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Abstract

Water is ubiquitous, most abundant and pivotal natural resource on earth. The fulfilment of basic needs may largely dependent on water. But this finite resource has qualitative and quantitative vulnerabilities. Increasing population, economic development, urbanization, changes in lifestyles, pollution and climate change have lead this vital resource into a global crises, resulting in to many problems. In other occasions even conflicts may arise. Many causes of global water crises have been identified but the major considered causes are; climate change, rapid increase in population and economic growth. Consequences include; flooding that makes people homeless and disease outbreak, drought, hunger and water pollution. Global climate change poses threat to water scarce areas. Like sub-Saharan Africa, Middle East and Asia, which are highly vulnerable to droughts and floods. For a majority of people living in rural Africa, extreme water scarcity leads to food insecurity. In conclusion government at all levels should support the right to water. While individuals should always conserve our natural environment so that aquatic ecosystems are sustained.

Keywords: Climate Change, Crises, Global, Population, Water.

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Introduction

Water is a ubiquitous natural resource covering approximately three quarter of the earth's surface. However, the highest percentage of water on the planet (over 97 percent) is in oceans, unusable by most terrestrial organisms, of the remaining three percent, more than two third is isolated as ice and snow at high elevations or latitudes and is functionally unavailable, leaving less than one percent of global water as both fresh and potentially available for meeting human needs (Postel *et al.*, 1996). The continent of Africa, for example, typically characterized by its desert terrain and perpetual year-long droughts has, as aforementioned, been struggling with water stress for centuries. Particularly in the case of Sub-Saharan Africa, hand dug wells and watering holes were the main sources of water dating back before the Common Era. Consequently, many areas have been unable to sustain their population's growing need for water (DeLago, 2013). The environmental impacts of the water crises are equally alarming. Multiple, cumulative and compounding problems with water supply and quality are converging globally. Increasing population growth is already competing with nature for finite water resources. A growing number of rivers do not make it to the sea, and there is widespread surface and groundwater contamination that makes valuable water supplies unfit for some uses. A growing number of contaminants, such as endocrine-altering substances, will demand higher wastewater treatment standards and more exhaustive monitoring of water contaminants (Bigas, 2012).

Water has been on the agenda of many summits, from the Stockholm Conference on the Human Environment in 1972 to the June 2012 Rio Earth Summit, yet water governance is only loosely institutionalized on the global level (Gleick and Lane, 2005). Recommendations produced at United Nations (UN) gatherings arguably are more legitimate and have greater steering power than those produced at non UN fora such as the World Water Forum (WWF) meetings (Gleick and Lane, 2005). Global demand for water reached 4.5 trillion cubic metres in 2012. If the current trends continue until 2050, water consumption will increase by yet another 55 percent (Biswas, and Kirchherr, 2013). Today water demand outstrips water supply by 300 billion cubic meters. The good news is that the water crises the world is facing at present can be solved with good policies and management practices with the use of proper technologies. The bad news is that despite available technologies and vast policy know-how, poor water management prevails in nearly all countries of the world (Biswas, and Kirchherr, 2013). A landmark report by the UNDP (2006) recognized for the first time that access to drinking water and sanitation services is a human right. This dialogue concluded in July 2010 with a UN General Assembly resolution, which formally recognized the "right to safe and clean drinking water as a human right. One hundred and twenty-two countries approved the non-binding 'right to water', while 41 countries abstained from voting. But acceptance of such a right without appreciating its implications may prove problematic (UN General Assembly, 2010). The aim of this article is to review the recent researches related to global water crises with the view to evaluate the causes and consequences of water quality, quantity that is now of global concern.

Water Availability

Water is the most widespread substance on earth. It covers more than 70% of the world's surface. It forms oceans, seas, lakes, rivers and the underground water. In a solid state, it exists as ice and snow cover in polar and alpine regions. A certain amount of water is contained in the air as water vapour, water droplets and ice crystals, as well as in the biosphere. Around 30% exists as fresh groundwater. Only about 0.3% of the total amount of freshwater on the earth is concentrated in lakes, rivers, soil moisture and relatively shallow groundwater basins, where it is easily accessible for economic needs (UNEP, 2002). Only 2.5 per cent of the global water is fresh, but the total usable supply for ecosystems and humans is less than 1 per cent. And when demand for water exceeds available supply, it results in water scarcity. According to FAO (2013) available global water varies according to region. Recently the data obtained has revealed that Middle East has the least available water in cubic meters per person (Table 1) while the highest available water was recorded in North America (13,401 m^3/Person), followed by Latin America with 7,200 m^3/Person. This is why the World Economic Forum, in its Global Risk Report 2013, suggests that decreasing water supply is among the top five risks, both by likelihood and impact that humanity faces over the next ten years (UNCCD, 2013).

