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The Water Crisis in Yemen: Causes, Consequences and Solutions

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Abstract

Yemen, a country located in a dry and semi-arid region of the Middle East, is already facing a severe water crisis. Mostly due to high population growth, misguided agricultural development and the growth of qat, a lack of law enforcement to regulate water use, and a vulnerable climate to climate change, the crisis may soon reach catastrophic levels. Beyond a brief description of the main causes of Yemen's water crisis, this article also provides a brief overview of the literature, some empirical background, an analysis on the consequences, and a discussion of some of the proposed solutions to Yemen's water crisis.

I. Introduction

Yemen is a country with one of the highest rates of population growth in the world. It is also the country with the highest rate of exhaustion of water sources in the Middle East. Sana'a is the only capital city in the world that may run out of water within the next decade. The combination of high population growth and exhaustion of water has contributed to a severe water crisis in Yemen that may be one of the most catastrophic in the world. Unless immediate action is taken, Yemen may experience mass fatalities caused by dehydration of its people.

Abdul Kareem Al-Eryani, a former Prime Minister of Yemen, said: "I am very pessimistic, frankly, for the next two to three years. Nature and man are squeezing Yemen. And I think this alarm bell should ring in various corners around us and in the United States as well."[1] The World Bank (2006) described Yemen as the single largest development challenge in the Middle East. Since the 1970s, Yemen has undergone a number of rapid social and economic changes that the government could not control. Many of these changes have led to water shortages.

[1] Kenyon (2008), last paragraph of news report.

According to Al-Asbahi (2005), Yemen's total renewable water resource amounts to 2.5 billion cubic meters per year, while the total demand is estimated to be 3.4 billion cubic meters per year, with 900 million cubic meters per year being covered from deep aquifers. Hence, ground water aquifers decline one to seven meters each year, with very rare recharge due to droughts that have been intensified by climate change. Given that the consumption of water is exceeding the rate of natural recharge, it is only a matter of time before the existing groundwater is all used up.

This article is about the causes, effects and proposed solutions to the Yemen water crisis. The next section provides a brief overview of the literature. The third section provides some empirical background on Yemen's water shortage. The subsequent three sections review and discuss respectively the causes, consequences and some of the proposed solutions to Yemen's water crisis. The last section provides some conclusions.

II. Literature Review

Besides a variety of news reports, there is very little literature covering Yemen's water crisis. Van der Gun (2009) looks specifically at Yemen as an example of how climate change impacts alluvial aquifers in arid regions. The Human Development Report 2006 on the global water crisis also provides various references to Yemen, though without making Yemen a focal point.[2]

The most comprehensive information on water resources in Yemen has been provided by Al-Asbahi (2005). He introduces the topic by illustrating how the scarcity of water in Yemen has become a water crisis and describes then the use and development of Yemen's water resources. Al-Asbahi provides also detailed information on the institutional background of water resources management in Yemen and discusses Yemen's water resources strategies, policies and legislations. He proposes various solutions to the water crisis, including rainwater harvesting and desalination of seawater as a resource.

A number of news organizations have published articles about the water crisis in Yemen. Most of them provide information on the causes and impact of the crisis. Some of the news reports also propose some solutions. The following news reports have been some of the most recent ones.

- Kasinof (2009) provides a report published by ABC news entitled "Yemen Water Crisis Fuels Conflict." This report discusses how the lack of water is causing conflicts in Yemen – from demonstrations, to small riots, to an intensified war between the government and a group of rebels. Kasinof (2009) also warns that if the water crisis is not solved, current conflicts may spin out of control, and new conflicts may arise. When it comes down to survival, people will fight to stay alive, and that can cause anything from an argument to a war.
- United Press International (UPI) Science News (2009) provides information on the tensions and conflicts induced by water shortages, and gives statistics on the severity of the crisis. "Water is definitely a security problem in the region," Samir Tariq, director of the Orient Center for Strategic Studies, told UPI.

[2] See United Nations Development Program (UNDP) (2006).

