Consumption Behavior and Water Demand Management in the Kingdom of Saudi Arabia: Implications for Extension and Education

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ABSTRACT

Arid climate, high temperatures, limited water supplies; and scarce fresh water resources are prominent features of the ecosystems of the kingdom of Saudi Arabia. Water results sustainability and ensures the survival of the living biota. Since the development of new water resources happens to quite expensive and difficult, therefore conservation of presently available supplies and their wise management by the households, farms and industries seems to be the most suitable option to combat water scarcity. Enormous quantities of water can be saved by employing the simple concepts and principles of Water Demand Management (WDM) in the conservation programs. Realizing the importance of conservation initiatives, the kingdom made generous offers to the consumers in the forms of free distribution of water saving devices and kits. The kingdom offered free friendly technical assistance and support for the installations of the sanitary fittings at the consumers' residences. These initiatives were also supported by the Extension and Education programs. Extension messages were brought to the water consumers and general public in the pictorial forms. They produced a positive impact and helped reducing the water consumption by 20-30 percent. The present study suggests the continuation of the extension education programs on water conservation.

انماط استهلاك وإدارة الطلب على المياه في المملكة العربية السعودية: دور الإرشاد والتعليم

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مصادر مائيه، استنزاف، تدابير محافظة، بناء قدرات، برامج تعليمية

المُستلخص

المناخ القاحل ودرجات الحرارة العالية ومحدودية مصادر المياه العذبة هي سمات النظم الايكولوجية في المملكة العربية السعودية. الماء مطلب اساسى لاستدامة وبقاء الكائنات الحية. بما ان استحداث مصادر مياه جديدة مكلف وصعب فان المحافظة على المصادر الحالية وإدارتها بحكمة في المنازل والحقول والصناعة يبدو افضل خيار لمقابلة ندرة المياه. يمكن توفير كميات كبيرة من المياه بتبني مفاهيم وقواعد ادارة الطلب على المياه في برامج المحافظة على المياه. ادراكا لأهمية مبادرات المحافظة على المياه فقد قدمت المملكة حوافز مجزية للمستهلكين تمثلت في التوزيع المجاني لأجهزة توزيع المياه ودليل استخدامها. كما وفرت المملكة دعما فنيا لتركيب الاجهزة الصحية في منازل المستهلكين. هذه المبادرات تم دعمها ايضا ببرامج ارشادية وتعليمية. الرسائل الإرشادية المصورة تم ايصالها للمستهلكين وعامة الناس. هذا المجهود كان له نتائج جيدة وساعد في تقليل الاستهلاك بنسبة 20 % -30 %. تقترح الدراسة الحالية الاستمرار في برامج الارشاد والتعليم للحفاظ على المياه.

Introduction

Among the natural resources, water is the most precious, strategic and valuable resource for the Arab World and the kingdom of Saudi Arabia that ensures the well being of Arab nations and sustains all the living organisms including human beings, animals and plants and economic growth (Zahid, 2012). However, limited supplies of sweet water and scarcity of fresh water resources are the major challenges faced by the kingdom. At the moment, the kingdom faces and witnessing absolute water scarcity and shortage and per capita availability is further decreasing due to factors like: an ever-increase in water consumption resulting from increasing population growth, irresponsible household consumption patterns; and are water consumption requirements of production sectors are expanding. On the other hand, currently about 35% of human water use is unsustainable, drawing from diminishing aquifers and reducing flows of major rivers. These factors, in turn, have multiplied the fresh water demands by manifolds. The world is currently shifting its interest from just emphasis on water provision, or supply, to a more balance between supply and demand through considering the management of water demand. The new concept has holds considerable potential of enormous conservation, therefore has been well-received in the kingdom. Water demand management is a managerial approach that aims at meeting the demand for water through the application of necessary and efficient measures and incentives to achieve fair and effective utilization of water. This approach also involves the application of some procedures of economizing water, that stimulate the consumer's interest and knowledge concerning the scarcity and limited nature of water resources (Al-Zahrani, 2009 a,b).

The kingdom of Saudi Arabia has launched a new strategy, supported by extension and education and based on the principles of water demand management for the wise utilization of water resources. Throughout the kingdom, a huge, massive tremendous water national campaign to create awareness among water consumers to rationalize use of water was launched. The new initiatives encouraged the citizens and residents to use water wisely and judiciously at their homes, farms and industries. As the parts of the water conservation strategy, millions of water saving devices were distributed free of cost generously among all households and at the same time, they were provided with a free and friendly technical support to install them at their homes (Al-Zahrani, 2009 a,b).

