Analysis of the Water Crisis in Egypt

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Abstract. In this paper, an analysis of Egypt's water shortage problem is given based on both social and physical reasons. A practical measure model is applied to evaluate the risk of water shortage in Egypt. The potential influencing factors are turned into 15 indexes. A serial of equations are used to standardize the indexes. Meanwhile, the weight of each index is calculated based on Entropy Weight Method. PSR is adopted to ensure the rational classification of all chosen indexes.

1. Introduction

Egypt has been suffering from severe water scarcity in recent years. Uneven water distribution, misuse of water resources and inefficient irrigation techniques are some of the major factors playing havoc with water security in the country. The River Nile is the lifeline of the country as it services the country's industrial and agricultural demand and is the primary source of drinking water for the population.

2. Social and Physical Reasons of the Water Crisis

2.1 Social Forces

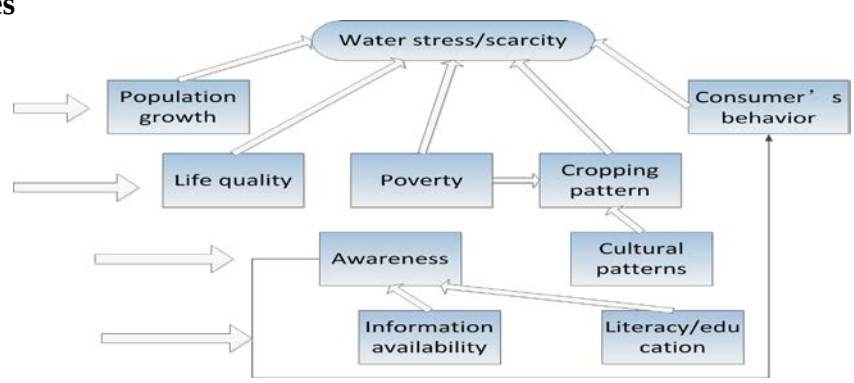

Figure 1: Different Levels of Social Forces Affecting Water Scarcity Conditions

The social forces can be viewed at four levels. Figure 1 reports the different layers of the social forces that forces that contribute to escalating the water scarce conditions over time.

A. Population growth and quality of life

Advancements in living standards together with population growth have already been reflected in expansion of water consumption levels for domestic use.[1] Domestic water use grew from 3.1 BCM in 1990 (Abu-Zeid,1991) to 5.23 BCM in 2000 (FAO Aqua- stat). Further augmentation of the life quality and the population growth will push up water demands.

B. Poverty

Often low-income levels and poverty in rural areas limit the farmers' ability to invest in agriculture pushing them to plant the low-cost crops namely water thirsty crops (i.e. rice, sugarcane). This shift in the cropping pattern triggers the increase in water use.

C. Cropping pattern

Cropping pattern plays a vital role in determining the irrigation water demand. Some changes in cropping patterns were made favoring production of high value-added crops. Among them were the

rice and the sugarcane with the highest water requirements among the crops cultivated in Egypt.

2.2 Physical variables

A. Water resources

Water resources in Egypt are limited to the Nile River, rainfall and flash floods, deep groundwater in the deserts and Sinai, and potential desalination of sea and brackish water[2] . The detailed water resource distribution is shown in Figure 2.

B. Basic demand of water

Figure 2 illustrates the present water distribution among different economic sectors. Agriculture is the largest consumer of water resources worldwide and in Egypt as well.

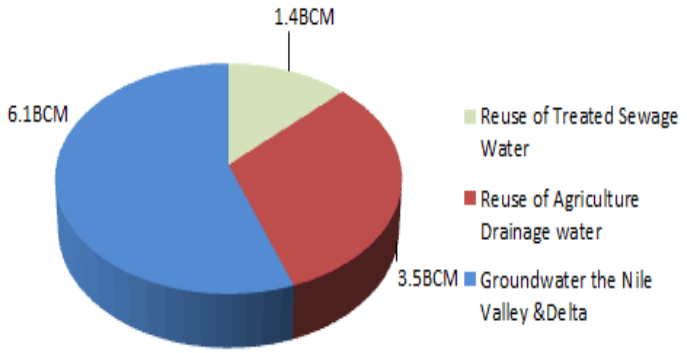

Figure 2: The present water distribution among different sectors

3. Assessment of water scarcity in Egypt based on PSR

- **Choose suitable indexes**

It is known to all that cropping patterns have an enormous on the agricultural water consumption and Consumer behavior contribute is closely related to both Per capita water consumption and domestic water consumption. Poverty can be linked to per capita GDP. Last but not least, population density can be used to represent population growth.

- **Application of PSR**

Through collection for information and statistic, we acquired the specific statistic in population, society, economy and water resources of Egypt. The following chart can be obtained by using PSR, and weight of all the indexes can be calculated with the whole procedure programmed in MATLAB .