- Kenyon (2008) provides interviews with the Yemeni population about the deterioration of plants and agriculture in the country and other physical changes that have occurred as a result of decreased water availability.
- Carter (2009) provides information on how the Obama administration is willing to help Yemen financially – but only if Yemen cooperates with the United States in relation to capturing terrorists.
- Lyon (2009) and Hill (2009) give a general overview of the situation in Yemen and particularly Sana'a, the capitol city that is most affected by the water crisis and destined to run dry in a decade unless immediate preventative action is taken.
- Al-Omari (2008) and especially Wardam (2009) discuss Yemen's climate vulnerability to global warming, which severely worsens the water crisis.

III. Empirical Background

Yemen is located in a dry and semi-arid region of the Middle East, where the average annual rainfall ranges from 500 to 800 mm in the high lands, 40 to 100 mm in the coastal areas and 50 mm in the desert areas (Al-Omari, 2008). Unlike other Middle-Eastern countries like Lebanon, Syria and Egypt, Yemen has no rivers. It depends on rainwater as well as underground water. Yemen's water shortage is far worse than that of any other country in the Middle East. The average person in the Middle East has 1,250 millimeter (mm) of water per year. The average person in Yemen has 140 mm of water per year. Figure based on WDI.

Water availability in Yemen is decreasing every year. The World Bank reports that in the year 1990, 71 percent of the Yemeni population had access to water. In 2004, this figure decreased to 67 percent. This does not follow the pattern of water availability in the region (Middle East and North Africa), where the water availability has been increasing from 87.5 percent of the population in 1990 to 89.5 percent in 2004. Yemen's water availability per capita is the lowest in the region as well as in the world.

In Yemen, urban areas have greater access to water than rural areas. However, the decrease in water availability is more drastic in urban areas. Water availability in urban areas decreased from 84 percent in 1990 to 71 percent in 2004. In rural areas, this figure decreased from 68 to 65 percent. At the present time, cities still have more water availability than rural areas – but at the rate of decreasing availability, this will soon change (World Bank).

Table 1 shows the sectoral use of water from 1990 to 2010. The table shows that water used for agriculture and irrigation has increased and is expected to increase further from 1990 to 2010. It is also increasing for domestic, urban and rural purposes and industrial and mining purposes. Overall, water use has increased since 1990 and is expected to increase. In 1990, total water use was 2,799 million cubic meters per year. In 2010 it was 3,970 million cubic meters per year – but since availability is declining and population is increasing, Yemen may soon run dry.

Table 1: Use of Water for a Period of 30 Years (1990-2010) in Different Water Use Sectors (million cubic meters per year)

Water Use	1990	2000	2005 (estimated)	2010 (estimated)
Agriculture/Irrigation	2,600	3,145	3,235	3,328
Domestic/Urban/Rural	168	210	265	552
Industrial & Mining	31	45	65	90
Total	**2,799**	**3,400**	**3,565**	**3,970**

Source: Al-Asbahi (2005), Table 1 (p. 4), based on data provided by the TNO Institute of Applied Geo-science.

IV. Causes of the Water Crisis

There are five key causes of Yemen's water crisis: (1) high population growth, (2) misguided agricultural development and policies, (3) the use of water to grow qat, (4) a lack of law enforcement to regulate water use, and (5) a high vulnerability to climate change.