In turn, citizens and residents were expected to strengthen the kingdom's initiatives and play their roles in water conservation. To compliment the kingdom's productive initiatives, extension strategies were designed to promote awareness on water rationalization and conservation in pictorial forms and buzz words. The kingdom expects all the water users to extend their cooperation on reducing water consumption levels and to changing their patterns and behaviors towards water. Among the water saving and conservation endeavors installation of water saving devices at their homes is of prime importance. In this article, an effort has been made to present an overview of water resources of the kingdom and different measures adopted so far and possible extension options to save and conserve water in Saudi Arabia have been discussed.

Materials and Methods

Several reports were reviewed and available data were interpreted to make inferences, draw conclusions and consequently recommendations have been made.

(1) Literature Review

(1.1) Water and Overview of Water Resources in the Kingdom of Saudi Arabia

Saudi Arabia is known as a deserted country with no permanent rivers and lakes, very little rainfall and characteristically arid climate. Since water remains the scarce commodity therefore is viewed extremely valuable, however, with the country's rapid growth, the demand for water has increased by many folds (Table 1).

Table 1: Projections of Water Demand in the Kingdom of Saudi Arabia 1420 -1430 AH / 2000 - 2009 AD

Billion Cubic Meters				Average Annual Growth Rate	
Plan & Perspective	Seventh Plan			Long-term Perspective	
Year Hijri AH	1420/21	1424/25	1429/30	1420/21-1424/25	1420/21-1429/30
Year AD	2000	2004	2009	2000-2004	2000-2009
Domistic Sector	1.8	2.10	2.40	3.1	2.7
Industrial Sector	0.47	0.64	0.77	6.4	3.8
Agricultural Sector	18.8	17.53	15.09	– 1.4	– 1.3
Total Demand	**21.07***	**20.27**	**18.26***	**– 0.77**	**– 2.1**

** MOEP Estimates*

Indeed, water is a crucial element for life and is a prerequisite for socio-economic development. Water consumption rates have been increased considerably due to the factors like: an increase in population; the higher living standards which changed domestic consumption patterns and helped improving health care condition; spatial growth of cities, governorates and centers, and increased production and water related needs in various sectors of the economy during the last two decades, the Kingdom's water consumption increased by five-folds. Kingdom's recent modernization drive laid special emphasis on provision of water resources development of new water resources received due attention (Al-Zahrani, 2009 a,b). Measures like rationalization of water for agriculture, industry and urban areas have been undertaken.

(1.2) Renewable Water Resources

On an average annual rainfall varies between 60 and 200 mm/year in the kingdom, with the exception of the Empty Quarter, which is very dry. Compared to the other regions of the country, rainfall in the South-Western region is relatively high, exceeding 600mm/year in some of the mountainous areas (Al-Zahrani and Muneer, 2009). Rains directly feed the renewable water resources comprising surface water that is collected in wadis (valleys) and behind dams and shallow ground water that accumulates in wadi sediments or cracks and fissures below ground surface. The volume of renewable surface water is not negligible. An extensive network of dams has, therefore, been built to collect it and utilize it optimally, and these also provide protection against floods, help recharge ground water wells and they directly provide drinking and irrigation water (Al-Zahrani, 2009 a,b).

(1.3) Non-renewable Ground Water Resources

Aquifers are a major source of water in Saudi Arabia. Ground water stored in sedimentary aquifers for thousands of years has been the main source of water supply for decades. They are vast underground reservoirs of water. Non-renewable water is a strategic stock that is depletable if not handled with great care and used optimally. The aquifers are still the most important water resource meeting the water needs for agricultural and municipal purposes. The volume of water utilized from them in 2004 was estimated to be 12,400 million cubic meters. The kingdom has made an effort to locate and map such aquifers and estimate their capacity. As a result, tens of thousands of deep tube wells have been installed in most promising areas for both urban consumption and agricultural use (Al-Zahrani and Muneer, 2007; Al-Zahrani, 2009 a,b).

