Basic Water Requirements for Human Activities: Meeting Basic Needs

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INTRODUCTION

The last few years have seen a remarkable change in the nature of the global discussion of issues ofenvironment and development. In the work of the Brundtland Commission [I], the extensive lead-up to the 1992 Earth Summit in Brazil, and in subsequent discussions and work, the intimate connections between environment and development have been accepted as a given. The questions now being discussed and researched are how to define and achieve development in a "sustainable" way. This is a much needed and welcome change.

Unfortunately, considerable debate and confusion surround both the terms "sustainable" and "development" and only modest forward progress has been made. This lack of progress is particularly disturbing in the area of water resources, which are vitally important for producing food, maintaining aquatic ecosystems, and protecting human health.

Among the concepts raised nearly 20 years ago during the 1917 Mar del Plata conference — one of the earliest international efforts to address global water problems — was that of "basic needs" [2]:

> all peoples, whatever their stage of development and their social and economic conditions, have the right to have access to drinking water in quantities and of a quality equal to their basic needs.

This concept was strongly reaffirmed during the 1992 Earth Summit in Rio de Janeiro and expanded to include ecological water needs [3]:

> In developing and using water resources, priority has to be given to the satisfaction of basic needs and the safeguarding of ecosystems.

Implicit in this phrase is the idea of minimum resource requirements for certain human and ecological functions, and the allocation of sufficient resources to meet those needs, This article defines and quantifies "basic water requirements" (BWRs) in terms of quantity and quality for four basic human needs: drinking water for survival, water for human hygiene, water for sanitation services, and modest household needs for preparing food. The concept of identifying water needs for growing food and protecting natural ecosystems is also briefly discussed. These minimal needs are also discussed in the context of international water law and two regions with a long history of water disputes: the Middle East and California. Finally, data are presented showing the current failure of many nations to provide even this basic level of clean water to their citizens.

Based on the analysis here, I recommend that international organizations, national and local governments, and water providers adopt a basic water requirement standard for human needs of 50 liters per person per day (l/p/d) and guarantee access to it independently of an individual's economic, social, or political status. Unless this basic need is met, large-scale human misery and suffering will continue and grow in the future, contributing to the risk of social and military conflict. Ultimately, decisions about defining and applying a basic water requirement will depend on political and institutional factors, but the concept may prove useful in meeting basic water needs for the next century.

DEFINING BASIC WATER REQUIREMENTS

Different sectors of society use water for different purposes: drinking, removing, or diluting wastes, producing manufactured goods, growing food, producing and using energy, and so on. The water required for each of these activities varies with climatic conditions, lifestyle, culture, tradition, diet, technology, and wealth, as shown over 20 years ago in the groundbreaking work of White, Bradley, and White [4]. The type of access to water alone is an important determinant in total water use. Tables 1 and 2 show that the level of domestic water use varies with distance from the water source and with the climate.

The term "water use" encompasses many different ideas

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Table 1. Domestic water use by distance to source

Source of water	**Water Use (liters per person per day)**
Public Standpipe, farther than 1 kilometer	less than 10
Public Standpipe, closer than 1 kilometer	20
House Connection, simple plumbing, pour, flush toilet	60 to 100
House Connection, urban, with gardens	150 to 400

Table 2. Rural household water use by climate and source'

Climatic Zone	Public Standpost liters/capita/day	House Connection[b] liters/capita/day
Humid	IO to 20	20 to 40
Average	20 to 30	40 to 60
Dry	30 to 40	60 to 80

[a] **Data** from rural developing countries
[b] Without flush toilets OF gardens.
Source: Reference 5.

and is often misleading and confusing. Among other things it has been used to mean the withdrawal (intake) of water, gross water use (intake plus recirculation plus reuse), and the consumptive use of water. In this article, I use the term "withdrawal" to refer to the act of taking water from a source to convey it elsewhere for storage or use. Not all water withdrawn is necessarily consumed, however. Indeed, for many processes, water is often withdrawn and then returned directly to the original source after use, as in water used for cooling thermoelectric power plants. Gross water use is distinguished from water withdrawal by the inclusion of recirculated water. Thus for many industrial processes, far more water is required than is actually withdrawn for use. Water "consumption" or "consumptive use" is taken here to mean the use of water in a manner that prevents its reuse, such as through evaporation, plant transpiration, contamination, or incorporation into a finished product. When the term water "use" is given, it refers to the amount of water required to meet a specific need or to accomplish a particular task.

