4th International Conference on Water Resources and Arid Environments (ICWRAE 4): 362-369
5-8 December 2010, Riyadh, Saudi Arabia

Desalination as an Option to Resolve Problems of Water Shortage in Jeddah City

Faten Fallatah

University of Malaya, Master Student Makkah, Saudi Arabia

Abectract: Jeddah suffers from water shortage due to the increasing water demand, lack of proper management and lack of water resources. Since ancient Jeddah's history, clean water has always been a scarce and costly commodity (MEPA,1994). The natural and traditional resources of water through rain and ground water could not supply the whole need. During the recent years significant infrastructures have been established to provide residents throughout the city with dependable water supply. Saudi Arabia Government has been planning to build new seawater desalination plants in addition to the already established ones to solve water shortage problems in Jeddah. The data for this study was collected by conducting interviews, site visits to the organizations and officers related to water management. This paper will discuss the various problems of water supply in Jeddah, as well as the environmental impact resulting from desalination plants in the west coast in meeting water needs to Jeddah city. The most important finding from this study is that Jeddah which has neither lake nor rivers can do better in water conservation by improving the current management practice and controlling water demand management via awareness campaign. Thus environmental hazards that caused by desalination plants can be avoided. In conclusion the best water management practices (BMPs) can lead to better water conservation and improve environmental impact related to water consumption.

Key words: Large cities • Population • Saline water desalination plant • Water consumption management • Water resources limitation

INTRODUCTION

Jeddah is the second largest city in the Kingdom of Saudi Arabia and the gateway to the holy cities of Makah and Al-Medina. It is rich in modernity as it was in history and traditions. The city grew from a tiny small walled town to a regional trade centre in few decades. Perhaps the most notable factor that has influenced the growth of Jeddah is the increase in supply of fresh water (Haddadin, 2002). Ever since its origins, the lack of water was the main serious problem for the inhabitants of Jeddah. As early as one thousand five hundred years ago, while the city was under the domination of Persian rulers, more than three hundred wells and cisterns were dug to provide a clean water supply for the growing population. Most of these sources eventually dried up.

Early in the twentieth century, Jeddah made its first attempt to producing its own clean water supply by installing a seawater distillation condenser. The experiment was not a success for the "Kindasah"1 as the residents pronounced condenser, produced very little water but made a great deal of noise. In contrast to the few gallons of drinkable water produced each day by the Kindasah, supplies improved dramatically immediately following the Second World War when income from oil exports funded the pumping of 11.4 thousand m^3 (TCM)of water a day from the wells in "Wadi Fatimah" or "Fatimah Valley" fifty miles away to the south.

The situation of water shortage was finally solved in the late 1970s by the installation of four modern desalination plants on a coastal lagoon in the north of Jeddah. This huge and powerful complex has the capacity to desalinate 30.2 thousand m^3 (TCM) of seawater a day, converting it to potable water while at the same time producing a low-cost electricity supply for the entire city, (SWCC, 2007.) As a delightful finishing touch, the municipality of Jeddah has collected the scrap metal parts remaining from the early Kindasah and commissioned an artist to assemble them into sculptural forms that are now located on the roadside lawns close to the new desalination plant, preserved for future generations as a historic reminder of Jeddah's past.

Jeddah's first seawater distillation plant was built by Ottoman Empire in the early 19th century. Through a process of condensation of the distillation of sea water, which was then known as (kindasah).

Corresponding Author: Faten Fallatah, University of Malaya, Master Student Makkah, Saudi Arabia

In 1907, the Ottoman Turks installed Saudi Arabia's first desalination plant in Jeddah. It was replaced in 1928 and now serves an artistic role as one of Jeddah's famous traffic island sculptures.

