IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 16, Issue 3 Ser. IV (May. - June. 2019), PP 48-52
www.iosrjournals.org

Use Virtual Water Strategy to Reduce Water Deficit in Sharkia Governorate

G. Mostafa[1], M. Fahmy[2], S. Ramadan[3] and O.Shalash
[1] *Professor of Hydraulics, Water and Water Structures Eng. Dept., Faculty of Engineering, Zagazig University,*
[2] *Assoc. Professor, Water and Water Structures Eng. Dept., Faculty of Engineering, Zagazig University,*
[3] *Ph.D. Water resources management, Lecturer, Water and Water Structures Eng. Dept., Faculty of Engineering, Zagazig University,*
4 Head of building maintenance administration, Sharkia south sector, Canal Company for electricity distribution,
Corresponding Author: G. Mostafa

Abstract: *Egypt is one of the biggest countries in Africa and Middle East, which is suffering from water deficit problem affected by increasing population and many developing projects. Egypt is suffering from deficit of water resources at the present and in the future.Modeling may be helpful in solving water shortage problemsin the Nile valley withsuccessful future planning. Many previous studies had applied mathematical, physical, numerical and mechanical models on Nile river basin and studying the impact of climate change and new strategies in waterresources management and using the GIS and share decisions withal participates.In the present research,we will study the effect of applying virtual water strategy on Sharkia Governorate as case studyas it is the third big governorate inpopulation and it is expected to suffering from water deficitproblem, as a previous study for the author get the water deficit amount=11.6 MCM/year for Sharkia governorate the changing crop pattern to the governorate will achieve good results in reducing water deficit amount.*

Keywords: *Integrated Water Resources Management, River Nile, Delta, virtual water*

Date of Submission: 02-06-2019 Date of acceptance: 17-06-2019

I. Introduction

More than half century many studies had applied on river Nile basin to achieve the best water management for Nile basin countries, nowadays, a new water management strategyis applied like virtual water (import intensive water products and export less water products for water scarce countries). In1999 the net amount of virtual water Egypt import was 80.2*109 m3 as the eighth big country in the world after Sri Lanka, Japan, Netherlands, Korea Rep, China, Indonesia &Spain [1]. Since that date several studies on virtual water have applied and we will mention of these studies. In 2018 a study on Saudi Arabia concluded that better management of virtual water (VW) could reduce water shortage because the export of VW was 4.2% of VW import [2]. in 2016 a study on the Middle East North Africa has published virtual water trade amount in this region. It was found that the MENA region suffers an opportunity cost of between 293.6 billion USD and 582.8 billion USD per year by exporting its scarce blue water resources, and an opportunity cost of between 19 and 35 trillion USD per year for the sake of its bloated agricultural sector [3]. Mexicoimports maize so, it saves 12 BCM/ year of its national water resources. This is the volume of water that it would need domestically if it had to produce the imported maize within the country [4]. In 2004 a research has been studied the relation between virtual water flows and crop trade then concluded that 13% of the water used for crop production in the world is used for export (in virtual form)not used for domestic consumption [5].In 2005 virtual versus real water in China was studied and the result showed that north China annually exports about 52 BCM of virtual water to south China[6].In 2018 A paper has studied the impact of climate change on three cereal crops(wheat,barleyl and canola) by using (Soil and Water Assessment Tool (SWAT) in Canada to estimate virtual water content. The results concluded that annual average export of these three crops is 138 BCM of virtual water [11].In April 2019, a study in China has been studied the impacts of socio-economic factors on regional grain virtual water flows using a structural equation modeling approach, that studyindicates that the regional socio-economic pattern will affect the grain virtual flow patterns and virtual water flows will exert great pressure on water resources in the virtual water export areas [12]. In this paper we will reduce water deficit in Sharkia Governorate as a case study for East Delta by changing crop pattern to get optimum operation to help the planners to choose the best strategy in water *resources management in this region.*

1.1 The Study Area

Sharkia Governorate is located on the east of delta and bounded by latitudes 30° 30`and 31° 00` N and longitudes 31° 30` E covering area of about 4922 km^2. It contains 14centers(Zagazig,Belbies,Menia AL Kamh,Mashtool,DiarbNegm,Al Ebrahymia,Abou Hammad,Faqous, Hehia,AbouKHabeer,KafrSakr,AwladSakr and Al Hussayniah) and Zagazig city is the capital as in figure (1). It has population of more than 10 million capita in 2017 and it is expected to reach 13 million capita in 2032. Bahr Mowais and Ismailia canal are the main canals feed the area with fresh water and it has more than 160 branch canal and 56 drains distribute from Bahr ALBakkar drain. Its total water resources =4.851 BCM.Sharkia governorate have an area of agriculture land 1,073,470 Feddan and its capital is Zagazig city. It has many Archeological areas like Tanis city in San al Haggar and Tal Basta in Zagazig. The main crops in the governorate are represented in table (1).