Minimum Drinking Water Requirement

An absolute "minimum water requirement" for humans, independent of lifestyle and culture, can be defined only for maintaining human survival. To maintain the water balance in a living human, the amount of water lost through normal activities must be regularly restored. While the amount of water required to maintain survival depends on surrounding environmental conditions and personal physiological characteristics, the overall variability of needs is quite small. Routes for water loss include evaporation from the skin, excretion losses, and insensible loss from the respiratory tract. Humans may feel thirst after a fluid loss of only 1 per cent of bodily fluid and be in danger of death when fluid loss nears 10 per cent [7].

Prior physiological studies have generated "reference values" for a daily human water requirement. Table 3 summarizes several estimates of total daily water requirements for a "reference" human. Minimum water requirements for fluid replacement have been estimated at about three liters per day under average temperate climate conditions. When climate and levels of activity are changed, these daily minimum water requirements can increase. In a hot climate, a 70-kilogram human will sweat between four and six titers per day without a. comparable change in food intake or activity [7].

The National Research Council of the National Academy of Sciences in the U.S.A. separately estimated minimum human water requirements by correlating them with energy intake in food. They recommend a minimum water intake of between one and one-and-a-half milliliters of water per calorie of food (1 - 1.5 ml/kcal). Note that a food calorie is equivalent to a kcal of energy. In this article, the energy content of food will be represented by kcals. This does not include the water required to grow the food consumed, which is discussed later. With recommended daily diets ranging from 2,000 to 3,000 kcals, minimum water requirements are between 2,000 and 4,500 milliliters, or 2 to 4.5 liters per day-comparable with the data presented in Table 3 [14].

Using these data, a minimum water requirement for human survival under typical temperate climates with normal activity can be set at three liters per day. Given that substantial populations live in tropical and subtropical climates, it is necessary to increase this minimum slightly, to about five l/p/d, or just under two cubic meters per person per year. A further fundamental requirement not usually noted in the physiological literature is that this water should be of sufficient quality to prevent water-related diseases.

Basic Requirements for Sanitation

A "minimum" must also be defined for providing sanitation services. There is a direct link between the provision of clean water, adequate sanitation services, and improved health. Extensive research has shown the clear health advantages of access to adequate sanitation facilities

Table 3. Average daily water requirements for survival'

Source	Average daily water intake in liters per capita per day
Vinograd [8]; Roth [9]	**2.5**[b]
World Health Organization [IO]	2.5
White et al. [4]	I.8 to 3.0
U.S. Environmental Protection Agency [I 1]	2.0
National Academy of Sciences [12]	2.0
Saunders and Warford [13]	5

'During normal activity and temperate climate.
[b] **This** value represents the actual fluid requirements measured for early space flights. The recommended intake minimum for Apollo astronauts under routine conditions in the command module was 2.9 liters per day.

and protecting drinking water from pathogenic bacteria and viral and protozoal agents of disease. Effective disposal of human wastes controls the spread of infectious agents and interrupts the transmission of water-related diseases.

Unfortunately, much of the world's population, particularly in developing countries, remains without access to clean drinking water or adequate methods to dispose of human wastes. According to recent estimates, more than 1.7 billion people lacked access to adequate sanitation services in 1990, while over 1.2 billion people lacked adequate clean drinking water [15]. During the decade between 1990 and the year 2000, nearly 900 million more people will be born in these regions [16,17]. It has been estimated that lack of clean drinking water and sanitation services leads to many hundreds of millions of cases of water-related diseases and between five and ten million deaths annually, primarily of small children [18-21].

For the most part, the world health community knows how to prevent these diseases, but lacks the financial and institutional capability needed to take definitive and effective action. While media attention to these problems increases when particularly acute regional crises occur, such as the recent disastrous outbreak of cholera in Latin America or among Rwandan refugees in Zaire, the more widespread chronic problems still beg for attention from the world community.

In recent reviews of epidemiological studies related to water and sanitation, the provision of adequate sanitation services was the most direct determinant of child health after also providing a minimum amount of water for metabolic activity and handwashing [19,20,22-24].

