sand"
Kyzyl-Kum	Uzbekistan, Turkmenistan, Kazakhstan	115,000 sq. mi.	Sands, rock—name means "red sand"
Iranian	Iran	100,000 sq. mi.	Salt, gravel, rock
Taklamakan	China	105,000 sq. mi.	Sand, dunes, gravel
Gobi	China, Mongolia	500,000 sq. mi.	Stony, sandy soil, steppes (dry grasslands)
POLAR			
Arctic	U.S., Canada, Greenland, Iceland, Norway, Sweden, Finland, Russia		Snow, glaciers, tundra
Antarctic	Antarctica	5.4 million sq. mi.	Ice, snow, bedrock
Patagonian	Argentina	260,000	Gravel plains, plateaus, basalt sheets

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Damming Rivers

"Nearly every river on Earth has been dammed by humans. There are an estimated 800,000 small dams, 45,000 large dams, and more than 300 major dams worldwide." The major source of information on dams is the World Commission on Dams, an independent body established by the World Bank and World Conservation Union in February 1998 to evaluate the pros and cons of large dams.

World's Largest Dams

		Volume (thousands)		
Dam	**Location**	**cu m**	**cu yds**	**Year completed**
Syncrude Tailings	Canada	540,000	706,320	UC
Chapetón	Argentina	296,200	387,410	UC
Pati	Argentina	238,180	274,026	UC
New Cornelia Tailings	United States	209,500	274,026	1973
Tarbela	Pakistan	121,720	159,210	1976
Kambaratinsk	Kyrgyzstan	112,200	146,758	UC
Fort Peck	Montana	96,049	125,628	1940
Lower Usuma	Nigeria	93,000	121,644	1990
Cipasang	Indonesia	90,000	117,720	UC

Atatürk	Turkey	84,500	110,522	1990
Yacyretá-Apipe	Paraguay/Argentina	81,000	105,944	1998
Guri (Raul Leoni)	Venezuela	78,000	102,014	1986
Rogun	Tajikistan	75,500	98,750	1985
Oahe	South Dakota	70,339	92,000	1963
Mangla	Pakistan	65,651	85,872	1967
Gardiner	Canada	65,440	85,592	1968
Afsluitdijk	Netherlands	63,400	82,927	1932
Oroville	California	59,639	78,008	1968
San Luis	California	59,405	77,700	1967
Nurek	Tajikistan	58,000	75,861	1980
Garrison	North Dakota	50,843	66,500	1956
Cochiti	New Mexico	48,052	62,850	1975
Tabka (Thawra)	Syria	46,000	60,168	1976
Bennett W.A.C.	Canada	43,733	57,201	1967
Tucuruii	Brazil	43,000	56,242	1984
Boruca	Costa Rica	43,000	56,242	UC
High Aswan (Sadd-el-Aali)	Egypt	43,000	56,242	1970
San Roque	Philippines	43,000	56,242	UC
Kiev	Ukraine	42,841	56,034	1964
Dantiwada Left Embankment	India	41,040	53,680	1965
Saratov	Russia	40,400	52,843	1967
Mission Tailings 2	Arizona	40,088	52,435	1973
Fort Randall	South Dakota	38,227	50,000	1953
Kanev	Ukraine	37,860	49,520	1976
Mosul	Iraq	36,000	47,086	1982
Kakhovka	Ukraine	35,640	46,617	1955
Itumbiara	Brazil	35,600	46,563	1980
Lauwerszee	Netherlands	35,575	46,532	1969
Beas	India	35,418	46,325	1974
Oosterschelde	Netherlands	35,000	45,778	1986

NOTE: UC = under construction in 2004. China's Three Gorges dam on the Yangtze River, begun in 1993 and expected to be completed in 2009, will be the world's largest and highest dam.

Source Department of the Interior Bureau of Reclamation and *International Water Power and Dam Construction*

World's Highest Dams

Name	River, location	Structural height		Gross reservoir capacity		Year completed
		ft	m	Thousands of ac ft	Millions of cu m	
Rogun	Vakhsh, Tajikistan	1099	335	9,404	11,600	1985
Nurek	Vakhsh, Tajikistan	984	300	8,512	10,500	1980
Grande Dixence	Dixence, Switzerland	935	285	324	400	1962
Inguri	Inguri, Georgia	892	272	801	1,100	1984
Vaiont	Vaiont, Italy	859	262	137	169	1961
Manuel M. Torres	Grijalva, Mexico	856	261	1,346	1,660	1981
Tehri	Bhagirathi, India	856	261	2,869	3,540	UC
Alvaro Obregon	Mextiquic, Mexico	853	260	n.a.	n.a.	1926
Mauvoisin	Drance de Bagnes, Switzerland	820	250	146	180	1957
Alberto Lleras	Orinoco, Colombia	797	243	811	1,000	1989
Mica	Columbia, Canada	797	243	20,000	24,670	1972
Sayano-Shushenskaya	Yenisei, Russia	794	242	25,353	31,300	1980
Ertan	Yangtze/Yalong, China	787	240	4,702	5,800	1999
La Esmeralda	Batá, Colombia	778	237	661	815	1975
Kishau	Tons, India	774	236	1,946	2,400	1985
Oroville	Feather, Calif., U.S.	770	235	3,538	4,299	1968
El Cajón	Humuya, Honduras	768	234	4,580	5,650	1984
Chirkey	Sulak, Russia	764	233	2,252	2,780	1977
Bhakra	Sutlej, India	741	226	8,002	9,870	1963
Luzzone	Brenno di Luzzone, Switzerland	738	225	71	87	1963
Hoover	Colorado, Ariz.-Nev., U.S.	732	223	28,500	35,154	1936
Contra	Verzasca, Switzerland	722	220	70	86	1965
Mratinje	Piva, Herzegovina	722	220	713	880	1973
Dworshak	North Fork Clearwater, Idaho, U.S.	717	219	3,453	4,259	1974
Glen Canyon	Colorado, Ariz., U.S.	710	216	27,000	33,304	1964
Toktogul	Naryn, Kyrgyzstan	705	215	15,800	19,500	1978
Daniel Johnson	Manicouagan, Canada	703	214	115,000	141,852	1968

Keban	Firat, Turkey	689	210	25,110	31,000	1974
Zimapan	Moctezuma, Mexico	679	207	n.a.	n.a.	1994
Karun	Karun, Iran	673	205	2,351	2,900	1976
Lakhwar	Yamuna, India	669	204	470	580	1985
Dez	Dez, Abi, Iran	666	203	2,707	3,340	1963
Almendra	Tormes, Spain	662	202	2,148	2,649	1970
Berke	Ceyhan, Turkey	659	201	n.a.	n.a.	2000
Khudoni	Inguri, Georgia	659	201	n.a.	n.a.	n.a.
Kölnbrein	Malta, Austria	656	200	166	205	1977
Altinkaya	Kizil Irmak, Turkey	640	195	4,672	5,763	1986
New Bullards Bar	No. Yuba, Calif., U.S.	637	194	960	1,184	1968
New Melones	Stanislaus, Calif., U.S.	625	191	2,400	2,960	1979
Itaipu	Paraná, Brazil/Paraguay	623	190	23,510	29,000	1982
Kurobe 4	Kurobe, Japan	610	186	162	199	1964
Swift	Lewis, Wash., U.S.	610	186	756	932	1958
Mossyrock	Cowlitz, Wash., U.S.	607	185	1,300	1,603	1968
Oymopinar	Manavgat, Turkey	607	185	251	310	1983
Atatürk	Firat, Turkey	604	184	39,482	48,700	1990
Shasta	Sacramento, Calif., U.S.	602	183	4,550	5,612	1945
Bennett WAC	Peace, Canada	600	183	57,006	70,309	1967
Karakaya	Firat, Turkey	591	180	7,767	9,580	1986
Tignes	Isère, France	591	180	186	230	1952
Amir Kabir (Karad)	Karadj, Iran	591	180	166	205	1962
Tachien	Tachia, Taiwan	591	180	188	232	1974
Dartmouth	Mitta-Mitta, Australia	591	180	3,243	4,000	1978
Özköy	Gediz, Turkey	591	180	762	940	1983
Emosson	Barberine, Switzerland	590	180	184	225	1974
Zillergrundl	Ziller, Austria	590	180	73	90	1986
Los Leones	Los Leones, Chile	587	179	86	106	1986
New Don Pedro	Tuolumne, Calif., U.S.	585	178	2,030	2,504	1971
Alpa-Gera	Cormor, Italy	584	178	53	65	1965
Kopperston Tailings 3	Jones Branch, W. Va., U.S.	580	177	—	—	1963
Takase	Takase, Japan	577	176	62	76	1979

Nader Shah	Marun, Iran	574	175	1,313	1,620	1978
Hasan Ugurlu	Yesil Irmak, Turkey	574	175	874	1,078	1980
Revelstoke	Columbia, B.C., Canada	574	175	4,298	5,300	1984
Hungry Horse	S.Fk., Flathead, Mont., U.S.	564	172	3,470	4,280	1953
Longyangxia	Huanghe, China	564	172	20,025	24,700	1983
Cabora Bassa	Zambezi, Mozambique	561	171	51,075	63,000	1974
Maqarin	Yarmuk, Jordan	561	171	259	320	1987
Amaluza	Paute, Ecuador	558	170	81	100	1982
Idikki	Periyar, India	554	169	1,618	1,996	1974
Charvak	Chirchik, Uzbekistan	552	168	1,620	2,000	1970
Gura Apelor Retezat	Riul Mare, Romania	552	168	182	225	1980
Grand Coulee	Columbia, Washington	550	168	9,390	11,582	1942
Boruca	Terraba, Costa Rica	548	167	12,128	14,960	UC
Vidraru	Arges, Romania	545	166	380	465	1965
Kremasta (King Paul)	Achelõus, Greece	541	165	3,850	4,750	1965
Pauti-Mazar	Mazar, Ecuador	541	165	405	500	1984

NOTES: UC = under construction in 2004. n.a. = not available. China's Three Gorges dam on the Yangtze River, begun in 1993 and expected to be completed in 2009, will be the world's largest and highest dam.