IV.1. Population Growth

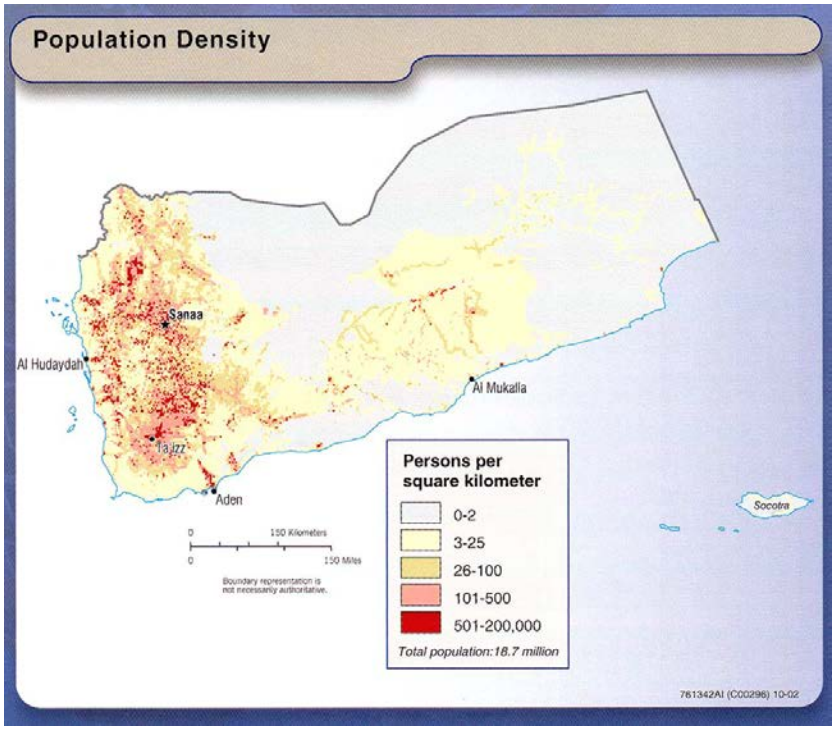
Yemen has one of the highest population growths in the world – and with more people comes the need for more water. Since 1990, the Yemeni population has nearly doubled. The World Bank estimates that in 1990, the population was 12.3 million. The population today is 23.1 million. The population is increasing most rapidly in cities; hence, water availability is decreasing most rapidly in cities. Figure 1 shows the population density of Yemen. It is evident that the majority of the population is clustered in cities like Sana'a, Aden and Ta'izz. Figure 2 shows that Yemen's annual population growth is amongst the highest in the world.

IV.2. Misguided Agricultural Development and Policies

In recent years, many Yemenis migrated to neighboring countries, like Saudi Arabia, to work in the oil industry. This stimulated the growth of the Yemeni market, which allowed agricultural technology to develop rapidly. Tractors, chemical inputs and tube well technology were introduced, which steered Yemen away from traditional farming practices and systems of water management. The country could no longer live in balance with its natural resources when these technologies were used.

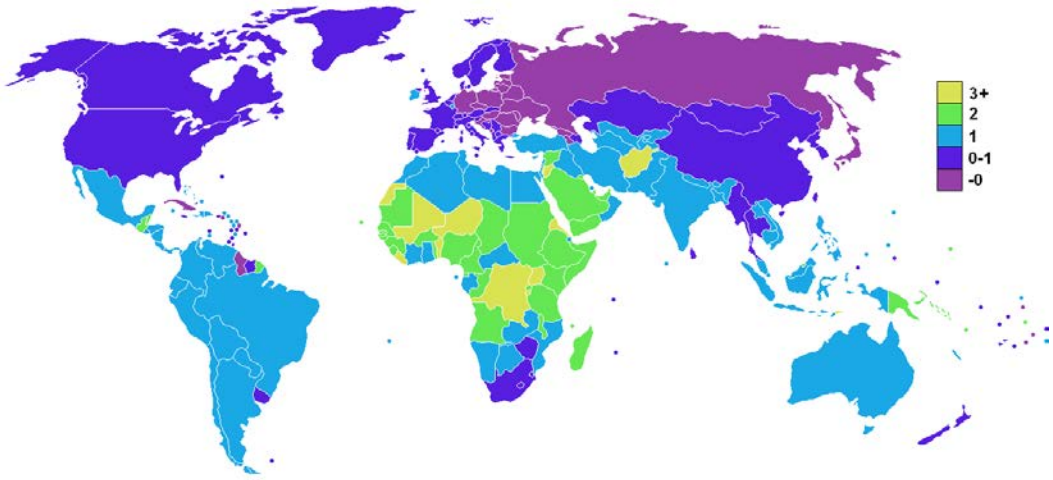
Furthermore, the government failed to prevent the sinking of wells and regulate groundwater extraction. It implemented policies that encouraged the use of water, including low-interest loans, cheap diesel pricing and public investment in surface or spate irrigation. Because of this, groundwater and surface irrigation have been significantly under priced, causing Yemenis to be wasteful in their use of water (Ward, 2001).