Nowadays, Jeddah as part of Saudi Arabia which has a serious water problem that can become a real crisis in the near future. Jeddah city natural water resource is represents only 6% of total water resources. Desalinated seawater is the main water resource for potable water, besides low salinity brackish well water. Desalinated water represents 94.% of total water resources (SWCC,2008). Despite the scarcity of water the rate of per capita consumption of water in Saudi Arabia to exceed 250 liters per day (the second largest consumer of water in the world).

The water problem is a result of many factors besides limited natural resources, such as the ministry of water and electricity established recently in 2003 so there is no clear water polices and regulations yet, the policy used for desalination of seawater, lack of timely response to match water demand increase with installed desalination capacity, lack of measures and public incentives for water conservation, unrealistically subsidized water prices 1.6 USD for 301 m3 and above, lack of awareness of the water value, high cost of desalinated water production (0.6 USD/m3 in 2009) and other aspects (SWCC 2008). The continued increase in water demand because of population growth and urbanities will continue to stress the limited water resources of Jeddah. Desalination may remain the resort for increasing the supplies to meet the demands, but only at the expense of increasing economic pressures. Because of the increasing scarcity of water resources and the significant benefits of water for society, economy and the environment, an integrated water resources management plan plays an important role in sustainable development.

According to official statistics show that the average Saudi resident consumes 230 liters of water per day. Although there is considerable knowledge on the water scarcity issue in Jeddah city. The community culture on water is very shallow and low price help to make people did not care about how much they used from water. Therefore it is necessary to educate the community about water for the reservoir and the status of geography, ground water level, even schools and universities did not give the source of this importance it deserves.

This concept is illiterate of the water was the competent authorities to explain and clarify the status of water for citizens. Because the knowledge of citizen's about water status can help to be more aware and support what the future may come from decisions affecting their life.

Thus, it is quite clear that desalination plant is a major water resource, which plays an important role in the support of natural ecosystems and as a source of water supply for industrial and domestic needs despite the fact that these desalination plants can cause series impact to environment and people.

Whereas Jeddah is still facing severe shortage in water supplies, the government of the Kingdom of Saudi Arabia plan to built new desalination plants to supply Jeddah city with clean water. As a part of facing these challenges, proper management of the demand is an extremely important issue toward achieving the water balance and to ensure that water use for a range of beneficial purposes is sustainable to decrees dependent on desalination which led to environmental impact. The main aim of this research are to address the need for better in practices water management by review environmental impacts resulting from sea water desalination and evaluate the water demand management such as water price and public awareness.

MATERIALS AND METHODS

Quantity of Water Pumping to Jeddah from Different Resources: By using different data which gathered from Saline Water Conversion Corporation (SWCC) and MOWE and NWC, the comparative study was done to identify the factors that are influencing the water supply in Jeddah and Riyadh. Both cities are considered the largest city in the Kingdom in terms of population and urbanization. The comparison between these two cities is aimed to assess the water shortage in Jeddah whether it is due to lack of supply or due to increase in population and urbanization. These comparisons were done on daily distributions both in Riyadh and Jeddah in year 2009. The data also include the reuse of water in both cities with consideration of two factors: population and urbanization which have strong relationship with water supply. The data of such distributions was gathered from site visits and interviews with the organization's staff.

Water Demand Management: To evaluate water demand management system in large cities including Jeddah, the study was conducted by the Ministry of Water and Electricity (MOWE) in gathering the data about the water consumption and the number of subscribers and consider the relationship between them by making comparison among these main cities and Jeddah itself. All collected data were analyzed by using comparative study, statistics study and historical information to understand current water demand management according to quantity of water supply to Jeddah and factors which affect it.

Data Collection: To arrive at a correct approach to estimate the amount of water production from different Jeddah water resources, the site visits were done at Saline Water Conversion Corporation (SWCC) and Ministry of Water and Electricity (MOWE) to carry out gathering of information. Officers from the Ministry and corporation were requested to answer questions concerning the water quantity extracted from these resources. The information about water production from Khalis aquifers and Wadi Fatimah were collected from National Water Company (NWC) while the information about amount of water produced from desalination plants was provided from Saline Water Conversion Corporation (SWCC).