There are many technologies for improving access to adequate sanitation services, with widely varying water requirements. In regions where absolute water quantity is a major problem, alternatives that require no water are available. Table 4 lists those technologies that require no water except for minimal washing. Where historical circumstances led to the use of wasteful, high-volume flush toilets, as much as 75 liters per capita per day, or more, have been used. Table 5 lists the wide range of sanitation technologies that require water. The choice of sanitation technology will ultimately depend on the developmental goals of a country or region, the water available, the economic choice of the alternatives, and powerful regulatory, cultural, and social factors [4,25].

Given these variables, can a recommended basic water requirement for sanitation be identified? Because alternatives are available that require no water, it is technically feasible to set a minimum at zero. Two factors argue against doing this: additional health benefits are identifiable when up to 20 liters per capita per day of clean water are provided [23]; and where economic factors are not a constraint, cultural and social preferences strongly lean toward water-based systems. Access to some water for sanitation, together with concurrent education about water use, decreases the incidence of diseases, increases the frequency of hygienic food preparation and washing, and reduces the consumption of contaminated food products. Accordingly, while effective disposal of human wastes can be accomplished with little or no water when necessary, a minimum of 20 liters per person per day is recommended here to account for the maximum benefits of combining waste disposal and related hygiene, and to permit for cultural and societal preferences. This level can be met with a wide range of technological choices.

Table 4. Sanitation technologies that require no water

Ventilated improved pits (VIP)
Reed Odorless Earth Closets (ROEC)
Ventilated Improved Double-Pit Latrines
Double-Vault Comporting Toilets (DVC)
Continuous Composting

Sources: References 25 and 26

Basic Water Requirement for Bathing

On top of these direct sanitation requirements, additional domestic water is used for showering or bathing. A review of a range of studies in North America and Europe (Table 6) suggests average (not minimum) water use in industrialized nations for bathing to be about 70 liters per person per day, with a range from 45 to 100 l/p/d. Data on water used for bathing in developing countries or in regions with no piped water are not widely available. Some studies suggest that minimum water needed for adequate bathing is on the order of 5 to 15 l/p/d and that required for showering is 15 to 25 l/p/day [25]. A basic level of service of 15 l/p/d for bathing is recommended here.

Basic Requirement for Food Preparation

The final component of a domestic basic water requirement is the water required for the preparation of food. While most detailed surveys of residential water use in industrialized countries do not provide separate estimates of water used for cooking, Brooks and Peters [29] estimate that water use for food preparation in wealthy regions ranges from 10 to 50 liters per person per day, with a mean of 30 liters per person per day. In a study done of the water provided for 1.2 million people in northern California, an average of 11.5 liters per person per day was used for cooking, with an additional 15 liters used for dishwashing [31]. Other studies in both developed and developing countries [4,14,32,33] suggest that an average of 10 to 20 liters per person per day appears to satisfy most regional standards and that 10 l/p/d will meet basic needs.

The Special Case of Food

The four domestic uses described above do not include water required to grow the food necessary for human survival. Minimum caloric requirements, cultural preferences for different kinds of food, regional climatic conditions, irrigation and food processing technologies,

Table 5. Sanitation technologies that require water

Sanitation Technology	Water Requirement	Minimum Water
Pit latrine	Water near toilet	1 to 2 liters/flush
Pour/Flush (PF) toilets	Water near toilet	6 to 10 liters/person/day
Vault toilets and cartage	Water near toilet	3 to 6 liters/person/day
Sewered PF toilets/septic tanks	Water piped to toilet	7.5 liters/person/day
Small-b-are sewerage	Water piped to toilet	>50 liters/person/day
Inefficient conventional sewerage	Water piped to toilet	>75 liters/person/day

Sources: References 25 and 26.

and a wide range of social factors all affect total water requirements for producing food. At present, no satisfactory analysis of these factors has been done. Rough calculations, however, offer some insight into how variable these factors can be.

Typical regional diets, compiled from the UN Food and Agriculture Organization [34], are shown in Table 7. Using average evapotranspiration requirements on a regional basis, estimates of rainfed and irrigated acreage, and assumptions about the efficiency of irrigation can give a first-order estimate of the water requirements to produce these regional diets. In fact, however, calculating actual water requirements to grow food is even more complicated. Among the other factors that must be considered are specific regional crop yield information, soil conditions, more precise climatic variations and effects, food processing and waste factors, and so on.