Falkenmark and Rockstrom, (2004) divided this resource into two categories which they call blue water and green water. Blue water is the liquid resource remaining after evaporation, and green water is the water originating as rainfall that subsequently returns to the atmosphere after evaporation or transpiration. Transpired rainwater is clearly a vital part of the resource for food production, and must be figured into estimates of present or future water shortages. The blue water resource of global runoff potentially accessible to humans are however difficult to estimate, and has considerable uncertainty (Postel *et al.*, 1996).

Global runoff is not evenly distributed over the planet's surface. There are some regions with excess water and others with chronic shortage. In regions with excess water, much of the volume flow of rivers and streams reaches the ocean without being used by humans, although it serves important environmental purposes (Gleick, 1998). In contrast, large areas of the globe receive low rainfall and are water deficient. Regions experiencing the greatest shortfall of freshwater are the Middle East, significant portions of Africa, and some parts of Europe and Southeast Asia (Postel, 1997).

Global Water Demand

Most studies carried out have identified that population growth as the principal driver of increases in the global demand for water. Although there are uncertainties surrounding future population projections, research shows that the world population is likely to grow by 30% between 2000 and 2025 and 50% between 2000 and 2050 (Bigas, 2012). The global population

that is expected to grow to projections of 9.5 billion by 2050 invites questions as to whether there will be sufficient water to support population increases of this magnitude (Bigas, 2012). Today, 1 billion people do not have access to safe and affordable drinking water and perhaps twice that many lack adequate sanitation services. In fact, inadequate drinking water quality is a leading cause of infant mortality worldwide (Jury and Vaux, 2005). Jury and Vaux (2007) observed that in 1995 18 countries were deemed water scarce in that they did not have adequate water supplies to meet the basic needs of their population, and 11 more were water stressed in that they did not possess adequate water supplies to meet the needs of all their people, for at least part of the year. The combined population of these 29 countries were over 450 million.

If all the freshwater on the planet are divided equally among the global population, there would be 5000–6000m^3 of water available for everyone (Jury and Vaux, 2007). Determining whether a country has a sufficient water supply to serve both its present and future population is a complex matter, because the relationship between population and water demand is contingent on many factors. For instance, a nation with enough wealth to import the food it needs to feed its population has a greatly reduced water demand compared to one that must grow its own nourishment. Moreover, a nation that can grow crops using only rainfall has a very different water budget than one relying on irrigation. Eating habit is also very important in determining water demand, particularly when meat is a significant portion of the diet (UN Water, 2007).

Causes of Global Water Crises

There are many factors that result to global water crises, but the major ones are; global climate change, rapid increase in population and economic growth (PAI, 1999). ACC (2010) has identified global water crises to occur as a result of rapid population, economic growth, increased demands for irrigation water and increased demand for urban water.

Climate Change

Climate change is a significant and lasting change in the statistical distribution of weather patterns over periods ranging from decades to millions of years (ACC, 2010). In other words it is the change in average weather conditions, or in the distribution of weather around the average conditions. Climate change is caused by factors such as biotic processes, variations in solar radiation received by Earth, plate tectonics, and volcanic eruptions. Certain human activities have also been identified as significant causes of recent climate change, often referred to as global warming (ACC, 2010). According to UNEP (2010). Climate change is one of the major challenges of our time and adds considerable stress to our environment, from shifting weather patterns that threaten food production, to rising sea levels that increase the risk of catastrophic flooding. The impacts of climate change are global in scope and unprecedented in scale. Without drastic action today, adapting to these impacts in the future will be more difficult and costly.