Sources: International Commission on Large Dams, *World Register of Dams 1998*, and other sources.

THE CONTROVERSIAL BIG DAMS

Some environmentalists argue that big dams are plain bad. They flood people out of their homes and off their lands; wipe out endangered habitats and species; spread water-borne diseases; deprive flood plains of the water and sediments of life-giving floods (while increasing the damage floods cause to people); ruin beautiful landscapes and submerge places of great cultural or spiritual importance. And that's just a partial charge sheet. Big dams even cause earthquakes (because of the weight of water in reservoirs), release greenhouse gases (because of the rotting of flooded vegetation), destroy marine fisheries (because they disrupt river-borne flows of freshwater and nutrients into oceans) and lead to coastal erosion (because the sediments that eventually fill reservoirs would previously have flowed out through estuaries and then been washed back by waves to protect the shoreline). Occasionally, they collapse and drown people. In the world's worst dam disaster – a mega-catastrophe that struck central China in 1975 when two large dams burst – as many as 230,000 people died.

Human-rights abuses regularly accompany big dams – not just in China. In the 1980s more than 440 Guatemalans, mainly women and children, were murdered by paramilitaries because of their refusal to accept the resettlement package offered to them to build the Chixoy dam.

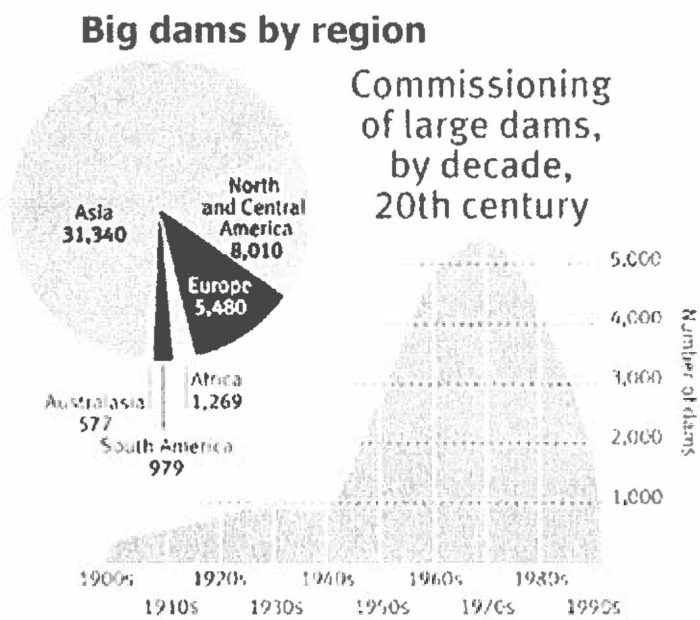
Today, almost everywhere that a big dam is being proposed or built there is a community or a group of activists organizing against it. In southern Mexico, indigenous communities are fighting to win reparations for dams built 50 years ago.

While not every big dam causes huge damage, cumulatively the world's over 45,000 large dams have done major harm. The World Commission on Dams, a World Bank-sponsored initiative backed by both dam supporters and critics, estimated that 40 to 80 million people have been displaced by dams. Sixty per cent of the length of the world's large river systems are at least moderately or severely fragmented by dams and related withdrawals of water for irrigation.

The big dam top 10

Country	No. of dams
1. China	22,000
2. US	6,575
3. India	4,291
4. Japan	2,675
5. Spain	1,196
6. Canada	793
7. South Korea	765
8. Turkey	625
9. Brazil	594
10. France	569

China has nearly half of the world's big dams.



Source: World Commission on Dams, 2000

But aren't dams, just a necessary tool that we must grudgingly accept for our greater good? Don't we need to store water to keep us and our crops alive through dry seasons and dry years? Don't we need to block floods? Don't we need hydroelectricity? Of course we do need to store water. In large parts of the world rain falls only during one or two wet seasons, and within those seasons almost all the rain might fall in just one or two storms. And global warming is going to make rainfall even less dependable.

Groundwater

Physically surface water percolates downwards through the pores and fissures in the rocks until it reaches an impermeable layer. It then becomes trapped and a water table forms in the rocks. The water beneath is known as **groundwater.**

Rocks which store water in this way are termed **aquifers.** Chalk, sandstone and some limestones provide exceptionally good aquifers and it is from these that man derives much of his groundwater. Over the years man's ability to extract these waters has improved. Simple stone-lined, hand-pumped wells and *Qanats* have given way to deep tube-wells from which the water is raised by pumps and hydraulic rams.

As a result, the rate at which man abstracts the groundwaters has increased; with it have increased the problems of groundwater exhaustion and falling water tables. The process , in recent years, has become the case of hostility and increasing tension among communities who share an aquifer. The **Waahe** (oasis) settlements in the Arabian Peninsula have been the cause of tension between Saudi Arabia-Qatar and United Arab Emirates-Oman. Libya-Chad-Egypt have similar problems in Africa. In other countries farmers and urban dwellers fight over the access to underground reservoirs of water and tensions are increasing both at local and national levels.

TAPPING GROUNDWATER

Some 97% of liquid freshwater is stored underground in aquifers. People, especially in rural areas, are increasingly dependent on groundwater – up to 2 billion people, a third of the world's population, rely on it.

Drinking groundwater[6]

Region	% of drinking water from groundwater	People served (millions)
Asia-Pacific	32	1,000 to 1,200
Europe	75	200 to 500
Latin America	29	150
United States	51	135
Australia	15	3
Africa	no data	no data
World		1,500 to 2,000

Aquifers are most severely depleted in parts of India, China, the US, North Africa and the Middle East. It can take centuries for aquifers to recharge, so the world is currently running a groundwater overdraft of 200 billion cubic meters a year.

Pollution is a major problem, resulting from human and farm animal waste, naturally occurring toxins, as well as the over 10 million different synthetic chemicals in use today.

References:

1 UNEP, *Global Environment Outlook 3* (Earthscan 2002).
2 Rob Bowden, *Water Supply: Our Impact on the Planet* (Hodder Wayland 2002).
3 Peter Gleick et al, *The World's Water 2002-2003* (Island Press 2002).
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6 Lester R Brown, *State of the World 2001* (Earthscan 2001).

Critical Areas

Fighting over buckets:

Every morning, at the first spluttering sounds of the water ration's arrival through the pipes in the pre-dawn dark, bodies spring from beds to fill buckets and pots. In larger houses tanks are monitored whilst the taps run. In the slums they have been awake before the first drops arrived. Queuing listlessly, half-asleep, with their pots by the communal tap, waiting. Sometimes the water runs for an hour, sometimes just a few minutes. Sometimes the water company skips a day or two, sometimes more. Sometimes it places a discreet notice, after the event, in the local papers. It usually takes the telephone receiver off the hook on such days. Rumours fly... another burst supply pipe? Everyone's in a fever, repeatedly babbling their fears about when the water might return.

The city's poor, with limited means of storage at their disposal, are forced to buy exorbitantly priced water brought in by tanker. Fights erupt. There have even been murders.

The city is Indore, a bustling hub of 1.5 million inhabitants located atop central India's Deccan plateau. There has been a 'water problem' here as far back as people can remember. Today it is estimated that water supply to the city is half of what is actually required. A rise in population and a steady decline in rainfall are usually blamed. But there are other culprits too.

Ironically, chief among them is the Government's vision originally intended to quell the shortfall. 'Modernity' and 'development' have been its burnished aims. They brought forth grandiose schemes to engineer water supplies to India's thirsty cities, complete with political rhetoric about delivering piped water to the rural poor. In Indore's case a project to suck up water from the Narmada River lay unfinished for years. It then failed to meet ever-increasing demand. Meanwhile Indore's own streams, an historical source of water, were neglected and turned into stagnant drains. Ecologists argue that the promise of a 'modern' tap in every home turns people into passive consumers of state-provided water and erodes the traditional role of communities in maintaining local water supply.

Water shortage is accompanied by a glorious inequality in supply. A street where the bureaucratic top brass live is conspicuous for its lush gardens even during the season of dust that is the central Indian summer. An industrialist's mansion down the road has an indoor swimming pool. And then there are whole localities with either a very tenuous supply or none at all.

Running low

It's the kind of crisis that is mirrored in cities right across the so-called developing world – with no end in sight. Today, for the first time in history, as many people live in urban concentrations as in rural areas. As cities swell unplanned and the newly dispossessed crowd into shantytowns and slums, their collective thirst grows. Old and leaky water infrastructure – an estimated 70 per cent of the water supply is lost as a consequence – combined with listless, cash-strapped and often corrupt administrations result in a situation that rarely improves. In grand development terms, to bring a reasonable supply to the billion people worldwide who lack a clean source of drinking water, the world needs to invest at least 80 billion dollars per year; an amount far from the reach of those who need it most.

If we consider that in the past hundred years, oil has been one of the major players of international relations, then what should we make of the business magazine *Fortune*'s assertion (in May 2000) that 'Water promises to be to the 21st century what oil was to the 20th century.' It implies both that water has a commercial value and that it is scarce. That it is invaluable to life cannot be questioned – humans can last for a maximum of three days without water. The Turks have a saying: 'Iraq has oil, we have water. Let them drink their oil.'

How scarce is water? Surely there's so much water around us. But only 0.01 per cent of our planet's water is available for our use. Even this would be sufficient for our needs, were it not for its uneven distribution: the amount of water available depends on the location of water bodies and the amount of rainfall. On the one side are nations like Brazil, the former Soviet states and Canada with an abundant natural supply; and on the other there are the arid zones of the Middle East and numerous African nations where nature is less generous. Some countries, like China, have plentiful water but experience stress due to mismanagement, pollution and the increasing demands of a large population.