(1.4) Desalinated Water

The state of presently available water resources necessitates the conservation of water renewable and non- renewable resources. Efforts were also pursued to implement large scale sea water desalination projects. Another major source of water is the sea. This is done through desalination, a process that produces potable water from brackish seawater. Saudi Arabia is seen as the world's largest producer of desalinated water (Ministry of Economy

and Planning, 2009a). Saudi Arabia is the world leader in desalination (Zahid, 2012) with approximately 30% of the global output. In Saudi Arabia, about 70% of drinking water is provided through desalination plants (SIWI, 2009). To meet the water requirements of its population, the kingdom is currently constructing the largest seawater desalination plant in the world in the East of the country. The kingdom is taking advantage of the state of the art technologies with implications for the whole Arab World. The plant is expected to produce some 1,025,000 cubic meters of pure water for the cities of the Eastern Province and at the same it would generate 2400 megawatts of electrical power (Zahid, 2012).

The Kingdom holds the world's top position in terms of the volume of production of desalinated water and the technology used in this regard (Ministry of Water and Electricity, 2008). The Kingdom ranks first in the world in utilization of sea water desalination technology. It has the largest water desalination capacity, with the volume of produced desalinated water reaching 2.9 million cubic meters per day in 2004. Desalination plants also provide a net contribution of 3,426 MW (megawatts) of electrical power to the national electricity grid.

Seventh Development Plan was instrumental adding three additional desalination plants in the cities of Khobar, Shuaiba and Jubail, with a total capacity of 710 000 cubic meters of water per day and 651 MW of electricity. With the introduction of three plants, the number of desalination plants operated by the Saline Water Conversion Corporation (SWCC) reached 30 plants, distributed along the coasts. By the end of the Eighth Development Plan, additional 580 million cubic meters/day volume of water was pumped into the existing total capacity. To be more efficient on water provision, a program for rehabilitation and renovation of existing desalination plants and facilities has also been launched (Table 2, Figure 1).

Table 2: Production Capacity of Desalination Plants by the end of the Seventh Development Plan, KSA, (2003)

Water Production Capacity	Net Water Production Capacity (000cu m/d)	Net Power Production Capacity (MW)
Existing Plants	2.167	2.775
New Plants	710	651
Total	2.877	3.426

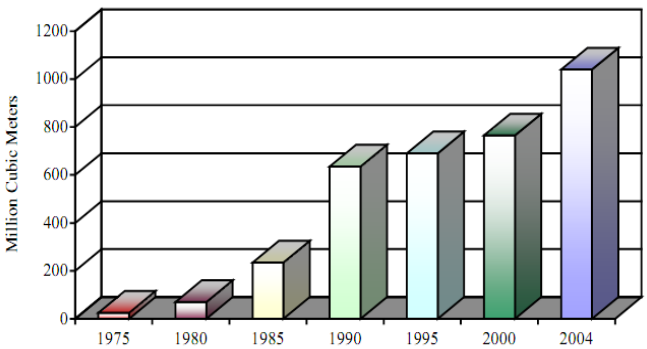


Figure 1: Production of Desalinated water in the Kingdom of Saudi Arabia

Production capacity was also enhanced by establishing a network of transmission lines and storage facilities. The lengths of pipelines reached 4,170 kilometers by the year 2004, and the number of pumping stations reached 30, in addition to 165 water reservoirs, with a total capacity of 9.4 million cubic meters. By the end of the Seventh Development Plan, this expansion enabled desalinated water to cover 51% of the overall water demand for municipal purposes (Wikipedia, 2009; Ministry of Economy and Planning, 2009b).

The Saline Water Conversion Corporation (SWCC) operates 27 desalination stations that produce more than three million cubic meters a day of potable water. These plants provide more than 70 percent of the water used in cities, as well as a sizeable portion of the needs of industry. They are also a major source of electric power generation (Al-Zahrani and Muneer, 2007).

(1.5) Reclaimed Wastewater

Another viable avenue is the use of recycled water to expand sources of water. The Kingdom aims at recycling as much as 40 percent of the water used for domestic purposes in urban areas. For this purpose recycling plans have been built in Riyadh, Jeddah and other major urban industrial centers. Presently recycled water is used for irrigating farm fields and urban parks (Ministry of Economy and Planning, 2009b).

Rising from 32% in 2000, an average rate of collection and treatment of wastewater reached 33.5% in a brief period four years. This rate varies substantially among cities, approaching full coverage in Jubail and Dammam, with an average between 30 to 40% in Riyadh, Jeddah and Al Madinah. About two thirds of municipal water is not collected and treated, and it percolates into the ground, causing a rise in surface water levels in some areas and causing environmental problems and health hazards. In addition, high leakage prevents making use of the substantial potential in wastewater (Al-Zahrani and Muneer, 2007; Al-Zahrani, 2009).