Effect of Climate Change on Water Crises

According to Morrison, *et al*., (2009) the future climate change will affect water supply, quality, and demand in the following ways; climate change will affect water scarcity and sustainable supply by increasing water shortages due to changes in precipitation patterns. It will also increase the vulnerability of ecosystems due to rise in temperature, changes in precipitation patterns, frequent severe weather events, and prolonged droughts. These factors, in turn, will further diminish the ability of natural systems to filter water and create buffers to flooding. Climate change will also lead to extreme weather, and sea level rise. Morrison, *et al*., (2009) also added that climate change will impact water quality by; increase extreme precipitation and flooding, which will increase erosion rates and wash soil based pollutants and toxins into waterways. It will also contaminate coastal surface and groundwater resources due to sea level rise, resulting in saltwater intrusion into rivers, deltas, and aquifers. Increase water temperatures will also lead to more algal and bacterial blooms that further contaminate water supplies. Morrison, *et al*., (2009) reported that climate change will increase water demand; by increase in water demand for agriculture, primarily for irrigation, due to prolonged dry periods and severe drought. Some research estimated that over 40 percent increase in land will be needed for irrigation by 2080. Climate change will also lead to increase in water demand for hydration needs for billions of farm animals due to higher atmospheric temperatures. The same climate change will increase quantities of water needed for industrial cooling due to increase in atmospheric and water temperatures. The impacts of climate change on the water cycle will vary regionally.

Increase in Population

Population growth is a major contributor to water scarcity. Growth in populations means mounting demand and competition for water for domestic, industrial, and municipal uses. Water is also needed for agriculture and industrial use, and for the evacuation of waste materials. The most water scarce or stressed areas are typically those with few water resources, high population densities, and high population growth rates. Population growth limits the amount of water available per person, drives people into marginal regions which are already water stressed and also into cities. For instance, most of the countries in the Middle East and North Africa (MENA) are regions that cannot meet their current water demand. Seven of the world's 10 water scarce countries are in the MENA region (Table 2) with per capita water availability projected to fall, by 2025, the situation is likely to be dire. (UN-Water, 2007). If population and consumption trends persist, it is estimated that the demand for water will surpass its availability by 56% and 1.8 billion people will be living in regions of water scarcity by 2025. This situation is exacerbated by the fact that developing countries are already experiencing water stress, which often has the highest population growth rates. The two main factors driving how much more food we will need are population growth and dietary change (UNWater, 2007).

Economic Growth

Economic growth is the increase in market value of goods and services produced by a country over time. It is conventionally measured as the percent rate of increase in real gross domestic product, or real GDP (Rosenberg, 1982). Some experts argue that a narrow view of economic growth, combined with globalization, is creating a scenario where we could see a systemic collapse of our planet's natural resources. Others observed that many natural resources have diminished. So far, one reason being that advancements in technology and science have allowed some previously unavailable resources to be produced (Alesina and Dani, 1994). Causes of global water crises are largely the result of population growth and economic development rather than just global climate change (Vörösmarty *et al.* 2000).

Consequences of Global Water Crises

The major consequences of global water crises that have direct impact to humanity are; pollution, diseases (Table 3), flooding, water scarcity, school attendance, cost of industrial productions etc. The United Nations created the Millennium Development Goals, which were adopted in 2000 by all the world's governments as a blueprint for building a better world in the twenty-first century. One target of the environmental sustainability goal was a plan to have by 2015 the proportion of people with sustainable access to safe drinking water. The assessment of the 2006 Progress Report was that the world was unlikely to reach this target in the designated time frame (UNDP, 2006).

Diseases

Gleick, (2004) has classified water-related diseases as a result of contaminated water into four categories: The first group is waterborne diseases caused by water which has been contaminated by human, animal or chemical wastes such as cholera, typhoid, amoebic and bacillary dysentery and diarrhoeal diseases. The second class is water-washed diseases caused by poor personal hygiene and skin or eye contact with contaminated water such as scabies, trachoma and flea-, lice- and tick-borne diseases. The third group is water-based diseases caused by parasites found in intermediate organisms living in water such as dracunculiasis, schistosomiasis and other helminths. The fourth group is water-related insect vector diseases caused by insects that bread in water such as dengue, filariasis, malaria, onchocerciasis, trypanosomiasis and yellow fever. Gleick (2004) also added that a parasite in water or insects breeding in water cause a lot of illnesses, the most serious of which are fatal. Table 3 lists the most serious of these water-related diseases, their morbidity, and the deaths they cause. These diseases kill over 5 million people per year. In addition, other diseases that are not generally fatal can cause a variety of incapacitating injuries. Thus, onchocerciasis and trachoma are responsible for over 6 million cases of blindness (Juryl and Vaux, 2007).