AFRICA

According to a UN Development Programme (UNDP) report, potential 'water wars' are likely in areas where rivers and lakes are shared by more than one country,. The main conflicts in Africa during the next 25 years could be over that most precious of commodities - water, as countries fight for access to scarce resources. The possible flashpoints are the Nile, Niger, Volta and Zambezi basins.
The report predicts population growth and economic development will lead to nearly one in two people in Africa living in countries facing water scarcity or what is known as 'water stress' within 25 years.
Water scarcity is defined as less than 1,000 cu.m of water available per person per year, while water stress means less than 1,500 cu.m of water is available per person per year.
The report says that by 2025, 12 more African countries will join the 13 that already suffer from water stress or water scarcity

The Nile battle
The influential head of environmental research institute Worldwatch, Lester Brown, believes that water scarcity is now "the single biggest threat to global food security".
He says that if the combined population of the three countries the Nile runs through - Ethiopia, Sudan and Egypt - rises as predicted from 150 million today to 340 million in 2050 then there could be intense competition for increasingly limited water resources.
"There is already little water left when the Nile reaches the sea," he says.
And he predicts that Egypt is unlikely to take kindly to losing out to Ethiopia - a country with one-tenth of its income.
Indeed water is already a catalyst for regional conflict.
In the dying years of the previous Ethiopian government, tensions with Egypt increased rapidly when the rulers in Addis Ababa pondered the construction of dams on the Nile.

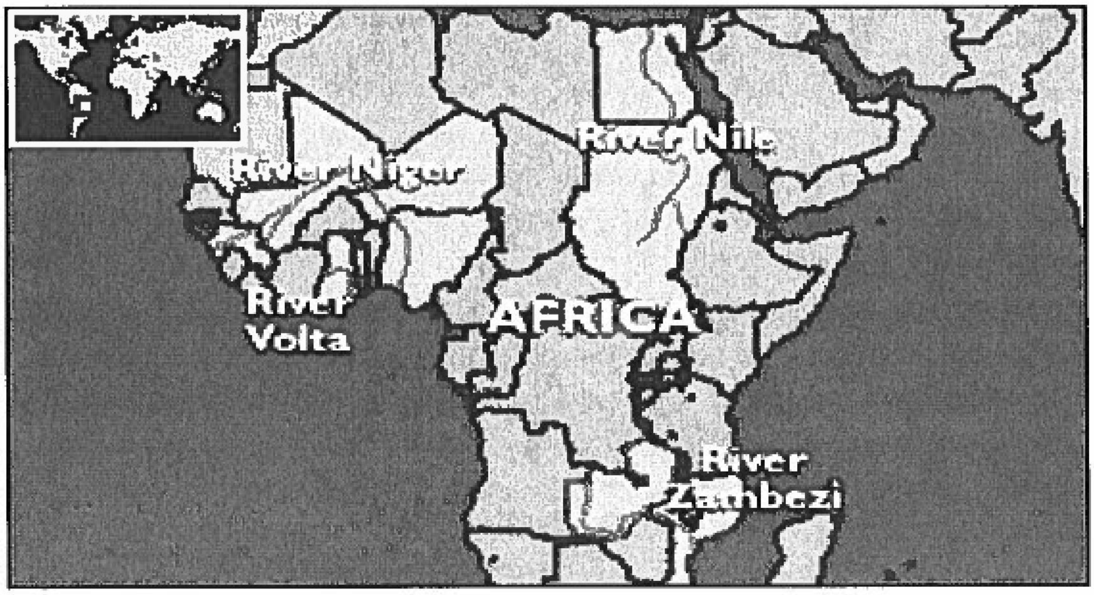
There is also another potential water war in Southern Africa involving Botswana, Namibia and Angola.
The River Cuito which begins in Angola before heading through the Caprivi strip in Namibia and ending in the marshlands of the Okavango Delta in Botswana runs through an area that is no stranger to tensions and conflict between neighbors.

Egypt – Sudan – Ethiopia

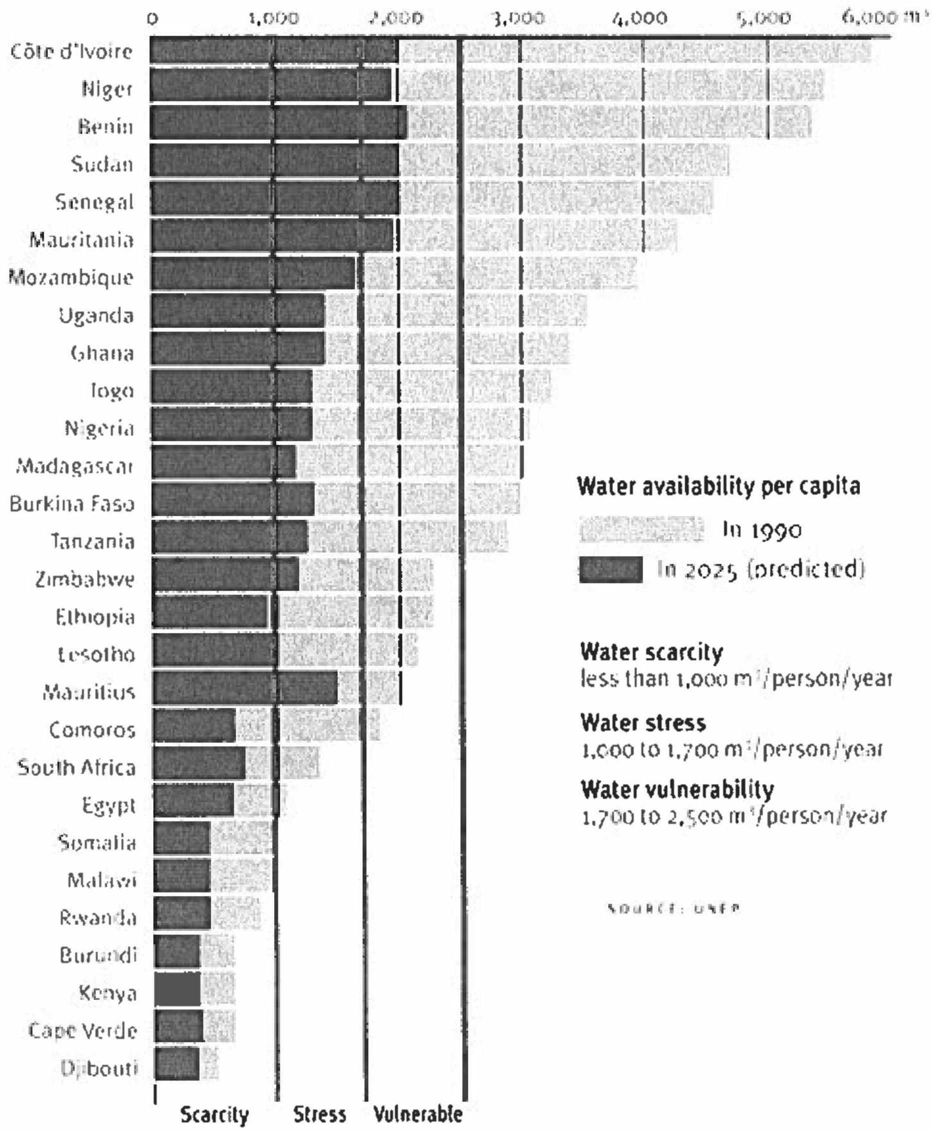
The beginnings of a crisis have materialized along the Nile as well. Ethiopia, making movements toward state building for the first time in a generation following the overthrow of the communist Mengistu regime in 1991, has focused upon water distribution as an issue of paramount concern. The North African country, currently ravaged by conflict with Eritrea, possesses neither the economic stability nor the investor confidence to facilitate desalination efforts. Consequently, Ethiopia has increasingly objected to the water use of neighboring Egypt, claiming present allocation – regulated by a 1959 agreement over Nile water – to be extremely unequitable. Asserting the 1959 agreement to be preferential to Egypt and Sudan, Ethiopia has hinted it may resort to a unilateral exercise of sovereignty or a military confrontation with Egypt.

Egypt, for its part, has long asserted aggressive control over Nile water. Situated downstream from a long line of countries with access to the Nile, water occupies a central plank of Egypt's foreign policy and national security stance. Concerns regarding water dependency spurred the efforts aimed at creating the capacity to trap and store water (including the construction of the Aswan High Dam) during the 1950s.[11] Despite these attempts, however, Egypt has become increasingly vulnerable on the water issue. Affected by environmental factors, water availability flowing to Egypt along the Nile has been significantly reduced, making Egypt increasingly dependent upon, and influenced by, the political climate and interstate dynamics of the region.

This growing vulnerability is likely to become a major source of political tension in the near future. Since Egypt has retained an aggressive military stance with relation to water, domestic Ethiopian development efforts (such as growing attempts to dam the Blue Nile) are likely to result in increasing regional tensions. In addition, Sudan has become an increasingly unstable factor in the Middle Eastern water calculus. Ravaged by civil war and guided by a radical Islamic fundamentalist regime, Sudan has manifested expansionist desires over Nile water, threatening to withdraw from the 1959 Agreement in August 1995. These movements have increasingly jeopardized the stability of neighboring nations, endangering Ethiopian and Egyptian access to water. As a result, tensions along the Middle East/North Africa boundary are on the rise, as water exacerbates and destabilizes the fragile regional status quo.



Water availability in Africa (see opposite)



The Middle East

The crisis over water in the Middle East is escalating. Despite existing agreements, dwindling resources – increasingly affected by pollution, agricultural/industrial initiatives and population growth – have elevated the strategic importance of water in the region. For Middle Eastern nations, many already treading the razor's edge of conflict, water is becoming a catalyst for confrontation – an issue of national security and foreign policy as well as domestic stability. Given water's growing ability to redefine interstate relations, the success of future efforts to address water sharing and distribution will hinge upon political and strategic approaches to this diminishing natural resource.

Approaching Crisis:

*Water Resources in the Middle East**

In the Middle East, water resources are plummeting. While representing 5% of the total world population, the Middle East & North Africa (MENA) region contains only 0.9% of global water resources.[1] The number of water-scarce countries in the Middle East and North Africa has risen from 3 in 1955 (Bahrain, Jordan and Kuwait) to 11 by 1990 (with the inclusion of Algeria, Israel and the Occupied Territories, Qatar, Saudi Arabia, Somalia, Tunisia, the United Arab Emirates and Yemen). Another 7 are anticipated to join the list by 2025 (Egypt, Ethiopia, Iran, Libya, Morocco, Oman and Syria).[2]

In addition to its scarcity, much of Middle Eastern water stems from three major waterways: the Tigris-Euphrates, Nile and Jordan River systems. Mutual reliance on these resources has made water a catalyst for conflict, spurring confrontations such as the 1967 War (fomented by Syria's attempts to divert water from Israel) and the Iran-Iraq War (which erupted from disputes over water claims and availability). Recognition of water's role as an obstacle in interstate relations has spurred numerous attempts at resolution, including diplomatic efforts (most notably the 1953-1955 U.S.-brokered Johnston negotiations) and bilateral and multilateral treaty efforts, ranging from the 1959 Agreement for the Full Utilization of Nile Waters to the 1994 Israeli-Jordanian Treaty.