Figure 1: Population Density



Source: University of Texas Libraries, Perry-Castañeda Library, Map Collection from Yemen (Wall Map, 2002); available at: http://lib.utexas.edu/maps/middle_east_and_asia/yemen_pop_2002.jpg

Figure 2: Population Growth Rate, 2005-2010



Source: Wikipedia (based on UN data); available at: http://en.wikipedia.org/wiki/List_of_countries_by_population_growth_rate

In the 1990s, the Yemeni government had placed import and export bans on certain resources to try to stimulate their economy. The export of fish was temporarily prohibited in 1994, because the country was in short supply of fish. In 1996, there was an import ban on fruits, vegetables and coffee – meaning, importing these products was made illegal (Enders, 2002). This was done to supposedly enhance the economy's efficiency and growth prospects. Though the ban on fruits and vegetables was lifted in 2000, the damage had already been done in terms of decreasing the groundwater level (Ward, 2001). Furthermore, many farmers continue to grow water-intensive fruits and vegetables as agricultural and trade policies make it highly profitable to grow them.

IV.3. Qat and Its Effect on the Crisis

More than half of Yemen's water is used to grow qat (or Khat). Qat is a narcotic drug that is chewed by 80 percent of the Yemeni population. Weir (1981) discusses the impact of qat on the people, the region and water in Yemen. Qat, in the form of chewable leaves, is used to produce excitation, forgo sleep and enhance communication between people. It also reduces feelings of hunger and fatigue – both of which are common in a country as impoverished as Yemen. Addiction to qat is similar to an addiction to cocaine – it is difficult to give up once an individual has started using the drug. Most Yemeni men and some women chew the leaves of this plant every day for its narcotic effect. It is a way of life in Yemen. Qat chewing starts after lunch, the main meal of the day, and continues for the rest of the day. It is a highly social event – families and friends gather in private homes, each bringing their own qat.

According to Worth (2009), farmers harvest this plant to make profit – and use the already-scare supplies of water to do so. Although the government has tried to limit the growth of qat, to preserve water – no one is listening. Farmers are unwilling to give up this crop because it is often their only source of income, and the majority of the population is addicted to this drug. Qat is one of the major causes of the water crisis because the crop is sucking up most of Yemen's groundwater. About 90 percent of the nation's groundwater is currently used to irrigate qat (Hill, 2008). "The increase in qat cultivation is having a huge impact on the groundwater (stock)," said Noori Gamal, senior hydro-geologist at the Ministry of Water and Environment. According to a news report by McGrath (2009), agriculture accounts for about 90 percent of Yemen's groundwater consumption, and at least 30 percent of this is used just for growing qat.

IV.4. Lack of Law Enforcement

The Yemeni government also lacks law enforcement to prevent water from being wasted. Wells are being drilled illegally into natural groundwater aquifers. This is happening at an alarming rate. Leaky pipes are common, sometimes wasting up to 60 percent of the water passing through them (Kasinof, 2009). In some basins (like the Sa'adh basin), Yemenis must drill up to 800 m in depth to reach any water. In any case, it is clear that the lack of law enforcement and flawed policies have contributed to the water crisis – which could have been prevented, or at least be less serious, if the government had implemented laws and policies that would have limited water use.

IV.5. Climate Vulnerability

Climate change is drastically affecting Yemen's water availability. The summary of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (2008) came to the conclusion that the climate in the Middle East and North African region will become even hotter and drier. As detailed in van der Gun (2009), this will increase the occurrence of droughts, potentially destroy agriculture, reduce tourism and cause rising sea levels and flooding in coastal regions.

To reduce the severity of climate change in this region, which includes Yemen, the World Bank will partner with affected nations to help them adapt in three ways:

- The first is infrastructure investment. Projects must be completed in ways that will limit their vulnerability to climate change. For example, buildings must be designed so that they will survive the changing climate. Building near the coast is discouraged, to avoid destruction due to flooding. The World Bank has $1.1 billion in its budget to help affected countries with their infrastructure investment.
- The second is building awareness and knowledge. The public needs to be informed of climate change and how to adapt to it. The World Bank is currently building a program in the Middle East and North African region for technical assistance on climate change adaptation.
- The third is policy reform. Countries that are severely affected by climate change need to change some of their policies in order to adapt. Fiscal reform (government spending and revenue collection) would be useful in improving efficiency of land use and the use of water and energy. Not only would this make for a more sustainable environment, but it would also free up public funds that could instead be used to protect the most vulnerable social groups from climate change (like the poor).