Water Shortage

Many of the world's cities are expected to face freshwater shortage in the future due to growing populations and related rise in water consumption as well as the decline in renewable freshwater resources caused by the effects of climate change. The urban and domestic domain contributes significantly to the exploitation of global freshwater resources, particularly in cities (Hutson, *et al.*, 2004). Several factors drive the progression towards water scarcity and over allocation of water, in many cases caused by a supply driven approach to development that does not take sufficient account of the limits of the water systems. As water becomes scarce, logics based on increased supply or a lack of understanding of the interrelations between the different sectors depending on water resources lead to increased shortages and conflicts between users. In many places, the institutional and legal tools needed to adapt and manage water scarcity are not available, leaving the way open to abuse and inequitable access to the resource (UN Water, 2007). Due to multiple factors, such as climate change and population growth, particularly in urban areas, it is expected that in general water stress will increase significantly worldwide by the middle of this century, (Figure 1) particularly in Africa, Asia, Australia, New Zealand, and Southern Europe, as well as in Latin and North America (Pachauri and Reisinger, 2007). The rapid urbanization facing developing countries is increasing pressure on public institutions to provide adequate supplies of clean water to populations. In most developing countries, the general public is not involved in strategies and policies regarding enhancement, conservation, and management of water supply systems (Ahiablame, 2012).

Rapid population growth and increasing water consumption for agriculture, industry and municipalities have stressed the world's freshwater resources. It is not surprising that, in some areas the demand for water already exceeds nature's supply with a growing number of countries expecting to face water shortages in the near future. Water shortage is becoming the greatest threat to food security and human health (Seckler, *et al.*, 1999). UN Agencies and Programme members of UN-Water have identified "Coping with Water Scarcity" as one of its priorities for the decade "Water for Life" and have developed a joint Plan of Action (PoA) to address this challenge. The primary objective of the PoA is to provide a coherent and comprehensive set of information, policy and international advice and technical support to countries and stakeholders that will enable them to address water scarcity issues more effectively at local, river basin and national levels (UN-Water, 2007).

Water Pollution

Water pollution occurs when pollutants are directly or indirectly discharged into water bodies without adequate treatment to remove harmful compounds (Laws, 2000). Water pollution is a global problem which requires ongoing evaluation and revision of water resource policy at all levels. It has been suggested that it is the leading world cause of deaths and diseases (Kennish, 1992). According to Conner and Freeman (998) Polluted water contains harmful bacteria and chemical substances such as toxics, nitrates, heavy metals, hydrocarbons, pesticides, etc. The bacteriological contamination of water is the main problem in developing nations. It is necessary to make appropriate tests to determine if water is safe for human consumption. Water pollution is a new problem approaching crises levels in many parts of the world. Estimated 80% of all diseases and over third of deaths in developing countries are caused by the consumption of contaminated water (Love, 1999).

Way Forward

There is no single and simple solution to water problems. Applying the lessons learned from successful methods elsewhere can greatly improve the effectiveness of water projects and policies. For these reasons we hereby suggest the following;

Internationally

- A continued global dialogue on the water crises.
- All governments should endorse the human right to water.
- Support ratification of the UN watercourses convention.
- Encourage the UN Security Council to focus on water security.
- Support to increased universal safe water supply.
- Facilitate links between national and global water, agricultural and energy policies.
- Encourage Cooperation and Act as a Mediator in Water Conflicts

Nationally the government should;

- Support Necessary Hydro-climatic Monitoring.
- Involve the private sectors in the provision of water supply.
- Strengthen water education programmes to public

States and local governments should educate;

- Individuals (men and women) on how to manage the available water and should be conscious in conserving it through daily activities.
- Individuals on how to support and protection ecological sustainability boundaries.
- The public on conserving water bodies both at urban and rural areas.

Conclusion and Recommendations

Water is crucial for all life on earth. It plays an essential role in our health, economy, food production, and environment. Despite its importance, water is a finite natural resource and cannot be created. Water crisis is everywhere in the world, which vary depending on the region, it could be on quantity (shortage) or quality (pollution). No one can predict the global water future, and it's believed that the world population will continue to grow. Therefore the crisis on water is expected to increase every year, unless strict measures are employed in all countries especially the developing ones. Every country should therefore support the right to water, so that MDGs number three can be achieved.