Increasingly, however, and despite these agreements, nations have begun to come into conflict over water. The natural scarcity of regional supplies, historically a point of contention, has been reduced to crisis proportions by a variety of factors:

- With population rates among the highest in the world, countries in the Middle East are consuming water at a much higher rate than can be replenished naturally. Rising populations, estimated to reach 423 million by the turn of the century (and double 25 years thereafter), have increasingly affected water resources in the region; [3] In an area already critically short of water, this depletion has been compounded by domestic pollution, which has contributed to a deterioration of usable resources and a general decline in the quality of available water; and

- Expanding initiatives in agriculture and industry have further eroded regional water availability. Spurred by growing populations, many nations have begun to overexploit their agricultural capabilities, resulting in desertification (reduction of arable land).

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*Compiled in part from:

Ilan Berman and Paul Michael Wihbey: **"The New Water Politics of the Middle East ".**

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As a result of these factors, per capita water availability in the Middle East has become the worst in the world, representing only 1/3 of Asian and 15% of African levels.[4] While progressive agricultural methods – such as drip irrigation – exist, they have, as a result of prohibitive costs, been implemented by only a handful of states. Nor have current desalination efforts in the region proven capable of meeting growing demands. The high energy and large costs associated with seawater desalination have limited efforts to cash and energy rich oil-exporting countries such as Oman and Saudi Arabia.

Influenced by declining availability and reductions in overall quality, crisis zones have begun to emerge along the major rivers of the region. Evolving conflicts – between Turkey and Syria over the Tigris and Euphrates Rivers; in the Jordan River Basin between Israel, the Palestinian Authority and Jordan; among Egypt, Sudan and Ethiopia over the Nile River; and within Saudi Arabia – are manifestations of water's growing role as a strategic and political force.

Turkey – Syria - Iraq

Turkish dam controversy

Britain's involvement in the construction of a controversial dam in Turkey is once more under scrutiny.

(BBC World Affairs Correspondent David Shukman traveled to the region and reported the following).

The arguments are bitter, the issues complex but at heart the question is simple: should Turkey build a vast new dam to generate electricity? The Turkish Government says its plan for the so-called Ilisu Dam, in the mountainous southeast of the country, will be a vital catalyst for development in a neglected region.

A huge international consortium of engineering companies is lined up to start construction. A British engineering company, Balfour Beatty, is one of several international firms involved in the construction plans. The contractors and the Turkish authorities say this project will be a model of environmental and social care. They promise that as the dam is built across the valley of the River Tigris, and a deep reservoir builds up behind it, the 15,000-20,000 people who will be forced to move home will be carefully resettled. Compensation will be offered. The historical monuments and ruins of earlier ages will be documented or even rescued.

And, as for fears that the dam will become an international flashpoint - with the countries downstream, Syria and Iraq - receiving less water, officials pledge that the design of the dam will make it impossible to hold water back, and anyway Turkey would never want to.

Local opinion : With those points in mind, I set out for the region itself to find out how local people are reacting to this plan. It was, after all, a promise of the British Government's that those affected by the dam must be consulted first. The answers I got from them were very clear.

My first destination was Hasankeyf, a small but ancient town perched on the banks of the Tigris. No one knows how long Hasankeyf has been settled. Some say there is evidence of habitation stretching back 11,000 years. What no one disputes is that the town has seen waves of humanity - the Romans, the Byzantines, the Persians, the Seljuk Turks, the Mongols. And in the 14th century came the forerunners of the modern-day Kurds. No wonder Kurdish people object to the planned dam so forcefully, calling it yet another attack on their culture.

The town contains some remarkably beautiful relics. Town mayor Abdul Kusen led me along the rocky paths that connect the site of an abandoned mosque with a ruined castle. Around us were intricately-carved stone doorways and panels bearing ornate Arabic inscriptions. Across the river was a small tower, delicately-decorated with turquoise tiles, which turned out to be a mausoleum to a mediaeval Muslim king.

The mayor explained that the new reservoir would flood the entire town. Only the highest parts of the ruined castle and the very top of the main minaret would remain above the water level. I wandered around Hasankeyf seeking out local opinion. An old weaver said his family had been settled for years and he did not want to move.

Two young waiters, who spend the summers working in the tourist resorts of the Turkish coast, said the dam would be a big "mistake". "Why not develop Hasankeyf as a tourist destination? That would be more help than the dam," they said.

No one was as openly critical in public as they were in private. This is not a part of the world where free speech is encouraged.

Decision time

Our movements were constantly monitored by a pair of plain-clothes security men. When an armoured Landrover rumbled past, we were asked to stop filming. Yet it is in this atmosphere, more intimidating for those who live here than for us, that the authorities are supposed to test local opinion. Campaigners against the dam say there can never be a real assessment of public opinion.

Meantime, along the Tigris and Euphrates Rivers, Turkey and Syria are currently approaching a massive confrontation over water resources. Relations between the two countries, strained at best, have been exacerbated since the 1980s by growing tensions over water, which have brought them to the brink of war several times.

Despite the signing of a protocol ensuring Syrian access to Euphrates water in 1987, Turkish development efforts have increasingly threatened to marginalize and even eliminate Syrian access to water. Most notably, the Southeast Anatolia (GAP) Project has provided Turkey, situated at the headwaters of the Tigris and Euphrates River system, extensive control over the flow of Euphrates water.[5] Turkish disruption of the flow of the Euphrates in January 1990 to fill water reservoirs in front of the Attaturk dam highlighted Syrian vulnerability to Turkish control over upstream water resources. Further complicating the issue is Syria's continued support for the extremist PKK (Kurdish Workers' Party) in its insurgency against Turkey, a move that has prompted Turkey to threaten a blockade of water.

In the future, Turkish-Syrian disputes over water could escalate into regional conflict. Both Syria and Iraq, situated downstream from Ankara, have become increasingly threatened by Turkey's large-scale consolidation efforts. Once fully operational, the GAP Project may reduce Euphrates water to Syria by 40% and Iraq by up to 80%.[6] Such activity, critical for Syria, will also be significant enough to substantially affect Iraq, currently somewhat autonomous because of its access to Tigris River water. In addition, aggressive Turkish acquisition efforts, currently concentrated on the GAP Project, are anticipated in the future to focus upon Tigris River water as well. Though currently divided in their opposition to Turkish efforts, such activity could nudge Syria and Iraq – despite their differences – into a strategic alliance, possibly destabilizing the region and precipitating a regional conflict.

Jordan – Israel – Palestinian Authority

The Jordan River Basin has also emerged as a flashpoint for conflict over water. Resources in the area, suffering serious overuse as a result of pollution and population growth, have increasingly impacted interstate relations.

Between Jordan and Israel, water resource issues are reaching a fever pitch. Despite the 1994 Israeli-Jordanian Treaty – which established comprehensive guidelines regulating the distribution, preservation and availability of water from the Jordan and Yarmouk Rivers – conflicts over water have risen to the forefront of relations between the two countries. Jordan, fed only by underground sources and the Jordan River, has experienced an escalating water deficit – one that is expected to reach 250 million cubic meters (nearly 1/3rd of current annual consumption) by 2010.[7] At the same time, Israel – currently utilizing almost all available water from its National Water System (consisting of the West Bank Mountain Aquifer, the Coastal Aquifer and the Lake Kinneret Basin) – has been forced to resort to overexploitation of available resources for expanding agricultural and industrial ventures.[8]

As a result, water has become a critical bone of contention between the two countries, a tension exacerbated by the recent effects of the region's harsh climate. Facing a looming deficit in water availability brought about by lingering drought conditions, Israel halved its annual allocation of 2 billion cubic feet of water to Jordan in March 1999. Jordan, hit hard and lacking adequate desalinization capabilities, has in turn found itself unable to sustain current levels of consumption, declaring drought conditions and mandating water rationing in May 1999.

A breakdown of relations between Jordan and Israel could lead to water grabs by either side. Plagued by escalating populations that are stretching water availability beyond sustainable levels, Jordan has placed increased value on its "hydraulic imperative," a move that has created growing Israeli fears of a Hashemite grab of resources.[9] For its part, Israel, facing reductions of internal water sources as a result of expanding Palestinian populations in the West Bank and Gaza Strip, may soon eye the Jordan and Yarmouk Rivers as important enough to risk conflict over.

The historically troubled relations between Israel and the Palestinians have also been magnified by water. Mutual reliance on the West Bank Mountain Aquifer, which rests atop the demarcating border of the disputed West Bank territory (and currently provides 1/3rd of Israel's water supply and 80% of Palestinian consumption), has created friction between the State of Israel and the Palestinian Authority. Despite being the most important source of long-term water for Israel, use of the Aquifer – as a result of its uncertain status – has not been implemented to the fullest extent possible. Israeli officials, while cognizant of the growing water crisis, fear Israeli dependency on potentially Palestinian-controlled water sources.

THE CONFLICT

It is midwinter in Bethlehem. Sturdy sprouts of new grass carpet the earth. In a clearing past a grove of olive trees, a snowy white lamb stands skittishly behind its grazing mother. The eldest member of the Darwish family leads her on a rope.

The scene is deceptively idyllic. To get here, you have to crawl deep into a ditch and over jagged rounds of barbed wire, then through a rocky field. The ditch and barbed wire are only a precursor to the towering wall slated for construction that will slice the Darwish farm in half and separate it from nearby Bethlehem - as well as a nearby Israeli settlement. There is just one route out of the farm; but the Darwishes are compelled to request written permission from the Israeli army to use it.

Israel says that it is building this wall to separate Palestinians from Israel and provide vital security. But the wall is doing other things too: dividing up agricultural land, separating communities and cutting farmers off from necessary resources. In the northern West Bank, the barrier has been constructed squarely on top of a major aquifer.