No comprehensive estimates have yet been made, though there have recently been efforts to make some regional estimates. Table 8 shows the estimated water requirements that would be necessary to grow the food needed to meet dietary demands in three arid regions: California, Egypt, and Tunisia [35]. California is a region with heavy meat consumption and heavy irrigation water needs. Tunisia and Egypt have much lower meat consumption, and Tunisia provides a comparatively lower fraction of agricultural water with irrigation. As this table shows, the water required to grow food is far above — by as much as two orders of magnitude-the basic water requirements for domestic human needs. Far more work is required, however, to actually determine "minimum" agricultural water needs to meet specific diets, as opposed to the average values provided in Table 8.

The water required to grow food must be considered a special case for several other reasons. Unlike the BWR for human survival and domestic use described in the previous section, food can be produced in water-rich regions and transported to water-poor regions. In fact, this occurs today on a vast scale and is only constrained by internal political policies that push for domestic food security, by economic problems related to import/export trade balances, and by transportation difficulties. As a result, providing a BWR for food production, however defined and quantified, should be considered independently from the responsibility of governments for providing the BWR for maintaining human survival and health.

Basic Water Requirements for Natural Ecosystems

No attempt is made in this paper to define and quantify precise BWRs to protect natural ecosystems, though the principle that some water be guaranteed to maintain ecosystem health has also been put forward [3,36]. In traditional water planning and management, the water needs of the natural environment are rarely considered or guaranteed. In the United States and Europe, some minimum flow requirements have been set for rivers and some minimum quality or temperature standards have been promulgated to protect environmental assets. In the United States, legislation has protected stretches of certain pristine rivers from development, and some water has been reallocated from major water projects and users to the environment. In California, for example, a combination of federal and state laws has set aside nearly 30,000 million cubic meters (mcm) of annual runoff for environmental purposes, including the protection of wild and scenic rivers, the Sacramento-San Joaquin Delta, and instream and wetlands flow protections for fish and waterfowl [30,36]. This represents nearly 28 per cent of total annual average runoff from the state. Similar legal efforts are under way internationally. In 1994, for example, the International Law Commission (ILC) produced a set of

Table 6. Average residential end-use of water in developed countries (liters per person **per** day)

End Use	United states [27]	United states [28]	Sweden [27]	The Nether-lands 1271	several North Amer. Cities [29]	Massa-chusetts [29]	Avge. Cali-fornia [30]	Northern Cali-fornia [31]
	70				90			
Toilets	60	95	40	39	66	84	127	109
Bath/Shower		75	70	27		73	99	78
								35
Kitchen Laundry	45	50 10	30	17	31	29	76 56	39
Yard/Other	75	11	25	4	5	4	178	171
Total Use (l/p/d)	295	246	215	104	225	212	531	171

Table 7. Average Regional Diets, 1989 (Calories per person per day)

Region	Maize	Soybean	Sorghum, Wheat	Rice	Pulses	Roots	Vegetables	Fruits	Vegetable Oils	Animal Fat	Sheep	Beef	Pig	Poultry	Eggs	Milk	Fish	Alcohol	Sweetener	All Other
Africa, South of Sahara	351	237	195	281	81	332	21	90	169	22	14	36	25	15	6	67	25	51	145	25
Centrally Planned Asia	118	43	380	1143	51	144	43	40	59	39	68	45	104	10	17	36	25	52	82	43
Eastern Europe	143	0	1095	32	39	100	74	74	269	274	20	79	202	47	50	250	15	165	381	37
Former USSR	3	16	1043	72	17	180	56	54	248	219	15	205	91	42	59	244	73	133	458	25
Latin America	274	13	438	256	69	124	30	133	220	63	11	89	50	65	20	156	30	78	401	34
Middle East/North Africa	84	28	1103	203	69	68	70	137	339	47	48	41	2	45	24	125	15	12	308	51
OECD-Pacific/Oceania	42	12	492	315	25	326	49	147	209	98	57	90	96	64	28	118	71	80	329	43
South and East Asia	87	41	315	1075	51	62	39	57	190	30	3	23	61	38	18	60	51	43	202	38
Western Europe	37	0	647	43	25	151	70	123	383	243	30	116	307	47	49	342	54	189	413	80
North America	27	2	537	112	28	81	105	146	364	129	21	232	202	136	46	267	48	154	431	68

"All others" includes sugar, nonalcohol stimulants, spices, offals, treenuts, other meats, and other aquatic.
Source: Compiled from Reference 34.

articles setting forth principles to guide the behavior of states. Article 20 explicitly requires "watercourse States" to "protect and preserve the ecosystems of international watercourses" [48].