Chemical Comparative Study: Chemical comparative study done in these paper used various chemical parameters such as pH test, conductivity, total dissolution, solids, total suspended solids, calcium, magnesium, sulphate, chlorides, m-alkalinity and temperature. All these parameters were used to compare Jeddah desalination plant effluent with both Presidency of Metrology and Environment (PME) standards and Massachusetts Environmental Policy Act (MEPA) standards as to assess the impact resulting from the processing of seawater. This is to be sure that more effective method proposed to meet Jeddah water shortage in desalination plant without considering the risks arising from it.

RESULTS AND DISCUSSIONS

Water Supply Management in Jeddah City: The availability of water which has been supplied to Jeddah from various resources such as Khluais Aquifers and Wadi Fatimah is shown in Figure 4.1.

The above figure shows the rate of daily supply which is distributed to Jeddah during the year 2006 until year 2009. This diagram shows that year 2008 recorded the lowest supply of water; which was due to a disruption of a major pipeline, which carried the supply from Shuaybah station to the northern suburb of Jeddah.

Jeddah has been obtaining water from Jeddah's plants, which has been su pplying exclusively to Jeddah municipality only, besides the supply from Shuaybah station and others such as Khluais aquifers and Wadi Fatimah.

From the above figure, it is clear that there is a steady increase in water supply from Jeddah station from 2006 until 2008. In 2009 it shows a slight decrease.

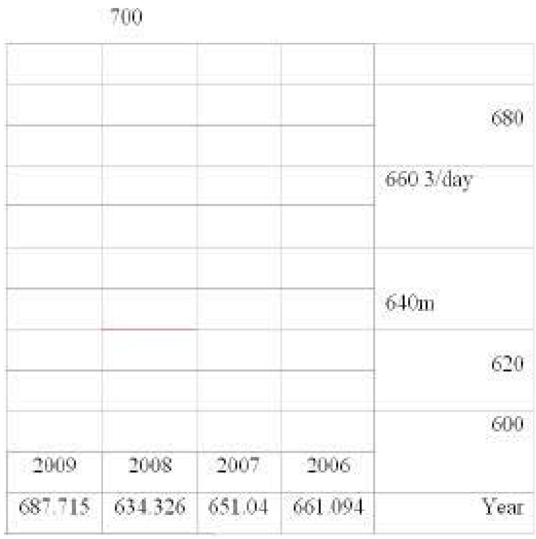

Fig. 4.1: Shows daily rate of water supply to Jeddah during the period 2006-2009

Figure 4.2 not Currectaly show

Fig. 4.2: Shows daily rate of water supply to Jeddah during the period 2006-2009 from various sources

Still the Jeddah plants conquered the supply's distribution compared to other sources. The second place is dominated by Shuayba plants. However there is a significant increase of water supply during the same period of time that Jeddah station reduced in production. Also, both Khluais aquifers and Wadi Fatimah shared the same amount of distribution. Nonetheless, production of water from both occupied least percentage of the whole distribution and shows slight decline from 2006 until 2009.

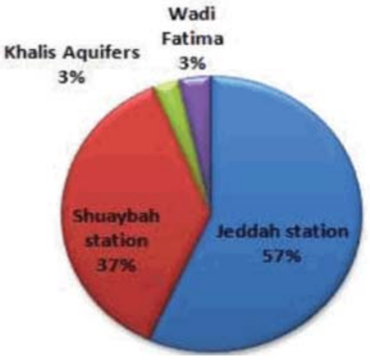

Fig. 4.3: Illustrates the percentage of sour of water supply to Jeddah city during the period from 2006-2009

Table 4.1: Shows the daily water distributions in Riyadh and Jeddah in 2009

Quantity (m_3/day)	Project type
1.453.748	The total water pumped to Riyadh city
657.000	The total water pumped to Jeddah city
2,110,748	Total

This result confirms previous studies which indicate that Jeddah relies heavily on the production of water from desalination plants especially from Jeddah's station and Shuayba station.