Two years into this bloody Israeli-Palestinian conflict, the region's competing actors are jockeying to maintain control of the available water. The combination of a naturally arid environment, years of drought and poor planning is proving to be dry tinder in a combustible atmosphere.

Take Israel's infrastructure minister Effie Eitam's order halting all Palestinian well drilling in the West Bank in October 2002, alleging that Palestinians were running a 'water Intifada' against Israel through unauthorized tapping. Besides endangering the crippled Palestinian farming sector, the move threatened the tens of millions of dollars of foreign aid money spent on unfinished water infrastructure.

The next day Fadl Qawash, the head of the Palestinian Water Authority, was irate. 'Year by year, we have less and less water. No more water in the springs, no more water from the weather and at the same time the Israeli side has applied a policy to reduce the water that they supply us,' he said. 'Now they are blaming us for stealing water. This is not stealing water. This is our water.'

There lies the crux of the problem. Israel has access to both high-tech solutions and water from the occupied West Bank. Palestinians, on the other hand, have far less water to work with and remain caught in the terms of agreements signed with Israel years ago. Palestinian long-term planning remains tentative as long as the issue of their regional water rights is unresolved.

Rock bottom

From the start, negotiations over water have been rife with miscalculations, poor planning and plain old huckstering. Palestinian negotiators headed to talks in 1993 and 1995 with few real numbers on the groundwater available in the West Bank and Gaza Strip under Israeli occupation since 1967. All the data they had was Israeli, and Israel was holding its cards close to its chest.

Four aquifers were under discussion: the western, northeastern and eastern aquifers in the West Bank, and the groundwater that lay under Gaza. Of these, only the eastern aquifer was not tapped to its full capacity according to Israeli engineers. It was determined that 78 million cubic meters might be pumped from that aquifer to fill immediate Palestinian needs.

But this was not the boon that Palestinians were looking for. They argued that as part of the process of decolonization of the occupied territories, Israel must also relinquish its hold on the water resources. Some 85 per cent of this water was already being used in Israel proper and by Israeli settlements dotting the West Bank and Gaza Strip.

There was no solving the conclusive issue of water rights and so the dispute was set aside for final talks (the talks that eventually collapsed at Camp David in the summer of 2000). Instead, a joint water committee was established for Palestinians to submit plans to develop the annual 78 million cubic meters of eastern-aquifer water that they had been allotted from the only underground water source entirely in the West Bank. A three-stage project was developed to dig new, deeper wells, with the United States Government pledging $211 million to move the project forward.

But by 1999, the contractors had finished their initial tests and determined that the eastern aquifer could not yield even half the promised amount. Worse, testing showed that the wells already drilled were coming up saline. The new pumping was using the precious resource faster than it could be renewed by annual rains.

The Demand

Israelis on average use 350 liters of water a day, four times as much per capita as do Palestinians. Israeli settlers in the occupied territories, many of them living a suburban lifestyle complete with lawns and pools, use more than twice that average. Palestinian daily consumption, on the other hand, is not more than 76 liters. The reality for some communities is much worse.

'In the Toubas area, for example,' says Qawash, speaking of a northern West Bank district, 'there is only one well for 50,000 people, which produces not more than five liters per capita [daily].'

Ongoing military operations have damaged essential water and sewage

connections. Beit Djan, a village 6 kilometers east of Nablus, was kept under a hermetic military siege for 25 consecutive days during February and March 2002. The result was a shortage in drinking water for both the people and their livestock; the village is not connected to a water pipeline and gets most of its drinking water trucked in from outlying wells.

Israel wants Palestinians to invest in desalination plants instead of sharing present supplies. Palestinians have embarked on one such project in Gaza that could provide water at $.55 a cubic meter. But this is a prohibitive rate as, right now, water in Gaza sells for $.23 a cubic meter. 'Israel itself should guard against waste,' says Palestinian Water Authority spokesperson Ihab Barghoti. 'Maybe they can afford desalination - they have the sea - but Palestinians can't afford this and so we are going to protect our rights.'

The longer it takes to sort out those rights, the more the facts shift in Israel's favour. Israel has already poured the cement for the massive wall in the northern West Bank that sits right on the western aquifer. In November, the department of agriculture in the Palestinian town of Qalqilya reported the military confiscation of 14 artesian wells for the construction of the wall; those wells produce 2.5 million cubic meters of water a year.

Israel's actions are guided by a newly recognized urgency. Predicting a 125-million-cubic meter water deficit for last year, the Government has enacted a four-billion-dollar plan to be completed by 2010 to build seawater and brackish water desalination plants, rehabilitate polluted wells and import water from Turkey by tanker. The seawater plants will produce water at a cost of $.50 per cubic meter, cheaper than any other such project in the world. Israel will also benefit from its own invention and wide use of drip irrigation. The technique minimizes water evaporation and allows roots to be fed by normally damaging briny water. Israel is also the only place in the world that has had regular success in seeding clouds for rain.

Efforts at cooperation between Israel and the Palestinians have so far proven markedly ineffective. Despite the passage of the 1995 Interim Agreement on the West Bank and Gaza Strip, which included a Water Annex dealing specifically with water resource distribution, Israeli-Palestinian relations have continued to be plagued by conflicts over water. The Palestinian Authority, in spite of the "equitable distribution" formula constructed under the Water Annex, has claimed to be suffering from uneven water allocation under Israeli guidelines maintaining water distribution proportions at 1967 levels. Even the Multilateral Water Resources Group, created in 1992 as part of the peace process negotiations, has failed to affect movement toward agreement on water sharing between the parties.

In the north of the country, growing Syrian designs over the Golan Heights, where Israel has remained firmly entrenched since the 1967 War, threaten to jeopardize another source of dwindling Israeli water, the Lake Kinneret Basin. At the same time, the possibility of Palestinian control of the West Bank suggests, at the very least, a further reduction of available water to Israel, currently utilizing the majority of the West Bank Aquifer. Due to an amalgam of factors, Israeli security prerequisites for dealing with the Palestinian Authority – the ability to protect its water sources from hostile action, pollution or co-option – are not currently met, making water a critical emerging issue of dispute between the parties. These fundamental disagreements have deadlocked talks between the parties and edged them closer to confrontation.

Barring technological advances, the delicacy of water appropriation was showcased last year when Lebanon began to divert what it reports as seven million cubic metres a year from the Wazzani Springs, which flow into the Jordan River and Israel. Israeli Prime Minister Ariel Sharon called the diversion a casus belli [cause of war] and American monitors were hurriedly brought in to assess the situation. According to Micky Simhai, director of Israel's northern water authority, if Lebanon has any thoughts of diverting more waterin the mounting crisis, the Wazzani could mean the next war.

Saudi Arabia

Saudi Arabia is another country rapidly approaching a dramatic crisis over water. In Saudi Arabia's case, however, the crisis stems from the country's lack of rivers and permanent bodies of water, as a result of which it relies heavily upon underground water sources for its agricultural and potable water supply. At present, 90% of Saudi Arabia's non-renewable deep-well water is utilized for agricultural purposes.[12] These resources, already precariously low, have been significantly eroded in recent years as a consequence of the Persian Gulf conflict. Iraq's burning of oil wells during the Gulf War further contaminated underground water resources already degraded by pollution seepage from agricultural activity, creating a deficit that has failed to be resolved to date, despite significant Saudi desalinization attempts.[13]

The state of water resources has significantly affected the nature and stability of the current Saudi regime. Though buoyed by oil revenues, which have facilitated massive desalinization efforts, Saudi Arabia has failed to adequately address its growing water concerns. Consequently, Saudi Arabia has begun to seek other water sources, a focus that has had pronounced effects on the region. Saudi Arabia's extensive exploration into the underground aquifers in its Eastern Province has reduced the agriculture and water availability of Qatar and Bahrain.[14] The resulting political tension points to an emerging conflict over water resources in the Persian Gulf Peninsula, one that may engulf both Saudi Arabia and her neighbors.

Disputes are also becoming visible between Saudi Arabia and Jordan over the Qa Disi Aquifer. Though currently utilized almost exclusively by Saudi Arabia, Jordanian vested interest in the aquifer, which runs beneath both countries, has increased in recent years, with Jordan's Minister of Agriculture publicly accusing Saudi Arabia of overuse of the aquifer as far back as November 1992. Expanding Jordanian utilization of the aquifer, which is likely in light of Jordan's looming water crisis, may emerge as a contentious issue between the parties in the near future.

A Strategic Umbrella for Middle East Water

Depleted by expanding populations, rising birthrates and growing agricultural initiatives, water is redrawing the geopolitical landscape of the Middle East. Already considered a zone of conflict in international planning, the Middle East stands poised to deteriorate into regional infighting over water allocation and accessibility.

To date, the volatile politics of the region have arrested the implementation of progressive efforts at water sharing. Turkey's proposed "peace pipeline" – designed to carry water from the Turkish Seyhan and Ceyhan Rivers to Saudi Arabia, Kuwait and other Gulf states – has, as a result of regional fears of dependence, failed to progress beyond the planning stage. Other regional initiatives, such as importing water by sea and comprehensive interstate water allocation, have also failed, threatened by fragmented politics and historic distrust.

This deadlock has eloquently illustrated water's integral role in the larger balance of power equation in the Middle East, where water-planning issues have become a function of the security and stability of regional regimes. Those countries living in the shadow of Iraq, where dictator Saddam Hussein remains firmly entrenched, fear a repeat performance of the 1990 seizure of Kuwait. Given the disarray of international efforts to depose or even contain the current Iraqi regime, these countries have been – despite their escalating crises over water – unwilling to engage in any regional activity that could exacerbate Baghdad's hostility. Movement is also visible in the eastern Mediterranean, where Syria's Assad and the PLO's Yasser Arafat have shown growing alignment with Iraqi and Iranian politics, much to the uneasiness of moderate regional neighbors such as Israel, Jordan and Turkey.