References

Ahiablame, L., Engel, B. and Venort, T. (2012). Improving Water Supply Systems for Domestic Uses in Urban Togo: The Case of a Suburb in Lomé, *Water* 4: 123-134

America's Climate Choices (2010). *Advancing the Science of Climate Change*; The National Academies Press, Washington, D.C. ISBN 0-309-14588-0. P.1

Aquastat (2013). Every drop count. FAO's global information system on water and Agriculture.
http://www.fao.org/nr/water/aquastat/main/index.stm. Accessed 22/11/2013

Bigas, H. (2012). *The Global Water Crisis: Addressing an Urgent Security Issue*. Paper for the InterAction Council, 2011-2012. Hamilton, Canada: UNU-INWEH.

Biswas, A. and Kirchherr, J. (2013). Can world's water crisis be solved? Combining good policies and management practices with right technologies could eradicate the global water shortages. The Business Times Published January 08, 2013. http://www.businesstimes.eom.sg/print/394584 .

Conner, S.L. and Freeman, L.A. (1998). Drinking Water Quality. Waterworks Publishing, Florida, USA. P. 31.

DeLago, C. (2013). *Race to 2015: America's Role in Eliminating the Water Crisis*. Stevens.

Institute of Technology, New Jersey . Pp. 7-22.

Falkenmark, M., and Rockstrom, J. (2004). "*Balancing Water for Humans and Nature*." Earthscan Press, London. Pp.22-40.

FAO (2013). Coping with Water Scarcity: An Action Framework for Agriculture and Food Security, Food and Agriculture Organization of the United Nations.

Gleick, P. (1998). *An introduction to global fresh water issues. In "Water in Crisis: A Guide to the World's Fresh Water Resources"* 1st Ed. Oxford University Press, New York. Pp.22-45.

Gleick, P. (2002). "Dirty Water: Estimated Deaths from Water-Related Disease 2000-2020." Pacific Institute Research Report. Online at www.pacinst.org/publications/.Accessed on 12/11/13.

Gleick, P.H., (2004). The World's Water 2004 – 2005. The biennial report of freshwater resources. Island Press, pp.7-41.

Gleick, P., and Lane, J. (2005). Large international water meetings: time for a reappraisal. *Water International,* 30:410-414.

Hinrichsen, D., Robey, B. and Upadhyay, U.D. (1999). Solutions for a water-short world. www. jhuccp.org/pr/m14edsum.stm.

Hutson, S.S., Barber, N.L., Kenny, J.F., Linsey, K.S., Lumia, D.S. and Maupin, M.A.(2004). *Estimated Use of Water in the United States in 2000*; U.S. Geological Survey: Reston, VA, USA,

Jury, W. A. and Vaux, H. J. (2005). The role of science in solving the world's emerging water problems. *Proceedings of National Academy of Science* 102(44):15715–15720.

Juryl, W. A. and Vaux, H. J.(2007). The Emerging Global Water Crisis: Managing Scarcity and Conflict. *Advances in Agronomy* (95):1-65

Kennish, M. J. (1992). *Ecology of Estuaries: Anthropogenic Effects*. Marine Science Series. Boca Raton, FL: CRC Press. Pp. 415–17.

Laws, Edward A. (2000). *Aquatic Pollution: An Introductory Text*. New York: John Wiley and Sons. P. 430. ISBN 978-0-471-34875-7

Love, P. (1999). Water worries. http://www.oecd.org. Accessed on 02 November, 2013.

Morrison, J., Morikawa, M., Heberger, M., Cooley, M. Gleick, P. and Palaniappan, M. (2009). *Climate Change and the Global Water Crisis: What Businesses Need to Know and Do*. United Nations Global Compact. Pacific Institute Publishers. Pp. 1-8

Pachauri, R.K. and Reisinger A. (2007). Climate Change 2007: Synthesis Report; Intergovernmental Panel on Climate Change: Geneva, Switzerland.

PAI, (1999). Sustaining Water: Population and the Future of Renewable Water Supplies.
http://www.cnie.org/pop/pai/h2o-toc.html. Accessed on 18/11/13.

Postel, S., Daily, G. C., and Ehrlich, P. R. (1996). Human appropriation of renewable fresh water. *Science* 271,785-788.

Postel, S. (1997). Pillar of Sand: Can the Irrigation Miracle Last? New York, W.W. Norton and Company.

Postel, S. (1998). Water for food production: Will there be enough in 2025? *Bioscience* 48: 629-635.