Despite these efforts, aquatic ecosystems throughout the world are under severe stress and threat of destruction. Globally more than 700 species of fish alone are considered threatened with extinction [37]. In the last couple of years, several have been added to the list, including major anadromous fish species. Basic water requirements to protect these species and, more broadly, whole ecosystems, must be identified and provided.

Ultimately, society will have to make decisions about which ecosystems should be maintained or restored and the indicators by which to measure their health. Then, minimum allocations of environmental water will have to be made on a flexible basis, accounting for climatic variability, seasonal fluctuations, and other factors, Ecosystem management will have to be flexible, with decisions reviewed frequently based on the latest information. Earticular care must be taken when human actions might lead to irreversible effects.

Other Water Requirements

There are many other human uses of water, including water for industrial and commercial use, and for power plant cooling and electrical generation. Water requirements to meet these demands depend on what precisely is being produced, on the technology used, and on a host of other characteristics. Detailed analyses are needed to evaluate these demands, but a wide range of requirements is described in Gleick [15]. Because water demands associated with these other sectors reflect human "wants" and not "basic needs," these demands should be provided only after basic human needs are met.

Table 8. Water requirements for growing food, in liters per person per day[1]

	California	Egypt	Tunisia
Total daily water input (l/p/d)	5,908	3,242	2,964
Percentage of water needed to produce meat in diet (%)	64.0	21.4	26.9
Percentage of total daily water input met by irrigation (%)	71.4	69.0	57.3

[1] These data are the water requirements needed to grow the food consumed within a region. Of course, many regions, including these, import and export food, and hence, water embodied in that food.
Source: Reference 35.

MEETING BASIC NEEDS: A RECOMMENDATION FOR A GUARANTEED BASIC WATER REQUIREMENT

Table 9 summarizes the water requirements for drinking water, hygiene, sanitation services, and food preparation. Recommended levels are based on fundamental health considerations and on assumptions about technological choices usually made at modest levels of economic development. Considering drinking water and sanitation needs only suggests that the amount of clean water required to maintain adequate human health is between two and 80 liters per person per day, or up to about 30 cubic meters per person per year. The low end of this range is an absolute minimum and reflects survival only. The upper end reflects a more complete satisfaction of basic needs using water piped directly to the house and toilet. This article recommends that a BWR of 25 liters per person per day of clean water for drinking and sanitation be provided by water agencies or governments.

This amount is just above the lower end of the 20 to 40 liters per person per day target set by the US. Agency for International Development, the World Bank, and the World Health Organization, each of which also exclude water for cooking and cleaning. It is also in line with the recommended standards of the United Nations International Drinking Water Supply and Sanitation Decade and Agenda 21 of the Earth Summit.

Adding water for bathing and cooking raises the total range to between 27 and 200 liters per capita per day, bracketing the level of 100 liters per capita per day identified by Falkenmark and others [38,39] as typical household demand in water-scarce regions. Falkenmark considers 100 l/p/d to be necessary to provide for some minimum acceptable quality of life [Falkenmark, personal communication, 1996]. The upper end of the range is equal to an annual need of about 75 cubic meters per person (m^3/p/yr). During recent severe drought in California, domestic water use in some of the wealthiest (but

Table 9. Recommended basic water requirements for human needs’

Purpose	Recommended Minimum (liters per person per day)	Range (liters per person per day)
Drinking **Water**[b]	5	2 to 5
Sanitation Services’	200 to over 75	
Bathing	**15**	5 to **70**[d]
Cooking and Kitchen	**10**	10 to **50**[d]
Total Recommended Basic Water Requirement	50	

*Excluding water required to grow food (see text).

[b] **This** is a true minimum to sustain life in moderate climatic conditions and with average activity levels.

[c] An average (not minimum) of 40 l/p/d is considered adequate for direct sanitation hookups in industrialized countries. The upper end of the range represents extremely inefficient toilets. In water-short regions, sanitation systems that use no water are available, but rarely embraced socially.

[d] The upper valuer here represent societal preferences for moderately industrialized countries. Use in some water-rich regions may exceed these amounts. The lowest valuer reflect minimum uses in developing countries.

water-short) regions was rationed to the equivalent of about 70 m^3/p/yr. These levels were achieved without any severe hardships, even in communities accustomed to far higher levels of household water use [40].