Agriculture constitutes 15 percent of Yemen's GDP. The government is worried that climate change will decrease the frequency and amount of rainfall, thereby destroying the country's agriculture. This would not only be a water crisis, but also a food and economic crises. The World Bank is helping farmers in Yemen by teaching them strategies to conserve and use biodiversity to make agriculture less vulnerable to climate change. The strategy emphasizes the conservation of agro biodiversity and developing coping mechanisms with climate change.

V. Consequences of the Water Crisis

V.1. Decline in Water, Tourism and Food

Yemen is the Arab world's poorest country. The average person in Yemen survives on one-fifth the amount of water that the World Health Organization considers adequate. In Sana'a, some residents receive piped city water once every nine days – others get none at all. The following are some quotes of what had been said on this issue:

- "Yemen's water share per capita is under 100 cubic meters a year, compared to the water poverty line of 1,000 cubic meters," said Hosny Khordagui, Head of the

United Nations Development Program's water governance program (see Lyon, 2009).

- Yemen is running out of water. "The catastrophe is coming, but we don't know when," said Abu Hatim from the World Bank. "Without water, peoples' health will suffer and many may not survive."[3]
- "This year, with no rain, nothing's growing – the coffee, the corn, the wheat, the khat – nothing" said Sheikh Abdullah Hussein Khalil, a resident in the Haraz Mountains. "A couple of years ago we might get as many as 150 tourists in a day, sometimes twice that. But now it's only a few and some days none at all."[4]
- The Haraz Mountains used to be lush and green, with fruit orchards, coffee bushes and qat trees. Now, the mountains are a hazy brown with a few blackened areas where a farmer has given up for the season and burned the land. The sheep are starving and thin, looking for something to eat (Kenyon, 2008).
- Based on Kenyon (2008) a shepherdess in the mountains said that five out of 25 of her sheep have died out of dehydration or starvation (which is caused by lack of plants as a result of no water). "It's hard, very hard this year," she said. "There's no rain, and the plants the sheep eat are dry. The sheep are dying, the plants are dying. There's nothing else to do; we wait for the rain. That's what we always do."

Tourists have no will to visit Yemen because of what it has become – largely due to the water crisis. Figure 3 shows the current state of the Haraz Mountains in Yemen. A few years ago, the entire region was green and lush. Now it is dry and barren, because of droughts and the decline in water.

Figure 3: Current State of the Haraz Mountains

Source: Matthew Kuehl for NPR, as posted at: http://www.npr.org/templates/story/story.php?storyId=90328214.

[3] See Lyon (2009).
[4] See Kenyon (2008).

The land is dried up, the people are thirsty and hungry, poverty is everywhere, and conflicts are continually arising. Without water, crops cannot grow – and without crops, there is no food. Yemenis are not only suffering from a water shortage, but also a food shortage. And with the decline in tourism previously mentioned, Yemen does not have the funds to import food for its people. The cost of staple foods is rising and the economic crisis has hit hard, making it difficult for Yemenis to afford them (Kenyon, 2008).

V.2. Water Crisis at the Heart of Yemen's Conflicts

Kasinof (2009) wrote that Yemen's water crisis has the potential to contribute to the country's instability and potential trajectory toward failure. According to Kasinof (2009), Abdulrahman Al Eryani, Yemen's Minister of Water and Environment, said that much of the country's rising militancy is a conflict over resources. "They manifest themselves in very different ways: tribal conflicts, sectarian conflicts, political conflicts. (…) Really they are all about sharing and participating in the resources of the country, either oil, or water and land." Current conflicts include a widening armed rebellion in the north and a violent separatist movement in the south. These are intensified by the water crisis, and further prevent the government from entering the regions to try to solve the crisis in an organized manner. Many regions are too dangerous for government engineers or hydrologists to go to.

A study by Sana'a University researchers found that between 70-80 percent of all rural conflicts in Yemen are related to water. A geology professor at the university estimates that Sana'as wells – one of its primary water sources – will run dry by 2015, based on the current water-usage rates. In Taiz, Yemen's third-largest city, residents are only allowed to access public water tanks once every 45 days. In Sana'a, there were 180 wells ten years ago. Today there are only 80. "We have a water shortage that reflects itself in fighting between the people," Deputy Planning Minister Hisham Sharaf said.[5] According to Lyon (2009), on August 24, 2009, one person was shot dead and three were wounded during water protests in the southern city of Aden. People fear that if the crisis is not solved, more serious conflicts could break out in Yemen to add to the ones that already exist.