Rapid expansion of cities and urban centers has necessitated concentrating on making use of the wastewater, by treating and re-using it in an effective way for appropriate purposes. In view of the importance of reclaimed wastewater, as an alternative to fresh water for agricultural, industrial and recreational purposes, projects have been launched during the implementation of Seventh Development Plan. For example, one of them, covering the area extending from South of Riyadh to Al-Muzahymiah in Riyadh Region, has been successfully functioning since 2006 (Ministry of Water and Electricity, 2008). Similarly, the Al-Hasa Irrigation and Drainage Authority (HIDA) is also making full use of the treatment plants being set-up at Hofuf, Mubaraz and Thoqba regions. Zahid (2012) considers treated waste water as a strategic resource with multiple urban uses such as irrigation of green areas, gardens and street trees. It has also an industrial value for refrigeration and manufacturing processes. In addition, it has the potential to supplant natural water resources in recreation and the enhancement of wildlife. According to him, every day the kingdom is presently processing 3.7 million cubic meters of waste water whereas only using 1.2 million cubic meter per day and about 75 percent of the treated waste water is being employed for agricultural purposes. Further he stated that by 2040, the kingdom would be treating about 8.0 million cubic meters of waste water per day and its significant portion would be used for human consumption/drinking purposes, in a country once confronted with acute fresh water storage.

(1.6) Water Dams

Kingdom of Saudi Arabia is the biggest country in the Arabian Peninsula. It spreads over an area of many regions with varying nature of terrains and landscapes, and large and small valleys. A huge volume and large flux of flood water passes through these valleys; and this huge volume can be lost if not managed. Fortunately suitable locations at different valleys are available where this flood water can be directed. Realizing the suitability of locations of these valleys for storing this flood water, building of dams in the valleys would be a constructive idea to conserve water.

Desert lands and high mountains occupy majority of the Kingdom's landscape whereas residential communities commonly exist on the banks of the valleys, therefore, constructing dams and increasing their number could be very helpful meeting the water requirements of nearby population; and mitigating risks and damages to be caused by fast flowing flood waters.

Dams are known to capture surface water gained in frequent flash floods. More than 230 dams with a total storage capacity of 8356 million cubic meters, collect an estimated 16 billion cubic feet of runoff annually in their reservoirs (Table 3).

Table 3: Distribution of Dams by Purpose and Storage Capacity, KSA 2004

Region	Distribution by Purpose					Storage Capacity (Million M^3)
	Total	Drinking	Control	Recharge	Irrigation	
Riyadh	60		18	42		80.4
Makkah	25	02	03	20		108.0
Al-Madinah	16		06	10		80.7
Qassim	03		01	02		3.1
Assir	64	14	16	34		378.1
Hail	17		03	14		9.3
Jizan	03	01	01		01	51.4
Najran	06		03	03		88.2
Al-Baha	26	01	03	21	01	31.2
Jouf	03		03			5.2
Total	**223**	**18**	**57**	**146**	**02**	**835.6**

Seventeen dams are under construction, with a total storage capacity of 979.5 million cubic meters. In addition to these, fifteen others have been planned to construct (Al-Zahrani and Muneer, 2007). Some of the largest dams are located in the Wadi Jizan, Wadi Fatima, Wadi Bisha and Najran. This water from these dams is used primarily for agriculture and is distributed through thousands of miles of irrigation canals and ditches to vast tracts of fertile lands that were previously not cultivated and remained fallow (Al-Zahrani and Muneer, 2007; Al- Zahrani, 2009 a,b).

Dams yield numerous benefits and serve many purposes, however, the basic and foremost remains the providing water for consumption (Figure 2). They play a definite and an appreciable role in:

(i) Recharging underground water in the dam area, and providing the wells with water in the agricultural regions, behind the dam.

(ii) Securing potable water through the treatment plants built on the dams.

(iii) Securing irrigation water for farming purposes, through direct irrigation for farmlands behind the dams through irrigation projects.

(iv) Protecting cities and villages from the risks of torrents, dangers of floods and preserving the lives and properties of citizens (Al-Zahrani, 2009 a, b).