Figure 4.3 indicated that Jeddah city depends in desalination plants more than other sources to obtain water during the recent years. Most of Jeddah water comes from Jeddah station which is about 57 %, followed by Shuaybah station which produced approximately 37 % of Jeddah's water, then followed by Khluais and Wadi Fatimah which both comprises of only 3 % of water distribution respectively. This result corresponds with previous findings made by SWCC.

In comparing the supply situation with larger city like Riyadh, its daily rate of water pumping (according to quarterly report Riyadh, April 2009) is about 1.453.748m3/day. While the daily rate of pumping water in Jeddah city at the same period is about 657.000m3/day. The figure can be referred in Table 4.1.

Daily amount of water which is distributed in Jeddah city is considered to be lower compared to the amount in Riyadh city, despite the fact that the two major cities are considered at same level of urbanization and population growth.

It is clearly seen that there is a strong correlation between urbanization and population in the city as well as the proportions of water consumption. There is also direct correlation between urbanization and population

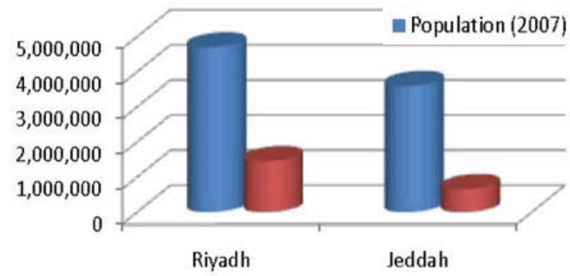

Fig. 4.5: Depicts the relation size and the amount of water consumed in the cities of Jeddah and Riyadh

and rate of water consumption. Which clearly means increasing urbanization and population would definitely increase rate of water consumption.

Comparing between the largest two cities in Saudi Arabia, Riyadh and Jeddah, we can find that although the difference between the numbers of population in both cities is estimated at about one million, daily amount of water which is supplied to Jeddah is about 657,000 m3 per day. It is nearly half of the amount of water which is supplied to Riyadh which is estimated to be about 1,453,748 m3 per day. Moreover, the urban area in Although Jeddah is the second largest in number of subscribers and water consumption, after Riyadh since 2000 to 2009, there are increasing number of subscribers and still growing. However, they increase dramatically from 2007 until 2009 due to an extreme water shortage faces Jeddah city. This problem emerged at the beginning of the holy month of Ramadan 2006 because of the disruption of a major pipeline, which carries water from Shuaybah station to the northern suburb of Jeddah. This had increase pressure of the water demand at that time.

From the table above, it is clearly observed that the deficit of water in Jeddah city is very high, which about 105.5 m3 is more than Riyadh city where the estimated deficit average is about 30, 7 m3.

Recycled Water in Jeddah City: Waste water and sewage are inevitable byproducts of human life and become a major problem in every civilization. There will come to a point where those wastage can no longer simply dumped at a convenient distance from the city or in the sea untreated since they have a nasty habit of returning to source. For an example, take a look at the sewage lake at Briman in the northeast of Jeddah city and later take a look at the sight and smell of the green algae on Hamra Beach in South Jeddah. A more constructive approach to sewage and wastewater is to see it not as a problem but as a valuable resource. It is rich in nutrients which, when recovered, could be used for agricultural irrigation.