Using minimum levels of 15 l/p/d for bathing and 10 l/p/d for cooking, I recommend here that international organizations and water providers adopt an overall basic water requirement (BWR) of 50 liters per person per day as a new standard for meeting these four domestic basic needs, independent of climate, technology, and culture. While biiions of people lack this standard today, it is a desirable goal from both a health perspective and from a broader goal of meeting a minimum quality of life.

To what extent does a state have an obligation to provide its citizens with a basic water requirement? Should the international legal community consider the right to a certain level of fresh water to be a basic human right? McCaffrey [4 1] has extensively explored international legal frameworks and law and concludes that there are obstacles to the establishment in international law of the human right to water as a binding obligation on states. He goes on to say, however, “it is clear that, at least in some form, the right may be inferred under the basic instruments of international human rights law? He further argues that the devastating consequences of being denied such water should require that relevant provisions of existing human rights instruments “ought to be interpreted broadly, so as to facilitate the implementation of the right to water as quickly and comprehensively as possible? The two international declarations quoted at the beginning of this article also suggest that states have the obligation to develop in such a way as to ensure that their use of fresh water is sustainable and adequate to meet the basic needs of its people. These declarations provide additional sup port for the conclusion that there is both a basic right to water.

I argue here that the right to water sufficient to meet basic needs should be an obligation of governments, water management institutions, or local communities. While in some regions, governmental intervention may be necessary to provide for basic water needs, many areas will be able to use traditional water providers, municipal systems, or private purveyors within the context of market approaches. Unfortunately, there are many reasons why governments or water providers may be unable to provide this amount of water, including rapid population growth or migration, the economic cost of water-supply infrastructure in regions where capital is scarce, inadequate human resources and training, and even simple political incompetence. Nevertheless, failure to provide this basic need is a major human tragedy. Preventing that tragedy should be a major priority for local, national, and international groups,

How would a proposal for providing a BWR be implemented? Defining and applying this principle might require that the BWR be made available to all inhabitants of a hydrologic region (such as a watershed or the area overlying a groundwater aquifer) prior to resolution of how to distribute remaining water resources. In areas served by municipal systems, subsistence water charges — lifeline rates — for basic levels would ensure provision of a minimum level of service to all users. Such rates have been used for many years by energy utilities and are now beginning to appear in water utility rate design. In regional long-term water planning, providing a BWR to all inhabitants should be set as the highest priority-together with identifying and providing a BWR for the natural environment-before allocations are made for other uses. In international river basins, such allocations will almost certainly require joint basin committees empowered to make binding management decisions for the region [42].

PROGRESS TOWARD MEETING BASIC HUMAN WATER NEEDS

Vast regions of the world and hundreds of millions of people lack the water required to meet the basic human needs proposed above. While the traditional measure of water scarcity has been per-capita water availability [49], it is now possible to begin to use data on actual water use-a measure more representative of actual human well-being. Using the BWR as a benchmark, Table 10 lists those countries whose reported domestic per-capita water withdrawals fail to provide 50 liters per capita per day. According to these data, in 1990 fifty-five countries with a population of nearly a billion people fell below the level recommended in this article. There are actually eight countries whose total reported water use in all sectors falls below the recommended BWR for just basic human needs.

In fact, there are strong reasons to believe that the actual number of people failing to receive the recommended BWR is far above the numbers reported here.

The data in Table 10 are country averages, and several large countries, such as India and China, report that their average domestic water use slightly exceeds 50 liters per person per day. We know, however, that average national water-use data hide significant regional variations, with large segments of populations usually falling below the average, while wealthier portions of the population tend to use far more per capita. In addition, the national water use data used in Table 10, while the best available, are known to be inadequate. For example, there are several countries on this list that are relatively water-rich, suggesting the possibility that official data on water withdrawals may miss substantial domestic water use that is self-supplied. Improving the scope, quality, and extent of water use data is vitally important.