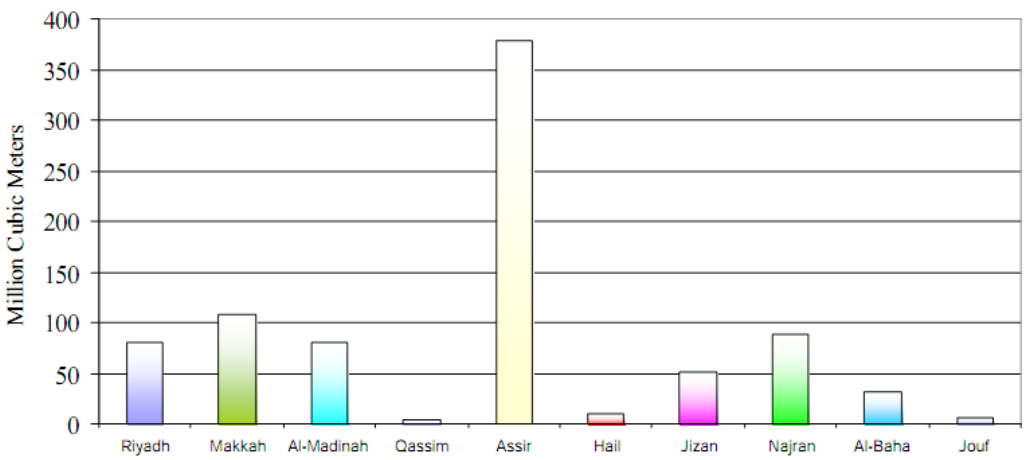


Figure 2: Storage Capacity of Water Dams Located at Various Cities of Saudi Arabia

Keeping in view, the Kingdom's terrestrial situation and valley's volume, different types of dams have been constructed. In the Kingdom, dams are built with concrete, earth filled and Rock filled dams. Underground dams are also not un-common to notice. High storage capacity dams are important for many their multiple uses. For example, King Fahad Bin Abdul Aziz Al Saud dam, was built in Bisha valley and its capacity exceeds 325 million cubic meters. Similarly Najran Dam with its storing capacity more than 86 million cubic meters plays an important role in protecting Najran city from torrents risks. Before the dam was constructed, torrents used to overrun the lands continuously, and now due to the dam, underground water storage capacity of the region has increased. Jazan Dam stores more than fifty million cubic meters and also reduces the flood intensity that used to overrun the region. An agricultural region covering an area exceeding 6000 hectare gets irrigation drainage through an integrated irrigation project attached to the dam. Dams used for securing potable water include Abha, Al Aqiq, and Truba and Ordah Dams. They have played a great role in securing potable water for Al-Taif City (Al-Zahrani, 2009 a,b).

Water is the first basic necessity of life and the presence of water bodies attract people to get settled around them. That's why - dams have played a great basic and vital role in the settlement of the inhabitants in their own environment. Due to the presence of dams, living stability and the development of life in these regions can be witnessed in the form of thickly populated residential areas and fertile productive farming lands (Al-Zahrani, 2009 a,b).

The region of Al Aqiq Dam has witnessed great development and progress and provides a great deal of potable water for whole region of Al Baha. Similarly Truba Dam is the source of obtaining water for the entire Al Taif region. Abha Dam and Atoud Dam in Aseer region provide water to the desalinated plants. Also Wadi Fatima Dam is water source for Jeddah city and makes the water available to the desalinated plant constructed on the dam and Wadi Fatima is still contributing water to Jeddah city (Al-Zahrani, 2009 a,b).

It has been noticed that dams have positive impact on the neighboring areas as well. They provide necessary moisture for the flourishing vegetation (flora) including all trees and herbs which grow in the immediate vicinity and the adjacent areas as well. Dams also facilitate the development of animal life (fauna) which reproduce and multiply in and around nearby the dam's lakes. The same applies to various types of birds. The construction of dams has led to the establishment and expansion of the agricultural areas by the local inhabitants, besides their great role in enhancing productivity and combing desertification in those regions (Al-Zahrani, 2009 a, b).