Table 4.3: Comparison between available water quantities and actual needs of water at houses in Jeddah city

Quantity Available	Leakage at home	Quantity after leakage	Leakage from Network
967 (1000 m3)	51 (1000 m3)	1018 (1000 m3)	436 (1000 m3)
437 (1000 m3)	23 (1000 m3)	460 (1000 m3)	197 (1000 m3)

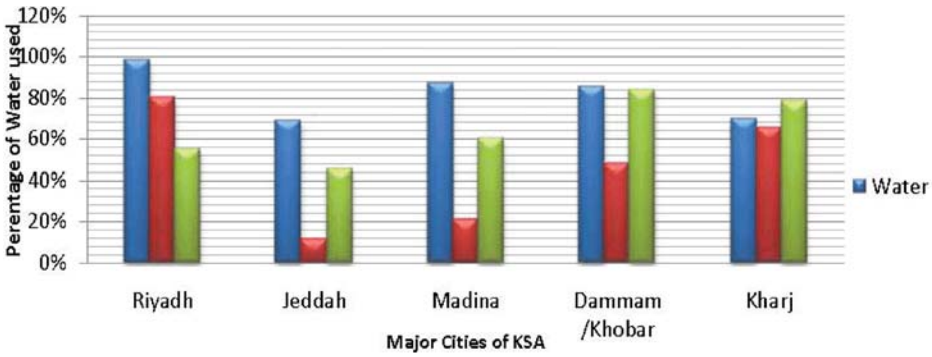

Fig. 4.8: Shows current situation of coverage water distribution, sewage collection and waste water treatment (current and under construction)

Fig. 4.9: Shows the current coverage versus 100% coverage in Jeddah city

The water itself when purified is a vital resource and is perfectly drinkable. One could argue that all water is recycled due to evaporation from the seas and lakes of the world and returned as rainfall but due to current climate changes and bizarre environmental outlook, it is essential that all things must be preserved and improved.

Riyadh city produced highest amount of water which is almost 100% of its coverage. Nonetheless, more than three quarters of this used water is treated. On the other hand Jeddah city which is the second largest city in Saudi Arabia produced least amount of water than all other major cities and also the amount of treated water is considered to be very low which is about 10% despite the fact that Jeddah city is considered to be the second largest city in term of population.

By calculating the difference between the current coverages of water distributions and comparison to sewage collection and waste water treatment in Jeddah. It is clearly seen that Jeddah needs to increase water distribution by 30% to reach 100% of water demand. Also, sewage collection need to increase by more than 50% to be able to collect all amount of water for retreatment. Moreover, waste water treatment need to be equal to water distribution.

It is clear that there are imbalance between water demands and water supplies in Jeddah city. By comparing Jeddah city and other cities like Riyadh, the increase in water demand is affected by factors mainly population growth and urbanization process of the city.

Another factor is the domestic water supply network which having poor maintenance condition such as leakages. Without special building techniques, while very substantial, if the present water habit is not changed, an acute water shortage will occur. Solutions to this problem cannot be found by only searching for additional water supplies, but requires bringing the needs for water in balance with available sources through efficient usage of the existing water supplies. To move towards this goal, water resources planning of alternatives under current and future water conditions should be applied through the input-output water transactions approach.

Case Study on Jeddah Desalination Plants: The second part of this study presents a case study on Jeddah desalination plants, where the descriptions of the plants along with multiple operational processes are discussed in details. It focused in the impact of Jeddah desalination plants due to the increasing water demand in Jeddah and decreasing amount of water from Khluais Aquifers and Wadi Fatimah. Therefore there is a need to build a new plant to supply clean water to Jeddah city. Saudi government plan is to increase the operating number of desalination plants and also to increase the capacity for each plants. But this plan can led to negative environmental impacts to Jeddah city. The SWCC in Jeddah use Multistage Flash Distillation (MSF) seawater desalination processes. MSF process has three distinct sections: heat rejection section, heat recovery section and brine heater. The feed water passes through the heat rejection and heat recovery sections. On leaving the first (warmest) rejection stage the feed stream is split into two parts, reject seawater which passes back to the sea and a makeup stream which is combined with the recycle stream. The combined stream then passes through a series of heat exchangers and its temperature rises as it proceeds towards the heat input section of the plant; the brine temperature is raised as it passes through the brine heater to the maximum value approximately equal to the saturation temperature at the system pressure. (Al-Mutaz 1994). There is others processes such as reverse osmosis (RO) system is more environmentally and economically efficient compared with the MSF system.