The link between Yemen's water crisis and conflict is not new. Sultan (2004) wrote an article for Asia Times that stated that most of the conflict is between a Shiite Muslim rebel group called Houthis and the Yemeni government. The Houthis are a militant organization from Zaydi Shia who believe they are fighting to defend their community from the government and discrimination. The government believes they are trying to take over and bring Shia religious law to the country. According to Sultan (2004), they are also said to be stirring anti-American sentiment.

Sporadic warfare has occurred in the region for several years, but the conflict has recently intensified. The ongoing conflict has escalated to a war in the Saada province, where the country's army has launched several offensives against the Houthis. This conflict is restraining the Yemeni government from focusing on the water crisis. In areas where the rebels are present, water usage cannot be regulated. The government needs to use its money

[5] See ECOWORLD, http://www.ecoworld.com/waters/yemens-water-crisis-mideast-warning.html.

and resources to fight the rebels – money that could otherwise be used to reduce the effects of the water crisis. Before a country can focus on sustainability, it needs to maintain peace – at least on its own grounds.

VI. Proposed Solutions

With no food, no water, and no income from tourism, what are the prospects for Yemen? It is clear that Yemen needs help to prevent that the water crisis reaches catastrophic levels. Foreign assistance could be useful, though has been very little in the past, largely due to political reasons. In 1990, when the United Nations Security Council voted to authorize the use of force to remove Iraqi troops from Kuwait, Yemen was one out of two countries (the other being Cuba) to vote against this resolution. Before 1990, the United States gave $70 million a year to Yemen in foreign aid. After the vote, the aid was eliminated for ten years. By the time the ten years had passed, the Bush administration was in power.

The Bush administration refused to provide assistance to Yemen because it was angry at Yemen's freeing of convicted terrorists. Yemen released one man from prison who was involved in the 2000 bombing of the USS Cole, which killed 17 American sailors. Yemen is also the homeland of Osama Bin Laden, whose father was born in Yemen. In 2002, a North Korean ship carrying 15 missiles, warheads and chemicals was intercepted on its way to Yemen. This made the United States unsure of Yemen's cooperation in its fight against Al-Qaeda.

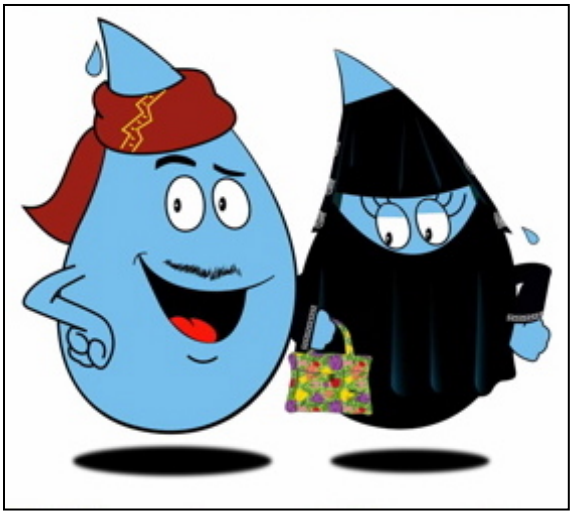
In 2002, the United States decided to give Yemen another chance by giving Yemen $30 million for security assistance. However, the following year ten suspected terrorists disappeared from a high-security prison located in Yemen and guarded by Yemenis. Also, thousands of Yemenis protested the war in Iraq in demonstrations (Carter, 2009). As a result, the Bush administration has been reluctant to grant Yemen any foreign aid – and many of the other Western nations are equally reluctant. This leaves Yemen alone, struggling to survive without foreign resources.

However, there is hope for Yemen when it comes to foreign aid. Yemen is home to al Qaeda – a safe haven for members to hide in the mountains and small villages. Some fear that al Qaeda is increasing their numbers in Yemen and taking over. President Obama sent a letter to the President of Yemen in September (Carter, 2009) in which he offered "that the United States would present an initiative to support Yemen to face all its development obstacles and enhance efforts or reforms through the International Monetary Fund (IMF), World Bank (WB) and donors as well as states of the Gulf Cooperation Council." As long as Yemen cooperates with the United States, the United States and its allies will financially support the nation – and that may be crucial in times where the water crisis is threatening the survival of the country.