Table 10. Countries with total domestic water use below 50 1/p/d

Country	1990 Population (million people)	Total Domestic Water use in liters/ person/day	Total Domestic Use as a Percentage of the BWR of 50 liters per person per day
Gambia	0,86	4.5	**9**
Male	9.21	8.0	**16**
Somalia	7.50	8.9	18
Mozambique	15.66	9.3	19
Uganda	18.79	9.3	19
Cambodia	8.25	9.5	19
Tanzania	27.32	10.1	**20**
Central Africa Republic	3.04	13.2	**26**
Ethiopia	49.24	13.3	**27**
Rwanda	7.24	13.6	**27**
Chad	5.68	13.9	28
Bhutan	1.52	14.8	30
Albania	3.25	15.5	**31**
Zaire	35.57	16.7	**33**
Nepal	19.14	17.0	34
Lesotho	1.77	17.0	34
Sierra Leone	4.15	17.1	**34**
Bangladesh	115.59	17.3	**35**
Burundi	5.47	18.0	36
Angola	10.02	18.3	37
Djibouti	0.41	18.7	37
Ghana	15.03	19.1	38
Benin	4.63	19.5	**39**
Solomon Islands	0.32	19.7	**39**
Myanmar	41.68	19.8	40
Papua New Guinea	3.87	19.9	40
Cape Verde	0.37	20.0	40
Fiji	0.76	20.3	**41**
Burkina Faso	9.00	22.2	**44**
Senegal	7.33	25.4	**51**
Oman	1.50	26.7	**53**
Sri Lanka	17.22	27.6	55
Niger	7.73	28.4	57
Nigeria	108.54	28.4	57
Guinea-Bissau	0.96	28.5	57
Vietnam	66.69	28.8	58
Malawi	8.75	29.7	**59**
Congo	2.27	29.9	**60**
Jamaica	2.46	30.1	60
Haiti	6.51	30.2	60
Indonesia	184.28	34.2	**68**
Guatemala	9.20	34.3	**69**
Guinea	5.76	35.2	70
Cote D’lvoire	12.00	35.6	71
Swaziland	0.79	36.4	73
Madagascar	12.00	37.2	74
Liberia	2.58	37.3	75
Afghanistan	16.56	39.3	79
Uruguay	3.09	39.6	**79**
Cameroon	11.83	42.6	**85**
Togo	3.53	43.5	**87**
Paraguay	4.28	45.6	**91**
Kenya	24.03	46.0	**92**
El Salvador	5.25	46.2	**92**
Zimbabwe	9.71	48.2	96

Data on domestic water use come from References 15, 43, and 44.

An additional problem is that there are few data to indicate the typical ***qualify*** of the water received. Poor quality of domestic water is a severe and widespread. problem, and it is likely that many people who may receive more than the recommended quantity are getting contaminated and unhealthy water. Furthermore, population growth is increasing in most of these regions faster than improvements to water availability,

In contrast to these figures, domestic water use in all industrialized countries far exceeds the BWR, though the quality of this water varies widely. In the countries of western Europe, the recommended BWR is typically less than 25 per cent of total domestic use. In the U.S. and Canada, a BWR of 50 l/p/d is less than 10 per cent of total current domestic use.

What might this BWR concept imply in regions where political conflicts over water resources are prevalent, such as the Middle East? Table 11 shows United Nations medium population projections for the parties of the Jordan Basin [45] and the water required to provide this population with a BWR. Guaranteeing the 1990 population of Israel, Jordan, and the West Bank with just a basic annual water requirement of 50 liters per person per day would require about 180 million cubic meters (mcm) of water annually. By 2025, this amount would rise to over 400 mcm. These quantities also exclude any demands from Syria and Lebanon, portions of whose population rely on water from the Jordan River basin. Estimates of the total annual renewable freshwater availability for all of Israel, Jordan, and the West Bank, are under 3,400 mcm. In the Jordan River basin, a proposal to guarantee the population a basic water requirement could mean allocating 50 l/p/d to all inhabitants of the basin before negotiating shares of remaining water among

Table 11. Populations and basic water requirements in the Jordan Basin

	Population (1,000s)		Total Water Needed to Satisfy BWR of 50 I/p/d	Total Water Needed to Satisfy BWR of 50 1/p/d
	1990	2025	(for 1990 in mcm/vr)	(for 2025 in mcm/vr)
Jordan	4,259	12,039	78	**220**
Syria	12,348	33,505	225	**611**
			85	**142**
Israel Lebanon	4,660 2,555	7,808 4,424	**47**	**81**
West Bank’	975	2.500	18	**46**

‘The UN does not include separate estimates of West Bank population and no recent census has been conducted. Future growth rates are highly dependent on uncertain immigration rates. A population of 2.5 million in the year 2025 was assumed here, but could be substantially higher or lower.