Environmental Impact from Desalination Plants: Desalination plants are major sources of pollution in Saudi Arabia. The government has assigned Presidency of Metrology and Environment (PME) for the control of pollution, protection of environment and to help in the planning, designing, executing and operating of these facilities that will be applied in a manner which shall not adversely affect the population. The main environment aspects which this study focus in gas emissions and sea water effluents.

Gas Emissions: The analysis of the gas emission due to Jeddah desalination plants from 23rd July 2008 to 12th August 2008 are tabulated in Table 4.4.

Sea Water Effluents: Table 4.5 shows the effluent characteristic from desalination plants to Red Sea. It is clearly noticed that the effluent increases the temperature of sea water because the difference of temperature between sea water and effluents nearly doubled. Also there is slight increase in effluent alkalinity. In addition to that the conductivity also has risen by a factor of 20000µs/cm above sea water. As the result to these effluents, the chloride will also be raised by 10000 ppm as Cl.. Moreover, the total dissolved solid on effluent also shown increase by almost 10000 ppm as well as the total hardness which is significant. Finally, all other elements such as Calcium, Magnesium, Sulphate, Copper except Silica and Fe also shown significance.

By comparing sea water, the effluent and potable one in Table 4.9, it is clearly observed that the potable water significantly higher only in pH level but low figures in all other parameters. On the other hand effluent water significantly higher in all other parameter such as conductivity, Td and others except TSS. We can say that effluent can affect sea water by raising sea water temperature and also other related parameters as shown at the Table 4.10.

Table 4.4: Tabulates the analysis of the gas emission due to Jeddah desalination plants 23rd July 2008 to 12th August 2008

FLUE GAS TEMP °C		SO2 PPM		NOX PPM		CO2 %		O2 %		DATE	
OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN		
165.0	321.90	1820	1654	165	172	11.84	12.48	5.27	4.42	B	23/7/08
149.10	338.10	1526	2236	113	-	9.72	14.89	8.08	1.21	A	30/7/08
158.4	334.90	1969	2151	162	195	13.27	14.70	3.36	1.46	B	
-	360.4	-	2226	-	199	-	14.90	-	1.19	B	31/7/08
114.1	400.2	1116	2214	91	194	6.81	14.32	11.95	1.97	A	01/8/08
165.6	259.5	1966	2230	170	203	12.97	15.15	3.77	0.87	B	
-	380.9	-	2332	-	199	-	14.90	-	1.20	A	02/8/08
132.4	398.8	1480	2038	140	195	9.96	13.27	7.77	3.37	A	05/8/08
174.2	258.7	1790	2098	179	211	12.37	14.77	4.56	1.37	B	
148.6	372.0	1278	2137	121	191	8.90	14.05	9.17	2.33	A	09/8/08
175.7	225.0	1885	2276	166	198	12.46	14.96	4.43	1.12	B	
148.6	372.0	1278	2137	121	191	8.90	14.05	9.17	2.33	A	12/8/08
175.7	225.0	1885	2276	166	198	12.46	14.96	4.43	1.12	B	

Table 4.8: Sea water analysis

Effluent	Sea water	Unit	Test	Effluent	Sea water	Unit	Test
630	450	ppmasCa++	Calcium	44	27	°C	Temp
2133	1477	ppmasMg++	Magnesium	8.92	8.13		pH
4900	3100	ppmasSO4-2¯¯	Sulphate	79700	58800	µs/cm	Conductivity
0.025	0.05	ppmasSio2	Silica	58978	40950	ppm	Total dissolved solids
0.021	0.003	ppmasCu++	Copper	31700	22300	ppmasCl¯	Chlorides
0.082	0.012	ppmasFe++	Fe	181	121	ppmasCaCO3	M-Alkalinity
				10350	7200	ppmasCaCO3	Total hardness