Treatment plants have been set-up on these dams to convert water stored in these dams potable by the Ministry of Water and electricity. Through the drinking water network or transmission units is made available to the consumers by movable water trucks. At least seven treatment plants have been set-up on the existing dams (Al-Zahrani, 2009 a, b). Initiatives of the Ministry of water & Electricity on building water treatment plants on the appropriate dams, to provide the consumers living in the neighboring areas to these dams and suffering from shortage or potable water, can further improve the water-supply situation in the kingdom. So far, some 230 dams have already been built in the kingdom whereas additional 25 dams in the various regions of the Kingdom are currently under construction with total capacity of 1,112,014, 230 cubic meters. It is encouraging to note that some 142 dams would be constructed in the near future (Al-Zahrani, 2009 a, b).

(2) Strategies to Change the Consumption Patterns and Consumers Behaviors towards Water

Kingdom of Saudi Arabia have taken all possible measures and adopted strategies to change the consumption patterns and consumers behaviors towards water. Initiatives taken so far include: Employing suitable technologies to enhance water-use-efficiency, modifying the irrigation practices to economize the growing crops, producing more with less drops of water; popularizing the concepts of water demand management; delivering water saving kits among the consumers and all these 3 strategies were supported by the extension

messages, educating the consumers and capacity building initiatives. It is anticipated that the strategies introduced by the kingdom would change the consumption patterns and consumers behaviors and they are briefly discussed as under:

(2.1) Water Resources and Agricultural Demand

Despite of the fact harsh climate and the shortage of water, Saudi Arabia had witnessed sound development in agriculture and water sector during the last four decades. The kingdom is quite conscious for agricultural sector fetching the greater share in the overall water consumption. Agriculture claims an overwhelming share of water consumption, with some 86.5 percent of total water consumed. Rationalization of water use in the agricultural sector has received adequate attention in development plans, policies and measures. The first four development plans sought a target of adding new water resources, and towards that end, embarked on an increased drive to set up desalination projects. With the initiation of the Fifth Plan in (1990-1995), a comprehensive review was conducted of water consumption rates of the agricultural sector. This helped in restructuring of crop pattern, resulting in reduced areas of high water consuming crops, such as wheat and barley, in favor of less water consuming crops, such as vegetables and fruits. Increased expansion was also pursued in the use of modern irrigation technology, with an aim to rationalize water consumption in this sector where water losses amount to relatively high rate of 30 percent (Al-Zahrani and Muneer, 2007).

(2.2) National Campaign for Water Conservation and Combating Shortage at the Household Levels

The Ministry of water and Electricity launched an extensive and huge national water saving campaign during the year 2004-2005 and the years after. The campaign aimed at creating awareness among the water consumers to save water efficiently and use water wisely. Display symbol and buzzword of the campaign "Decision is yours" proved very attractive and effective for catching the attention of the general public and the consumers. Water saving devices and kits (free of cost) were made available by the kingdom to all the water consumers free of cost by reaching to the general households (3.0 million) and the consumers (1.6 million) living in the government and (1.5 million) in the private buildings. All efforts were made to reach every single consumer without exercising any discrimination. The campaign launched met great success and realized tangible results. For example, water consumption at the household level was reduced by 30% whereas 20%-30% water consumption was reduced in the government buildings. Sanitary stores were able to sell more than 309 thousand shower saving devices. Due to the efforts made by the Ministry of water and Electricity in raising the awareness among the water consumers to use water in rational manner, some valuable achievements in economizing the water were made (Al-Zahrani, 2009 a,b).

(2.3) Water Conservation through Water Demand Management (WDM)

To keep pace with development and maintain and ensure enough water supplies, the Kingdom has adopted innovative measures (see, table1). All water matters are handled by the Ministry of Water and Electricity. Scarcity of fresh water resources represents one of the major challenges facing the world generally and the Kingdom of Saudi Arabia (KSA), specifically.

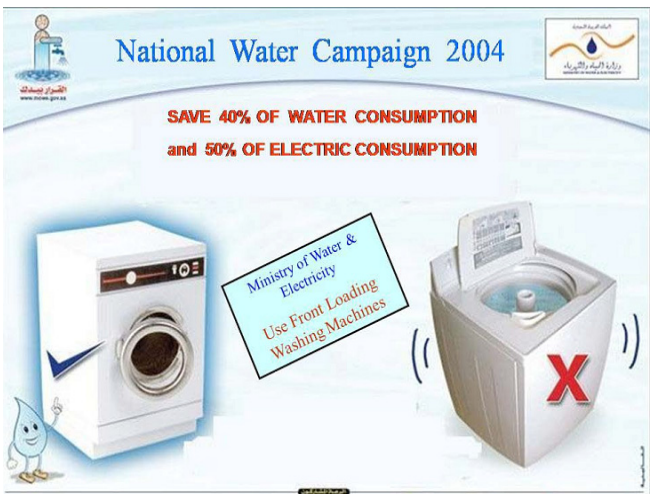
The kingdom suffers from absolute water scarcity and is witnessing ever decreasing water per capita in addition to continuously increasing water consumption due to population growth, house consumption patterns and the ever-increasing consumption of production sectors. This, in turn, has led to growing increases in fresh water demands for different purposes. At the global level, if a nation gets into the situation like this, the best viable could be shifting its focus from looking for new water resources to a more balanced approach namely "Water Demand