Recently, the Yemeni government has with the help of GTZ (a German development agency) introduced a national mascot, named Rowyan, to persuade people to limit their water usage. Rowyan is an animated raindrop with a moustache and a headdress. As shown in Figure 4, Rowyan has a wife – who is also a raindrop – that is dressed in a veil and black robes, and carrying a handbag. Rowyan and his wife appear on television in short advertisements, promoting the proper use of water – using it sparingly and avoiding

wasting the water. The cartoon is meant to grab the attention of television viewers and persuade them to change their consumptions lifestyles to help save the country from the water crisis. It is proving to be an effective tool in spreading awareness.

Figure 4: Rowyan and his wife as animated raindrops



Source: http://news.bbc.co.uk/2/hi/middle_east/7595552.stm

The visual impact of the cartoon is designed to appeal in a country with low literacy levels, where advertising and market research are limited (Hill, 2008). The cartoon also attracts children, who are the generation of the future and will influence water use. “Rowyan really seems to have captured the public’s imagination,” Jochen Renger, head of GTZ’s sector in Yemen said. “This indicates people are receptive to the message at some level. But is there a behavioral change? We don’t know yet.”

According to Al- Al-Asbahi (2005), there are a number of solutions to minimize the water crisis, which can be summarized in four points:

- Rainfall water harvesting is technique to prevent as much rainfall from being wasted as possible. The Yemeni government must construct dams to prevent water from flowing away. The government should also construct weirs, which are small overflow-type dams that are used to create millponds to prevent water loss. Water concrete tanks (to store water and canals must also be built. These structures all prevent water from disappearing into the ground. It is much easier and more effective to use surface water than to drill and pump groundwater.
- Improving the irrigation efficiency is another important technique. Irrigation systems are in use in Yemen, but often waste water because they are broken or have leaks. Sometimes up to 60 percent of water in irrigation systems is lost due to leaks. Improving the system, through use of better pipes and sprinkler systems, would drastically reduce that number. The improved systems represent

only four percent of the total area irrigated with groundwater. The efficiency of the traditional irrigation system is only between 30 and 40 percent, which means a lot of water is lost.

- Extensive investigations for groundwater are necessary to determine how much groundwater is available to cover the drinking water requirements for the Yemeni population. Precise calculations need to be made so that everyone has water.
- Extensive studies for desalination, which is the practice of converting saltwater from the ocean into drinkable water, would be useful to provide water to populations living near the coast. However, a problem with this is, it is expensive to desalinate water, and this would subsequently raise the price of water for the population, which may not be affordable.

VII. Conclusion

The water crisis in Yemen has the potential to cause the destruction of the nation. The water crisis was triggered by a sharp population increase, misguided agricultural policies promoting the use of water, the growing of qat, a lack of governmental regulation on using water, and a vulnerable climate to global warming. Due to inadequate water, Yemenis are suffering from lack-of-water-induced food shortages, and dehydration-related health problems. The water crisis has also triggered some local conflicts, which led to a decline in tourism and had therefore also negative implications on Yemen's economy. Internal conflicts have also made it impossible for the Yemeni government to regulate water use in conflict-affected areas.

For Yemen to survive as a nation, some believe it must cooperate with the United States to receive foreign aid, regulate water use and implement strict regulation policies, prohibit (or at least minimize) the cultivation of qat, import fruits and vegetables that require lots of water, prepare for climate change and use positive images (like the Rowyan cartoon) to encourage the population to participate in water conservation methods.

Al-Asbahi (2005) recommended that Yemen uses rainfall water harvesting methods, improves its irrigation efficiency, investigates groundwater availability and studies the desalination of water to possibly use it as a future source. Today, Yemen is trying to make some changes, though only time will show if these attempts will be sufficient to avert an even more severe crisis.

References

Al-Asbahi, Qahtan Yehya A. M. (2005) "Water Resources Information in Yemen", paper presented at the United Nations Intersecretariat Working Group on Environment Statistics (IWG-ENV), International Work Session on Water Statistics, Vienna (June 20-22), available at: http://unstats.un.org/unsd/environment/envpdf/pap_wasess3a3yemen.pdf.