Table 4.9: Seawater, effluent and potable water analysis

Potable water	Effluent	Sea water	Unit	Analysis
8.55	8.18	8.11		pH
605	62100	58800	µs/cm	Conductivity
304	43100	40470	ppm	Total dissolved solids
	0.54	1.4	ppm	Total suspended solids
4.0	490	460	ppm as Ca+	Calcium
10.2	1540	1490	ppm as Mg+	Magnesium
21	3600	3010	ppm as SO4¯¯	Sulphate
173	23800	22300	ppm as Cl¯	Chlorides
2.5	128	121	ppm as CaCO3	M-Alkalinty
34	36	27	°C	Temp

Table 4.10: Sea water, recycled wastewater analysis

Wastewater	Recycle	Seawater	Expressed as	Analysis	No
8.92	8.71	8.13		PH	1
79700	75100	58800	µs/cm	Conductivity	2
58978	54823	40950	mg/l	Total dissolved solids	3
31700	29700	22300	Cl¯asmg/l	Chlorides	4
181	161	121	CaCO3asmg/l	Total alkalinity	5
10350	9100	7200	CaCO3asmg/l	Total hardness	6
630	595	450	Ca+asmg/l	Calcium hardness	7
2133	1850	1477	Mg+asmg/l	Magnesium hardness	8
0.021	0.013	0.003	Cuasmg/l	Copper	9
0.082	0.052	0.012	Feasmg/l	Iron	10
4900	4350	3100	SO4asmg/l	Sulphates	11
0.025	0.021	0.05	SiO2asmg/l	Silica	12

Table 4.11: Discharge and water quality standards for Saudi-Arabian waters (based on PME, 2001)

Water quality standard*	Discharge standard	Pollutant
1°C	Case by case	Temperature
0.1	6-9	pH
5 %	15 mg/l	Total Suspended Solids
5 %	0.5 mg/l	Chlorine
5 %	0.2 mg/l	Copper
5 %	0.2 mg/l	Nickel

* maximum deviation from ambient values

Table 4.12: Comparison between Saudi Water Conversion Corporation SWCC range and MEPA standards

UNIT	MEPA RANGES	SWCC RANGES	POLLUTANTS	NO	UNIT	MEPA RANGES	SWCC RANGES	POLLUTANTS	NO
PPM	1	0 10	AMMONIA (AS NITROGEN)		14	PPT		0-100	SALINTY
	1								
PPM	0.1	0-10	ARSENIC	15	PH UNIT		6-9	0-14	PH
	2								
PPM	0.02	0-10	CADMIUM	16	PPM	NONE	0-25	TOTAL SUSPENDED SOLIDS	3
PPM	0.5	0-10	CHLORINE (RESIDUAL)	17	°C	AS MEPA	0-100	TEMPERATURE	4
PPM	0.1	0-10	CHROMIUM TOTAL	18	NTU	75	0-1000	TURBIDITY	5
PPM	0.2	0-10	COPPER	19	PPM		0-20	DISSOLVED OXYGEN	6
PPM	0.05	0-10	CYANIDE	20	PPM	25	0-50	BIO-CHEMICAL OXYGEN DEMANDS(BOD)	7
PPM	0.1	0-10	LEAD	21	PPM	150	0-200	CHEMICAL OXYGEN DEMAND (COD)	8
PPM	0.001	0-10	MERCURY	22	PPM	50	0-100	TOTAL ORGANIC CARBON	9
PPM	0.2	0-10	NICKEL	23	PPM	5	0-20	TOTAL KJELDAHL NITROGEN	10
PPM	0.1	0-10	PHOSPHATE	24	PPM	0.01	0-20	TOTAL CHLORINATED HYDROCARBOS	11
PPM	1	0-10	ZINC	25	PPM	8 (NOT > 15)	0-20	OIL & GREASE	12
MPN/1 00ML	1000		TOTAL COLIFORM	26	PPM	0.1	0-20	PHENOLS	13