Management" (WDM). In the situation, nations maintain a balance between supply and demand and employ the scientific principles and concepts of water demand management (Al-Zahrani, 2009 a,b).

Water demand management is a managerial approach, which aims to meet the demand for water through the application of necessary and efficient measures and incentives to achieve fair and effective utilization of water. This approach also involves the application of some procedures of water preservation, which aim to stimulate and increase consumers' interest and knowledge concerning the scarcity and limited nature of water resources. The path forward appears to lie in improving water use efficiency through: demand management; maximizing water resource productivity of agriculture; minimizing the water intensity (embodied water) of goods and services; addressing shortages in the non-industrialized world; moving production from areas of low productivity to those with high productivity; and planning for climate change (Al-Zahrani, 2009 a,b).

(2.4) Role of Extension and Education and Need for Capacity Building

All efforts made and initiatives taken so far by the kingdom may not have caused that impact if Extension Education support would have not been there. These initiatives like free distribution of water conservation kits at the door steps of the consumers produced tangible results when they were complimented, assisted and supported by the Extension and Education programs. Extension messages were brought to the water consumers and general public in the pictorial forms (presented below). They produced a positive impact and helped reducing the water consumption by 20-30 percent. Encouraging results collected by the Ministry of Water and Electricity on the saving of water suggests the continuation of the extension messages and the future education of the water consumers on the subject. Looking at the pivotal role played by Extension and education making it a regular and permanent feature and integral component of the future water conservation programs would be a wise step to take by the kingdom. The possible and productive role of Extension and Education can also be enhanced by arranging water related trainings and by launching capacity building programs both for the professionals and the consumers, intending to be the part of the water conservation programs in the kingdom. A comprehensive extension education strategy comprising of multiple components (including launching of awareness creation campaign) was introduced, implemented that resulted tangible results and was well-received. Its brief pictorial account is presented as under: Extension messages helped creating awareness among the general public through National Water Campaign 2004 (Figures 3).



(A)

(C)

(B)

(D)

Figure 3: Extension Messages Helped Creating Awareness among the General Public through KSA National Water Campaign 2004

(A, B, C, D: *Pictorial forms messages brought to general public water consumers in KSA*)

Conclusion and Recommendations

Conclusion

Kingdom of Saudi Arabia is a water-deficit country and an acute shortage of water remains the biggest challenge in the kingdom. The Kingdom considers water as an essential ingredient to realize sustainability and to ensure nation's life and security. The government realized the problems created by factors like: arid climatic conditions, limited water supplies, and rapid growth in water demand, and introduced specialized agencies for water production and distribution, as well as regulations and measures to achieve effective water demand management in the interests of the community and for the preservation and conservation of its water resources.

Recommendations

(I) At the moment, the available sources are not in the position to meet the needs of the people and above all, the growth in the demand for water has led to its partial depletion, particularly in the case of non-renewable fossil water which is the main source of fresh water supplies. To meet the current demands, concerted efforts are needed to develop water resources through the use of advanced technologies such as cloud physics to increase the amount of rain and to improve the recharge efficiency of ground water.

(II) Al-Ibrahim (1990) stresses that attention should be paid on adopting conservation and water-demand management programs to achieve an acceptable balance between water needs and availability. He is of the opinion that there is considerable scope for improving the efficiency of water use in various sectors like house-hold, industries and agriculture.

(III) The kingdom must shift its emphasis from supply development to demand management to avoid wasteful, inefficient uses of critical and non-renewable water resources.

(IV) The state regulations on the use of water, reduction in domestic water demand by the introduction of new water pricing policies, leakage detection and all other control measures that could conserve water must be applied with letter and spirit.

(V) Concerted efforts for enhancing public awareness on the value of water should be made by all the stake-holders working with the public.

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