Future efforts to normalize regional tensions over water will hinge upon the equitable distribution of available resources, and the creation of security frameworks to ensure their safety and stability. Despite the volatility of Middle Eastern politics, the beginnings of such frameworks are already in place. Turkey and Israel have manifested a burgeoning strategic alliance on economic, political and military affairs. Jordan and Israel have commenced a comprehensive dialogue on political and military affairs (including joint counterterrorism initiatives), efforts strengthened by the signing of 1994 Israeli-Jordanian Treaty. These developing alliances could, with the proper international support, serve as a fulcrum for regional stability.

Laying the Groundwork

Only under a new strategic architecture can the normalization of growing water conflicts become a realistic option. The creation of an alliance system based on the use of strategic resources in a rational and equitable manner may allay current fears and facilitate interaction on the basis of mutual benefit. A stable strategic grouping capable of intimidating Syria's Assad into passivity, or quelling Saddam's expansionist efforts, would facilitate the commencement of large-scale regional water planning. Since extensive water planning proposals will necessitate the establishment of pipelines and energy grids stretching across borders, a political and military structure that can ensure the safety and security of these carriers (and by extension the precious liquid within them) will be a prerequisite to effective water sharing. The eventual creation of such a structure could be facilitated through coherent regional coordination in the near term, including:

Resolving outstanding disputes over water – the requisite first step toward the creation of a regional political alliance over water issues hinges upon the resolution of current disputes affecting moderate, alliance-building countries. Jordan and Israel, currently locked in an escalating struggle over Jordan River Basin water, desperately need guarantees of water security and availability. Such needs could begin to be addressed through the creation of a trilateral (and potentially quadrilateral, with oversight by the United States) Turkish-Israeli-Jordanian diplomatic track geared at resolving current conflicts over water. Progressive solutions, and ones currently unexplored by the governments of these countries, could include the establishment of a trade agreement instituting Turkish water allocation to Jordan, a move that would provide an alternative source of water for Jordan while easing Israel's growing worries over water availability.

Integrating water into regional strategic cooperation – Further movement towards strategic water security could be assisted through the integration of water as a distinct element of coordination among the burgeoning strategic alliances taking shape in the region. Creating a solid political-military framework on water issues (perhaps through the formal signing of a Memorandum of Understanding similar to the one which laid the foundation for U.S.-Israeli strategic coordination in 1981) could initiate a broad range of collaborative ventures, such as:

- the creation of concrete military coordination, including mutual defense agreements over regional water supplies, among cooperating nations;

- the commencement of research and development efforts on the issue of regional water sharing – including multilateral plans for creation of a regional grid of interstate carrier systems;
- the establishment of a structure for regional information-sharing regarding environmental conditions and technological breakthroughs. Such an effort could include the construction of a Turkish-Israeli-Jordanian regional database to expedite centralized responses to emerging water conditions and changes.
- The integration of water into emerging regional frameworks of strategic cooperation would also provide a forum for individual governmental involvement, facilitating the passage of domestic legislation and allocation of funds, as well as spurring the creation of specialized agencies designed to coordinate intergovernmental efforts on water issues. In addition, the formalization of strategic interaction over water will substantially further

international economic investment by creating coherent regional movement toward securing the safety and availability of resources.

These regional efforts can be cemented by the domestic initiatives of individual nations. Internal reform, restructuring and development will assist further movements toward consensus over water resources on a regional level. Such domestic efforts could include:

The modernization of current systems of water distribution and processing – Statistics indicate that water networks in Jordan and the Occupied Territories currently lose up to 55% of carried water as a result of leakage from old and damaged piping.[15] The initiation of repair and reconstruction efforts by regional governments would therefore increase the efficiency and capacities of existing systems, reducing water waste and raising available totals. Such modernization efforts are also likely to bring larger economic dividends. The implementation of a coherent modernization plan would invite international development and involvement by private contractors and engineering firms, (and facilitate financing from the World Bank and other financial institutions).

Consolidate strategic control over current water efforts – On the strategic level, a reexamination of current initiatives is also necessary step. While representing the only currently viable method of addressing regional water woes, desalinization is a dangerous and ultimately futile mechanism for change in the region. As water has risen in strategic value, so have imperatives regarding its security. Vulnerability to attack, dependency on foreign sources of energy, and prohibitively high costs consequently make desalinization efforts a strategic liability for countries in the region. In fact, desalinization may actually escalate the potential for an eruption of conflict by presenting easy, complete methods of water processing – a prize water-starved nations may soon not be able to resist. A turn away from current desalinization efforts would free up much-needed capital and consolidate the strategic posture of nations in the region.

Implementation of progressive domestic water initiatives – In light of water's growing role in the high politics of the region, the success of a strategic alliance over water will be predicated upon the success of domestic responses to water reduction. Research and development efforts geared at exploring emerging innovations in water technology should therefore be regarded as a national security priority by nations in the region. Possible innovations could include the initiation of "water harvesting" efforts through the construction of micro-scale dams and aquifers to gather rainfall and storm run-off. Such initiatives could substantially increase the agricultural and potable supplies of regional nations; studies indicate that such a technique could provide a 5% increase to the water supplies of Jordan, Israel and the Palestinian Authority.[16] Another option is the implementation of a 'virtual water' approach (based upon the processing of grains and foodstuffs to release trapped water for agriculture) which is, by some assessments, actually significantly more efficient than importation or desalinization.[17]

The Future of Middle East Water

Facing historical, psychological and political barriers that have impeded cooperation and deadlocked diplomacy, nations in the region are sliding toward conflict over water. Water's growing role in the emerging hydropolitics of the region has stressed the need for a new approach to safeguard this diminishing resource. The integration of water into developing strategic cooperation frameworks becoming visible among regional states could facilitate the protection and preservation of water resources. This interaction could eventually pave the way for the long-term security of Middle East water. In light of the formidable barriers that have prevented agreement to date, such an approach may represent the only method by which to turn back the tide of the new water politics of the Middle East.

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South Asia

The Ganges: Troubled waters

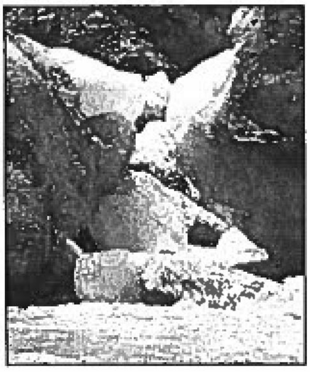
(The BBC Hindi Service's Shiv Kant travelled down the Ganges from its source to the delta).

No river in the world plays a more important economic, social and cultural role in the lives of more people than the Ganges. Emerging from the central Himalayas, the river flows through the north Indian planes, providing water and drainage for over 350 million people.It is a meeting point for both the rich and poor, who believe it is a divine route to heaven. Ironically, this divine status may be threatening the river's very existence.

Source of the river

The river emerges in spectacular fashion from an ice cave under the Gangotri glacier, which is receding by hundreds of feet every year.

A team of glaciologists monitoring the glacier blame global warming, which is causing a decline in the snowfall needed to replenish the glacier.



The glacier which supplies the Ganges is retreating

But they also point to the mushrooming huts and tents around the glacier used by a rising tide of pilgrims, who further increase the temperature by burning fossil fuel.

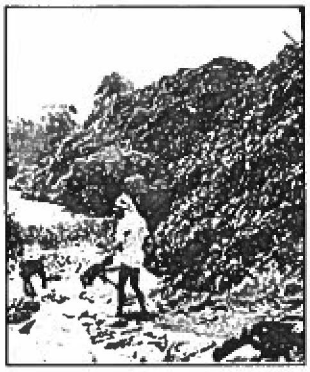
The river is also fed by a dwindling supply of subsoil streams. These streams are drying up because much of the forest has been cut down.

Dirty waters

Soon after the Ganges begins its slow journey through north Indian planes, some 165 miles downstream at Rishi Kesh, most of its dry-season flow is diverted to canals, first at Haridwar and then near Aligarh.

At the same time, towns and industries discharge a large amount of waste in the sacred waters.

By the time the river leaves Kanpur, one of the big industrial centres along the river, the load of human, animal and industrial waste becomes overwhelming, threatening the rare species of fish, dolphins and soft-shell turtles.



Riverside rubbish moutains near the holy city of Benaras

Fighting pollution

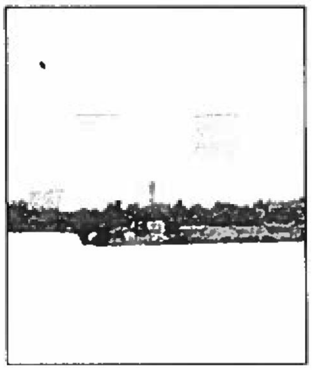
Alarmed by the rising level of pollution, the Indian authorities launched an ambitious Ganga Action Plan in 1986 to clean the river.

But 14 years on, the environmentalists say little has been achieved.

Although more than $600m has been spent, environmentalists say it was largely on inappropriate technology.

For example, sewage treatment plants were bought, which need constant power supplies that are not available.

However, the experts say the level of pollution in the river has been contained, even if it has not been eliminated.



Narora nuclear power plant discharges its waters into the Lower Ganges canal

Meanwhile, the government is planning to build more than 50 dams and barrages to regulate the river-flow, supply water and generate power. The largest of them near Tehri has already attracted controversy amid concerns about safety and the envirnoment.

Into Bangladesh

The river has also been the source of long-standing water dispute with Bangladesh.

India has built a barrage just before the Ganges enters Bangladesh in order to keep the port of Calcutta open during summer.

Bangladesh complains that the diversion leaves little water in the river, turning its south-western parts into a desert.

Both countries made a new agreement in 1998 to share the river water but the problem won't go unless serious effort is made to improve the dry-season flow.

The population in the Ganges river basin is growing at an alarming rate. And as more and more people move to the cities, demand for water is set to explode.

Sri Lanka's Drought

By BBC Correspondent: Frances Harrison in Colombo

The International Federation of Red Cross and Red Crescent Societies has launched an appeal for emergency funds to help 300,000 people in southern Sri Lanka affected by prolonged drought.

The Red Cross is asking for $700,000 to support the worst affected farmers, whose families no longer have enough to eat.

One survey has already found a high level of malnutrition among children in the area, thought to be linked to the crisis.