Sources: Population data from Reference 55.

the riparians (Syria, Lebonon, Jordan, Israel, and the Palestinians). In international basins, such a policy would require setting up institutional structures, such as a Joint River Basin Commission, to monitor agreements and allocate water. The recent peace treaty between Israel and Jordan provides the beginnings of such a basin commission.

Shuval [46,47] and Gleick [42] each raised the concept of applying a minimum water requirement in the context of the water disputes in the Middle East. In both approaches, their "minimum" levels included considerable amounts of water required for human uses in addition to the basic needs described above.

Shuval [46] set a minimum at 125 cubic meters per person per year in order to satisfy domestic needs as well as modest industrial and gardening needs. Gleick [42] proposes a lower minimum — 75 cubic meters per person per year — also including some industrial and commercial activities. Using the higher levels proposed by Shuval would increase the total minimum demand in the region to 1,200 mcm/yr in 1990 and about 2,800 mcm/yr by 2025. This latter amount approaches the total for the reliable supply in the entire Jordan Basin. Satisfying tbis larger "minimum" would require taking almost all the water now used to grow food and applying it to meet domestic and industrial needs. This implies major restructuring for the region's agricultural water policy-a restructuring that has already begun.

In California, like the Middle East, growing populations are coming up against natural water constraints. While California water planners and policymakers have managed to stave off these constraints in the past through massive infrastructure development, the era of building new large dams, reservoirs, and aqueducts is drawing to a close. The current dilemma facing California water managers is how to meet new demands using new approaches. Under traditional water projections, Californians face a shortfall of more than two billion cubic meters per year by 2020, more than one billion cubic meters ofpermanent groundwater overdraft, declining ecosystem health, and continued inefficient water use in almost all sectors [30]. This kind of traditional forecast, while highlighting the nature of current problems, no longer offers any guidance on how to develop sustainable water policies.

A new approach presents a sustainable vision for California's water resources in the year 2020 [36]. In this analysis, seven criteria for sustainable water use are presented, including providing BWRs for maintaining human health and the health of natural ecosystems. Identifying desirable end results, focusing on demand-side management, and applying the sustainability criteria produces a vision of California's water system that is far more efficient and equitable and that meets basic needs as well as providing water for extensive agricultural production. In this approach, meeting BWRs first coopts only a tiny fraction of total renewable supply, but sets societal priorities in a more equitable way than current management approaches.

CONCLUSIONS

Recent efforts to integrate environmental issues and concerns with sustainable economic and social develop ment have returned to the concept of meeting basic human needs first proposed nearly two decades ago. One of the most fundamental of those needs is access to clean water. This article presents the concept of a basic water requirement (BWR) for human domestic needs and recommends that a BWR for drinking, basic sanitation services, human hygiene, and food preparation be guaranteed to all humans. Specifically, 50 liters per person per day of clean water should now be considered a fundamental human right.

Hundreds of millions of people, especially in developing countries, currently lack access to this BWR, resulting in enormous human suffering and tragedy. Furthermore, rapid population growth and inadequate efforts to improve access to water ensure that this problem will grow worse before it grows better. This problem should be a far higher priority for governments, water providers, and international aid organizations than it appears to be.

In the past, long-term planning for the management and allocation of freshwater resources has relied upon traditional projections of human demand for water, compared projected demand to estimates of available supply, and developed the policies and physical infrastructure necessary to bridge the gap between the two. Absent from traditional water planning has been any voice for natural ecosystems, any thought that the goals, aspirations, and desires of future generations may not be the same as those of the present generation, and any explicit representation of the complex interactions between land-surface processes, atmospheric behavior, the natural biota, and society, It is time for a change. A first step toward sustainable water use would be to guarantee all humans the water needed to satisfy their basic needs.

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Objectives

The principal objectives of the International Water Resources Association are:

- *to advance water resources planning, development, management, administration, science, technology, research. and education on an international level;*
- *to establish an internntional forum for planners, administrators, managers, scientists, engineers, educators, and others who are concerned with water resources; and*
- *to encourage coordination and support of international programs in the field of water resources. including cooperation with the United Nations and its agencies, and other international and national organizations, in activities of common interest.*