Rosenberg, N. (1982). *Inside the Black Box: Technology and Economics*. Cambridge, New York: Cambridge University Press. P. 258.

Seckler, D., Molden, D., and Barker, R. (1999). Water Scarcity in the Twenty-First Century, International Water ManagementInstitute. www.cgiar.org/iwmi/WB1Cover.htm.

UNCCD (2013). World Day to Combat Desertification. Awareness Raising, Education and Communication Unit United Nations Convention to Combat Desertification (UNCCD). Bonn, Germany. Web-site: www.unccd.int.

UNDP (2006).Beyond scarcity: Power, poverty and the global water crisis, United NationsDevelopment Programme .New York.

UNEP (2002). Freshwater Resources. United Nations Environmental Programme. www.unep.org/vitalwater/html

UNEP (2010). Climate change. United Nations Environment Programme (UNEP).
15 Rue de Milanhttp://www.unep.org/climatechange/

UNWater (2007). Coping With Water Scarcity: Challenge of the Twenty-First Century, World Water Day 2007. Pp. 9-22.

UN General Assembly (2010). *Resolution Adopted by the General Assembly 64/292: The Human Right to Water and Sanitation.* United Nations General Assembly (A/RES/64/292;
http://daccess-ods.un.org/TMP/5539215.80314636.html, accessed 13 March 2012).

Vörösmarty, C.J., Green, P., Salisbury, J. and Lammers, R.B. (2000). Global Water Resources: Vulnerability from Climate Change and Population Growth, *Science*, 289: 284–88.

WHO (2004). World Health Organization, Geneva. Online at www.who.int/water_sanitatibn_health/publications!facts 2004/en!

Tables

Table 1: Water Availability by Region, 2013

Region	Average water Available (Cubic meters Per Person)
Arab World (Middle east)	500
Sub-Saharan Africa	1,000
Caribbean	2,466
Asia-Pacific	2,970
Europe	4,741
Latin America	7,200
North America	13,401

Source: AQUASTAT (2013) FAO, (2013).

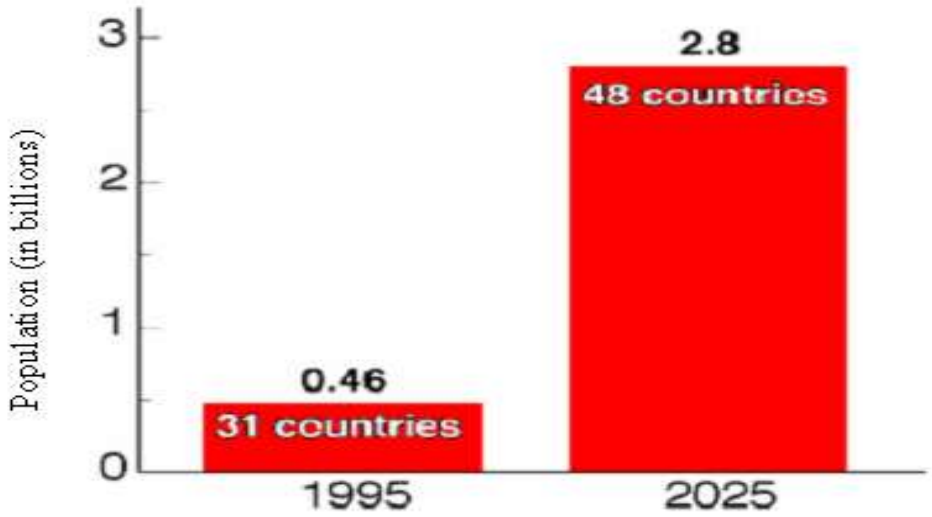
Table 2: Population Pressures on the Top Water Scarce Areas of the World

Country	Population 2010 (Thousands)	Projected Population	Per Capita Water Availability in 2035
Kuwait	2,737	4,328	4.6
UAE	7,512	11,042	13.6
Qatar	1,759	2,451	21.6
Bahamas	343	426	46.9
Saudi Arabia	27,448	40,444	59.3
Bahrain	1,262	1,711	67.8
Libya	6,355	8,081	74.3
Maldives	316	392	76.6
Yemen	24,053	46,196	88.8
Singapore	5,086	6,098	98.4

Source: UNDP (2006).

Figures

Figure 1: Population in water scarce countries, 1995 – 2025.



Source: Hinrichsen, *et al.*, (1999)