Al-Omari, Moneer (2008) "Yemen's Water Crisis Looms", *YemenPost.com* (11. August);

available at: http://www.yemenpost.net/42/Health/20081.htm.

Carter, Sarah A. (2009) "Obama offers anti-terrorism aid to Yemen", *Washington Times - Politics, Breaking News, US and World News* (9. September); available at: http://www.washingtontimes.com/news/2009/sep/09/obama-offers-aid-to-yemen-for-terrorism-fight/.

Hill, Ginny (2008) "Comic answer to Yemen water crisis", *BBC News, News Front Page* (4. September); available at: http://news.bbc.co.uk/2/hi/middle_east/7595552.stm.

Intergovernmental Panel on Climate Change (IPCC) (2008) *Climate Change 2007: Synthesis Report -- Summary for Policymakers* (Geneva, Switzerland: Intergovernmental Panel on Climate Change).

Kasinof, Laura (2009) "Water Crisis at Heart of Yemen's Conflicts", *ABC News (November 9); available at: http://abcnews.go.com/WN/yemen-water-crisis-fuels-conflict/story?id=9013421&page=1; also published as* "At heart of Yemen's conflicts: water crisis", *The Christian Science Monitor.com (*5. November); available at: http://www.csmonitor.com/2009/1105/p06s13-wome.html.

Kenyon, Peter (2008) "Water, Food Shortages Squeeze Yemen" Washington, DC: *NPR : National Public Radio : News & Analysis, World, US, Music & Arts (3.* June); available at: http://www.npr.org/templates/story/story.php?storyId=90328214.

Lyon, Alistair (2009) "Water crisis threatens Yemen's swelling population", *Reuters.com (*August 30); available at: http://www.reuters.com/article/environmentNews/idUSTRE57T0HK20090830.

McGrath, Cam (2009) "Qat Cultivation Draining Water Reserves" *IPS, The Story Underneath—Yemen* (28. May); available at: http://ipsnews.net/news.asp?idnews=47016.

Sultan, Nabil (2004) "Asia Times - Asia's most trusted news source for the Middle East." *Asia Times Online: Asian news hub providing the latest news and analysis* (10. July); available at: http://www.atimes.com/atimes/Middle_East/FG10Ak02.html.

United Nations Development Program (UNDP) (2006) *Human Development Report 2006 — Beyond Scarcity: Power, Poverty and the Global Water Crisis* (Houndmills, Basingstoke and New York: Palgrave MacMillan); available at: http://hdr.undp.org/en/media/HDR06-complete.pdf.

United Press International (UPI) (2009) "Yemen's water crisis a Mideast warning", *UPI Energy Resources*; available at: http://www.upi.com/Science_News/Resource-Wars/2009/10/29/Yemens-water-crisis-a-Mideast-warning/UPI-52511256844951/.

Van der Gun, Jac A. M. (2009) "Climate Change and Alluvial Aquifers in Arid Regions: Examples from Yemen", in: Fulco Ludwig et al. (eds.) *Climate Change Adaptation in the Water Sector* (London, UK and Sterling, VA: Earthscan).

Ward, Christopher (2001) "British-Yemeni Society: Yemen's water crisis", *AL-BAB: an open door to the Arab world* (July); available at: http://www.al-bab.com/bys/articles/ward01.htm.

Wardam, Batir (2009) “Vulnerability to Climate Change in the Middle East”, *Arab Environment Watch - Jeeran Blogs (based on* The Palestine Telegraph, processed from World Bank resources, 11. November); available at: http://www.arabenvironment.net/archive/2009/11/969153.html.

Weir, Shelagh (1985) *Qat in Yemen: Consumption and Social Change* (London: British Museum Publications).

World Bank (2006) *Middle East & North Africa Region (MENA) – Yemen* (Washington, DC: The World Bank, *Country Brief*, August); available at: http://siteresources.worldbank.org/INTYEMEN/Resources/YEMEN-ENG2006AM.pdf.

Worth, Robert F. (2009) “Thirsty Plant Dries Out Yemen”, *The New York Times - Breaking News, World News & Multimedia* (1. November); available at: http://www.nytimes.com/2009/11/01/world/middleeast/01yemen.html.