The Red Cross says there has been no rain for nearly two years in Hambantota, a normally lush green agricultural region at the southern tip of Sri Lanka.

Local people say the rain pattern has changed dramatically in the last five years and this is the worst drought they remember for half a century.

Changed landscape

Aid workers who have visited the area say the tropical landscape has turned grey and dry, with not even a leaf visible in some places to feed livestock.

All the wells and reservoirs in four villages have completely dried up, and many more wells and small lakes are in the process of disappearing.

Local people say weather patterns have changed recently

Thousands of people are now reliant on tankers to bring in drinking water.

One charity working in the area, World Vision, said the food situation was now very critical. A survey they conducted jointly with the government found that 30% of children under five years old are now malnourished.

They believe there is a direct link between the ongoing drought and malnutrition and have, like the government, been running food for work programmes for some months.

Hungry children

World Vision also say attendance at some schools has dropped by up to a quarter because children are too hungry to concentrate on their classes.

Even if the next monsoon rains do come towards the end of this year, farmers will not get a harvest until well into next year and they are already in debt after the loss of four successive crops.

Now the Red Cross is launching an international appeal for money to feed nearly 40,000 of the worst affected people for the next six months.

The federation says this is a slow onset disaster in a forgotten corner of Sri Lanka, but they are hoping it will catch the attention of donor governments and Red Cross societies around the world.

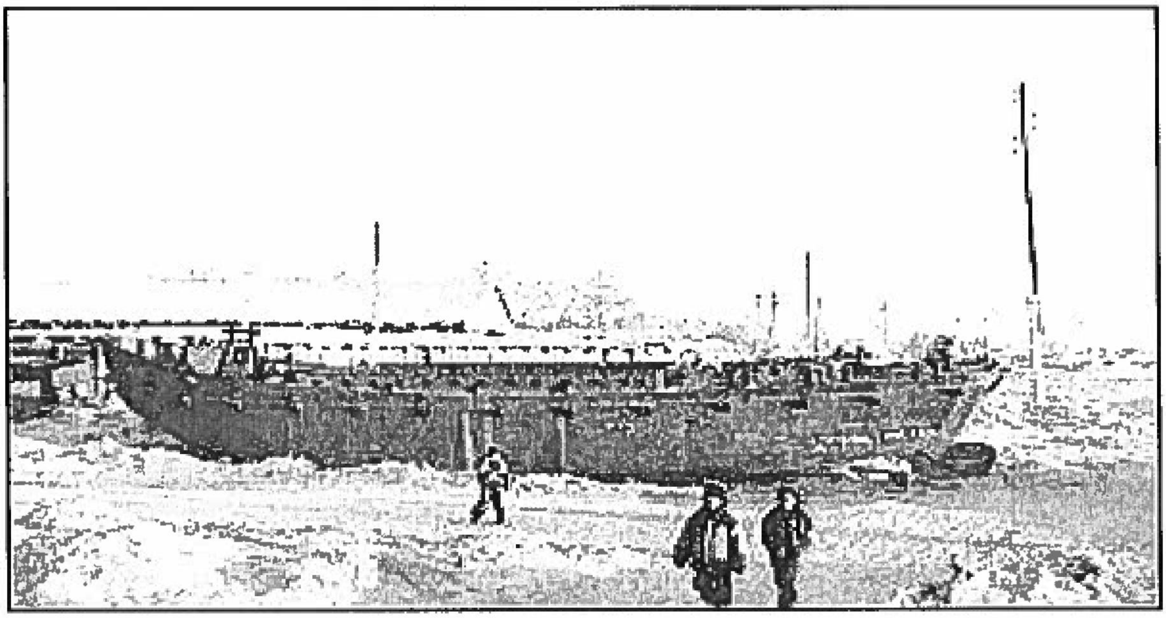
Central Asia

The Aral Sea Tragedy

By BBC's Paul Welsh in Uzbekistan

Forty years ago, Muynak was a busy fishing port where the waters of the Aral Sea lapped up against the shoreline. Today the waters have receded so much, that there is not a drop as far as the eye can see. When the former Soviet Union diverted the Ama Dariya and the Syrdariya - the rivers which fed the Aral Sea - to grow cotton in the desert, they created an ecological and human disaster. You need to take to the air to appreciate the scale of the damage that has been done.

What was the fourth biggest inland sea is now mostly desert. What appears to be snow on the seabed is really salt. The winds blow this as far as the Himalayas. An analyst from the organisation set up by five countries nearest the old sea told me that by changing farming methods, they have slowed down the rate of shrinking. Still, it will be years yet before what is left of the sea begins to grow again. All of this was done in the name of cotton - grown where it would not grow naturally. The Soviet Union developed huge plantations here. It remains the main source of income for the newly independent republics.



Children play in a ship cemetery in the Aral Sea

Change is difficult, but change they must. Miles from the Aral Sea, the ground is encrusted with salt.

Decades of heavy irrigation have raised the water table and brought all the salts the soil held to the surface.

Disease is rife

The human misery is huge. One victim has tuberculosis, which is rife and on the increase in the rest of the population.

Disease is rife

The human misery is huge. One victim has tuberculosis, which is rife and on the increase in the rest of the population. Cancers, lung disease and infant mortality are 30 times higher than they used to be because the drinking water is heavily polluted with salt, cotton fertilisers and pesticides.

Rim Abdulovich Giniyatullin of the International Agency for the Aral Sea Program hopes that the rest of the world can learn lessons from the Aral Sea tragedy."Don't allow the misuse of water," he warns. "Be careful about how much you use, and stop before the source starts to shrink."

The Utegenova family lives in Muynak. One of them works - but only part-time. Jobs and food died with the sea. The Utegenovas are constantly hungry and sick. Their tea is salty because of the contaminated water. It killed their father who died 10 years ago of cancer of the oesophagus, a common complaint here.Zulayho, who is pregnant, goes for more water. Like 80% of expectant mothers, she is probably anaemic. She knows that if her child survives, it will almost certainly be ill. "I know the water is not good. If my children get ill, I take them to the doctors," she explains. "But whatever the doctor does the children don't get well again - because they still have to drink this water."

The Red Cross and Red Crescent have begun to bring food to the most destitute. Rice, flour and oil supplement a meagre diet. These organisations are only able to help 10% of those living below the poverty line in a poor country. Nina Nobel of the Red Cross says that she hopes it will help to reduce some diseases. "Particularly tuberculosis," she says. "The immune system becomes weakened due to poor nutrition. People become very vulnerable.

"You have these big extended families living in very poor conditions right now and the tuberculosis spreads very quickly."

Bleak future

The children of Muynak have made a playground out of the wrecks of ships which might have provided food and a future for them. As I walked with Togian Ibragimova, Muynak's deputy mayor, through the ship graveyard, the rusting remains of their fishing fleet, she expressed the concern that no one would ever learn from what has happened to the Aral Sea and its people.

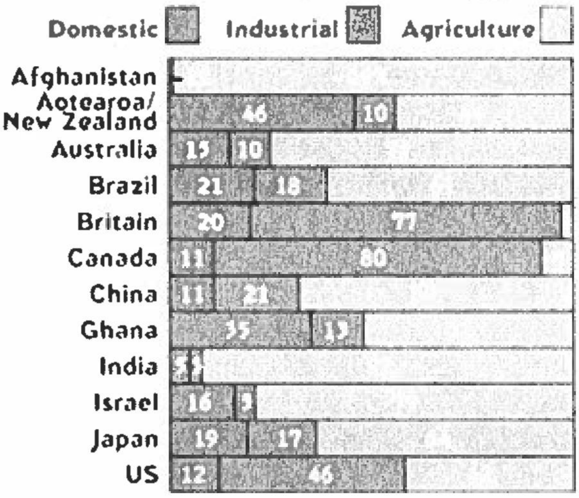
"It could happen again," she explains. "No one looked scientifically at what changing farming methods here would do." "It could easily happen again and again. Human beings can be very stupid."

WHERE'S IT GOING?

Our increasing thirst is a result of growing population, industrial development and the expansion of irrigated farming. In the past 40 years, the area of irrigated land has doubled.

World water use[2]

Water use, selected countries, 2000[1]



Average water (in litres) needed to produce a kilo of food[3]

Potatoes	1,000
Maize	1,400
Wheat	1,450
Rice	3,450
Chicken	4,600
Beef	42,500

SIGNS OF STRESS

- By the mid-1990s, 80 countries home to 40% of world population encountered serious water shortages. Worst affected are Africa and the Middle East.

- By 2025 two-thirds of the world's people will be facing water stress. The global demand for water will have grown by over 40% by then.

- The only ray of hope is that the growth in actual use of water has been slower than predicted.

People without access to a safe water supply, 2000 (in millions)[4]

Region	Rural	Urban	Total
Africa	256	44	300
Asia	595	98	693
Latin America & the Caribbean	49	29	78
Oceania	3	0	3
Europe	23	3	26
North America	0	0	0
World	926	174	1,100

"Most of the world's water crises can be resolved but would require political will and spending from US$50 billion to $100 billion a year"

-- United Nations' top envoy on water issues, 12/3/2003 --

"Humanity woke up happy to welcome the twenty-first century.
We turned and looked around and there was brightness and freshness in the air.
We had departed from the traditional history that was written with red ink -- wars, skirmishes, conflicts, murders -- many of them arising because human existence was dependent upon land and natural resources.
We had to protect our own lands."

-- Shimon Peres at the General Assembly of the United Nations, 15/11/2001 --

"*Israel will retain control of the security zones - the Jordan Valley, and the West Bank hills on the west - during the interim agreement period.*
Israel will also continue its hold on the highways running across the West Bank and the water sources of the aquifer."

-- 2001 election campaign promise by the present prime minister of Israel, Ariel Sharon --

"World population, now 6.1 billion, has doubled since 1960 and is projected to grow by half, to 9.3 billion, by 2050. Some 2 billion people already lack food security, and water supplies and agricultural lands are under increasing pressure. Water use has risen six-fold over the past 70 years; by 2050, 4.2 billion people will be living in countries that cannot meet people's daily basic needs. Unclean water and poor sanitation kill over 12 million people each year; air pollution kills nearly 3 million".