By comparing Sea water, recycle and wastewater analysis, which is shown in Table 4.10. It is obvious noticed that the wastewater significantly higher than others in all parameters as expected, sea water recorded the lowest rate. There is no particular chemical discharge to red sea from Jeddah desalination plant. Water quality standards for Saudi water, is it based on local standards from Presidency Meteorological and Environment (PME). Compression between Jeddah desalination plants Jeddah ranges and PME ranges shown in Table 4.11. While comparison between Saudi Water Conversion Corporation SWCC and MEPA shown in Table 4.11.

Table 4.12 shows that there are huge differences between SWCC and the Massachusetts Environmental Policy Act (MEPA) range. For example, it is shown that pH level in Jeddah plant can increase from 0 to 14 but the MEPA standards ranges only from 6-9, also the turbidity and all other parameters, In general Jeddah plant has wider range while MEPA has narrower range. Because there is no Ministry of Environment in Saudi Arabia except Presidency Meteorological and Environment (PME) which does not have any policy and regulation or force to handles such issue by monitoring and assessment. So SWCC itself has responsibility for maintaining the environmental criteria and standards required (SWCC 2008).

CONCLUSION

This paper investigate the current WDM situation in Jeddah city and the available tools which can be applied to control water demand in term of wise use of water under the existence of water shortage. In fact, there are some important findings as there is unbalance between water supply and demand in past and present in Jeddah city, there is also strong relationship between urbanization and population growth in Jeddah city with water demand management. The study also found there is not any governmental monitoring for environmental impact resulting from sea water desalination plants, moreover there is not any details specification and standards for environmental impact from sea water desalination plants. In addition to all above, There is no systematic WDM program in Jeddah city and there is no effective water pricing system to act as efficient WDM instrument.

Finally, changes in management practices by government are key activities in efforts to reduce water shortage. This can be attributed by changes in water management practices, particularly water charges and may also be related to raising of public awareness through national campaign.

REFERENCES

Ministry of Agriculture, 2008. Controls the use of treated sewage water for irrigation, Riyadh, Saudi Arabia Arabic published.

Ministry of Economy and Planning, 2007. annual report.

Ministry of Economy and Planning Statistical, 2009. Year Book, Riyadh, Saudi Arabia, pp: 672.

Ministry of Finance and National Economy, 2008. Total Population in 2007, Published Report in Arabic, Riyadh, Saudi Arabia, pp: 190.

Ministry of Hajj, 2008. Annul Report Jeddah Population Growth Jeddah, Saudi Arabia, pp: 1-15 10.1007/1-4020-5414-9_7.

Ministry of Planning, 2007. Seven Development Plan 1990-1995, Riyadh, Kingdom of Saudi Arabia, pp: 453.

Ministry of Planning MOP, 2007. Fourth Development Plan, Riyadh, Saudi Arabia.

Ministry of Planning MOP, 2009. Seven Development Plan, Riyadh, Saudi Arabia.

Mohamed, 2007. Desalination experience in Kuwait, 204: 29.

National Water Company (NWC2007-2008) Annual Report.

Presidency of Metrology and Environment PEM, 2007. Annul Report.

Saline Water Conversion Corporation (SW.C.C.), 2007. Annual Report.

Tolba, 2006. Arab Public Opinion & the Environment Report of 18 Country Survey.

Vincent, 2003. Jeddah's Environmental Problems, Journal article, The Geographical Review, pp: 93.

World Bank, 2007. Kingdom of Saudi Arabia: The Water Sector of Saudi Arabia.

Haddadin, 2002. Water Resources in Jordan: Evolving Policies for Development, the Environment and Conflict Resolution, Washington: Resources for the Future; 1edition, pp: 22,33,12.