Using the data of natural environment, social economy and water resources in Egypt during 2002 ~ 2012*[3]*, and after the standardization, we are able to concluded risk assessment indexes of state index, pressure index and response index, as shown below.

Table 1: risk assessment indexes of state index, pressure index and response index

year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
state	0.40	0.401	0.401	0.401	0.402	0.40	0.40	0.403	0.40	0.404	0.404
pressure	0.38	0.387	0.390	0.394	0.401	0.40	0.41	0.422	0.43	0.444	0.449
response	0.21	0.224	0.223	0.232	0.246	0.26	0.28	0.303	0.31	0.327	0.340

Analysis of the obtained data

Index	Symbol	Weight
Total amount of renewable freshwater resources	X1	0.152022315
Annual mean precipitation	X2	0.153417015
Per capita water consumption	X3	0.012552301
Tributary runoff	X4	0.082287308
Actual evaporation	X5	0.069735007
Population density	X6	0.125523013
Waste water discharge	X7	0.051603905
Urbanization rate	X8	0.075313808
Agricultural water consumption	X9	0.034867503
Industrial water consumption	X10	0.009762901
Domestic water consumption	X11	0.016736402
Investment in wastewater treatment	X12	0.061366806
Wastewater treatment rate	X13	0.058577406
Per capita GDP	X14	0.083682008
Scientific research and development expenditure（%of GDP）	X15	0.012552301

Figure 3: Comprehensive evaluation indexes and weight of water shortage

As it is indicated in the data, in 2012 the risk of state achieved its peak 0.404. So they are the risks of pressure and response.

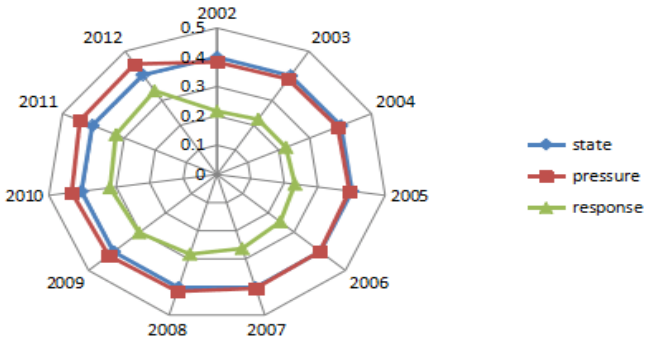

Figure 4: Analysis of data

Via studying the yearly change of the comprehensive risk index, we can draw the conclusion the trend of it is increase.

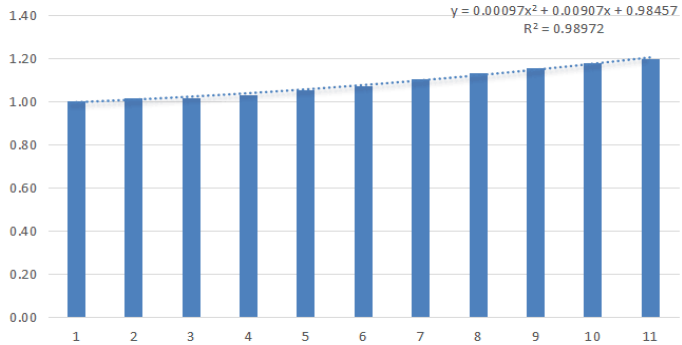

Figure 5: Yearly change of the comprehensive risk index

- **Ecological risk analysis of water resources**

According to the general statistical principles, comprehensive water resources eco- logical risk level is divided into three categories, as shown in Table 2, the comprehensive ecological risk index less than 1.00 is considered as low risk, while index higher than 1.10 is considered as high risk, and between them is medium risk.

4. Conclusion

Based on the classification criteria, the comprehensive ecological risk of water re- sources in Egypt from 2002 to 2012 was evaluated, as shown in Table 2.

Table 2: classification criteria and comprehensive risk index

Level of risk	Parameter of risk	year
Low risk	**<1.00**	**2002**
Medium risk	**1.00-1.10**	**2003-2008**
High risk	**>1.10**	**2009-2012**

References

[1]Xiangjuan Zhang ,xin Li, Xiuxia Li, etc. With the analytic hierarchy process to estab- lish the Beijing-hangzhou grand canal in suzhou high-tech zone section of the water environment bearing capacity index system research [J]. Journal of environmental protection and circular economy, 2011, 31 (2) : 42-44.

[2]Wai Wang,Xinyi Xu,Hongrui Wang, etc. Based on PSR and DCE integrated model of water shortage degree and the change trend analysis [J]. JOURNAL OF NATURAL RESOURCES, 2015, 30 (10).

[3]Abdin A E,Gaafar I. Rational water use in Egypt[J]. M. El Moujabber, L. Mandi, G. Trisorio Liuzzi, I. Martin, A. Rabi, R. Rodriguez (eds), 2009: 11-28.