-- UN Population Fund's *State of World Population 2001* Report --

The recommended basic water requirement per person per day is 50 litres. But people can get by with about 30 litres: 5 litres for drinking and cooking and another 25 to maintain hygiene. The reality for millions comes nowhere near.

Populations using the least amount of water'

Country	Litres of water used per person per day
Gambia	4.5
Mali	8.0
Somalia	8.9
Mozambique	9.3
Uganda	9.3
Cambodia	9.5
Tanzania	10.1

By contrast the average US citizen uses 500 litres per day, while the British average is 200.

The rural poor

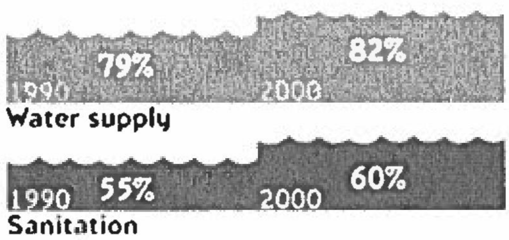
People in rural areas are four times more likely than those in cities to have no safe supply of water. The burden falls unequally on women who sometimes have to walk for hours to fetch water. A jerrycan of water weighs 20 kilos.

The urban poor

They are less likely than the well-off to be connected to mains water supplies and pay on average 12 times more per litre. In Jakarta, Indonesia the poor pay water vendors 60 times the price of water from a standard connection; in Karachi, Pakistan, 83 times; and in Port-au-Prince, Haiti and Nouakchott, Mauritania, 100 times.

Progress?

Viewed in percentage terms both water supply and sanitation provision have improved in the last decade.



However, the actual number of people in need has barely changed due to the rise in world population.

Crisis and challenge

Today in almost every area of the world it has become evident that there is a water problem – scarcity, depletion, pollution, lack of sanitation, failing rains due to global warming, big dam projects blocking up rivers, privatization, inequities of distribution, cross-border conflict, turning water into a source of profit and mismanagement.

The head of the UN environment programme, Dr Klaus Topfer, says he thinks a war triggered by water scarcity is very likely.

Dr Topfer, a German who earlier served as his country's environment minister, makes the prediction in an interview with the journal Environmental Science and Technology (EST).

EST is published by the American Chemical Society, which with more than 155,000 members claims to be the world's largest scientific society.

Dr Topfer says he is "completely convinced" that there will be a conflict over natural resources, with water the likeliest of the possible causes.

"Everybody knows that we have an increase in population, but we do not have a corresponding increase in drinking water, so the result ... is conflict."

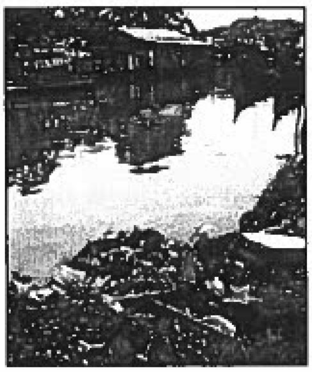
Avoiding waste

Dr Topfer proposes monitoring worldwide reserves of drinking water, and establishing agreements for the use of water, including underground supplies.

He argues as well for "economic instruments to stimulate the use of new technologies" to promote water conservation.

And with an eye to the dramatic global population growth he expects, Klaus Topfer calls for a revolution in the efficiency with which we use water.

He wants the new, more efficient technologies to be made available "on preferential terms" to developing countries.



Pollution is reducing the inadequate water that is available

On the brink of the new millennium, the world has no more fresh water than it did 2,000 years ago, when the population was less than 3% of its present size.That finite resource is in fact becoming smaller, as fresh water is increasingly unuseable because of pollution.

Thirty one countries, most of them in Africa and the Middle East, are now suffering water stress or scarcity. By 2025, the total affected will probably number 48 countries.

One in four goes without

They will account for 35% of the expected global population by then.

And countries like China and Pakistan will be close to joining the list. The human cost of water scarcity today is immense. About 1.4 billion people, a quarter of the world's population, do not have access to clean, safe water. More than 2 billion people have no proper sanitation.

Access to safe water pays huge dividends

Every hour more than 600 people die because their water supplies are contaminated, inadequate, or non-existent.And the health of many of those who survive is often permanently damaged. Yet the benefits of tackling the problem are similarly immense.

A review of nearly 150 studies shows that providing clean water and sanitation meant infant and child deaths fell by an average of 55%.Some countries registered even greater declines. In Costa Rica, for example, there were in the 1970s 68 deaths per 1,000 live births. In the 1980s this figure had been reduced to 20 per 1,000.

Researchers attributed three-quarters of the mortality decline to water and sanitation projects.

It is our common knowledge that freshwater on earth follows a cycle: it is constantly being replenished, some of it soaking into the ground and into vegetation, some of it meandering through streams and rivers on its way back to the sea. The moment one starts using freshwater beyond the rate at which it can be replenished, the hydrological cycle is endangered.

The crisis is particularly acute in relation to our groundwater reserves, lying deep under the surface in aquifers, upon which a third of the world's population depends. Water can take thousands of years to percolate into aquifers (some contain water from the last ice age). Some have since sealed up, allowing little possibility of recharge. Because the reserves of water they hold are large, humans have been tapping them like there is no tomorrow. Currently we are pumping out about 200 billion cubic metres (1 cubic metre = 908 litres) more than can be recharged, steadily using up our water capital.[1]

Take California with its lush lawns and 560,000 swimming pools. Having taxed the Colorado River to the limit, the region's aquifers are being guzzled up. By 2020 officials predict a water shortfall nearly equivalent to what the state is currently using. Another more distant water source needs to be found to gulp down. Consumption is the operative word for US water use.

Monomania is perhaps the chief reason why Libya's Colonel Qadhafi has embarked on a grandiose project to draw water from an aquifer beneath the Sahara desert and transfer it 3,500 kilometres by a network of giant pipelines to irrigate his country. The cost of this Great Man-made River [sic] is reaching $32 billion. Its water will be so dear – at about $10,000 to irrigate a hectare, that they'd better start growing gold. But the promise of abundance is political capital that Qadhafi is only too keen to exploit, even if it were far cheaper for Libya to import food instead. The aquifer can never be renewed, as hardly any rain falls in the Sahara. How long would the water last? Recent estimates hover between a mere 15 to 50 years. What would the results be? Apart from huge subsidence in the Sahara, there is the prospect of the Nile seeping into the emptying aquifer thus plunging Egypt into crisis.

The Environmental Damage of Large-Scale Projects

We compound shortages and profligacy by persistently poisoning our water. In India, where water is considered sacred, the notion that it will absorb all ills has probably not helped to stop the pollution of the country's major – and holy – rivers. Much of Eastern Europe has filthy rivers; in Poland the problem is so bad that the water of the majority of its rivers cannot even be put to industrial use. But whereas polluted rivers can be rejuvenated through concerted action, as in the case of the Hudson river in the US or the Funan in China, once aquifers are poisoned, major problems appear. Today groundwater around major cities, near industrial developments or beneath industrial farms inevitably contains contaminants. Hardly surprising as fully 85 per cent of pesticides don't reach their targets and nitrogen fertilizers are notorious for seeping into ground water. We produce industrial contaminants so toxic that they can only be diluted to safe levels by millions of times their quantity of water. Yet 60 per cent of the liquid industrial waste in the US is injected straight into deep groundwater in the fond hope that none of it will ever bubble up into the water people actually use. We dump our rubbish in landfills from where it begins its slow leak into the ground. We overpump our coastal aquifers to the point that seawater rushes in to kill them.

Shifting gear

Our environment just can't afford another spendthrift century. During the 20th century the world's population tripled. Water consumption grew sevenfold. One of the major reasons for this surge has not been domestic consumption, although this has undoubtedly grown more lavish, but a wasteful model of agriculture that has turned food-growing into an industrial process . The scale is no longer human and sustainable, but gigantic and destructive. And it demands intensive irrigation. Today farming accounts for 70 per cent of our water use with the lion's share taken by irrigation. But the crops promoted are often inappropriate, the lands used marginal and the returns diminishing. There is a widespread salinization of soils caused either by irrigation which draws salts to the surface in dry areas or else the evaporation of irrigation water that leaves salt in its stead. Poor management has led to the salinization of a full 20 per cent of the world's irrigated land. One estimate suggests that up to 10 per cent of the world's grain is being produced by water that will not be renewed.

It is clear that we need a rapid gear change in the way we think about water. We need the widespread adoption of sustainable farming methods, the promotion of industries that recycle their water (Germany is doing it) and a link in industrial processes that allows one to reuse another's waste water.

This much we know – that current technologies can save 50 per cent of agricultural water and 90 per cent of industrial, to say nothing of domestic use. We also know that desalinization is expensive and will cause marine pollution when the hot, briny residue is dumped back in the sea. We have painfully learned that large-scale projects to divert water great distances do serious environmental damage. And then there are the wealthy nations who not only use their natural endowment of water more wastefully but consume water invisibly in industrial production. It takes 400,000 liters of water to make a car. If you take this into account each Australian, living on the driest continent on earth, consumes more than a million liters of freshwater annually.

Environmental activists say: 'The water crisis is an ecological crisis with commercial causes but no market solutions. Market solutions destroy the earth and aggravate inequality. The solution to an ecological crisis is ecological, and the solution for injustice is democracy. Ending the water crisis requires rejuvenating ecological democracy.'

Steps should be taken to encourage conservation movements that aim to put the stewardship of this precious fluid in the hands of local communities. The message is clear – water belongs to us all.

To return briefly to Indore's thirst. The biggest local newspaper is offering financial support to initiatives to catch rainwater and channel it underground to rejuvenate dry wells. Some local politicians are beginning to see that such small solutions actually work. And groups of ordinary residents are taking up the challenge. It's a different kind of connection to water. A respectful kind that's echoed in this verse from the ancient Hindu holy text, the Rig Veda:

'O, waters of life! Full of noble virtues!
You are the beacon of light, divine and pure,
Envelop me in your majestic tides and hold me secure.'

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entails the construction of large-scale irrigation systems and energy sources, including 22 dams and 19 hydroelectric plants. The Project covers 19% of total economically irrigable Turkish land and is anticipated to significantly increase regional income and employment.

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