Fig. (1); Sharkia Governorate centers.

II. Methodology

Virtual water is defined as the total volume of water needed to produce and process a commodity or service.For example, it is estimated that 1700 liters of water are required to create 500gm of rice figure (6-10).

Table (1) winterCrop pattern in SharkiaGovernorate [8].

Crop Name	Area (Feddan)	Water Requirement (m^3*10^3/Feddan)	Total water req (m^3).
Wheat	558204.4	1,670	932201348
Peen	96612.3	1,090	105307407
Clover	257632.8	2,310	595131768
Potato	161020.5	1,480	238310340
total	1073470		1870950863

Table (2) Summer Crop pattern in Sharkia Governorate [8].

Crop Name	Area (Feddan)	Water Requirement (m^3*10^3/Feddan)	Total water req (m^3).
Tomato	150285.8	1,470	220920126
Rice	601143.2	4,370	2626995784
Cotton	193224.6	3,570	689811822
Maize	128816.4	2,900	373567560
total			3911295292

From table (1&2) the total water requirements for summer and winter crops=1.8+3.9 =5.7 BCM

As Sharkia Governorate is consider the third biggest governorate in population in Egypt,and it is having a big agriculture land so that it consumes more water. If we replace water intensive crops like wheat with less water crops like quinoa, we will save a huge amount of irrigated water. Wheat needs 1,670 m^3/Fed while quinoa consume 1,000 m^3/Feddan and reduce area cultivated by rice because it consumes 4,370 m^3/Feddan and import it will be cheaper than cultivate it. quinoa is a high source of plant protein and it enter Egypt in 2005 starts at Nowaibagh.

It is a winter crop cultivate at November and takes 100-120 days and it can grow in saline and draught soil, the cultivated area reaches 80 feds in 2018. The productivity of one feddan reach 2-2.5 ton.the crop pattern of the governorate is represented in figures (2 and 3). If we know that 500gm of rice need1,700 liters of water from growing until cooking as in figure (4).The virtual water literature treats water as an economic or environmental good, back grounding its role as a political good by importing water intensive products, to reduce pressure on domestic water resources.

The area cultivated by wheat= 558,204feddan consume water=558,204*1,670= $932*10^6$ m^3. If we replace only 30% of this area by quinoa=558,204*30/100 = 167,461*1,000= 167,461 $m^3$of water we will save=279,659.87–167,461 = 112,198.87 m^3 of water which means that replace 30% of wheat by quinoa the water consumption will reduce by =1,000/1,670*100 =59.8% =1-60% =40% we could apply this strategy on other crops like sugar cane, cotton, maize and rice.

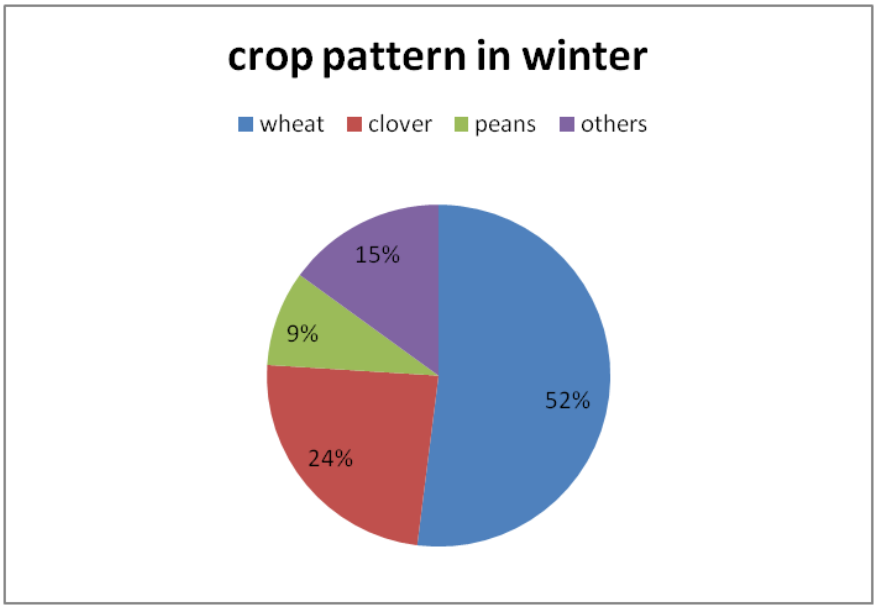

Fig. (2); crop pattern in winter

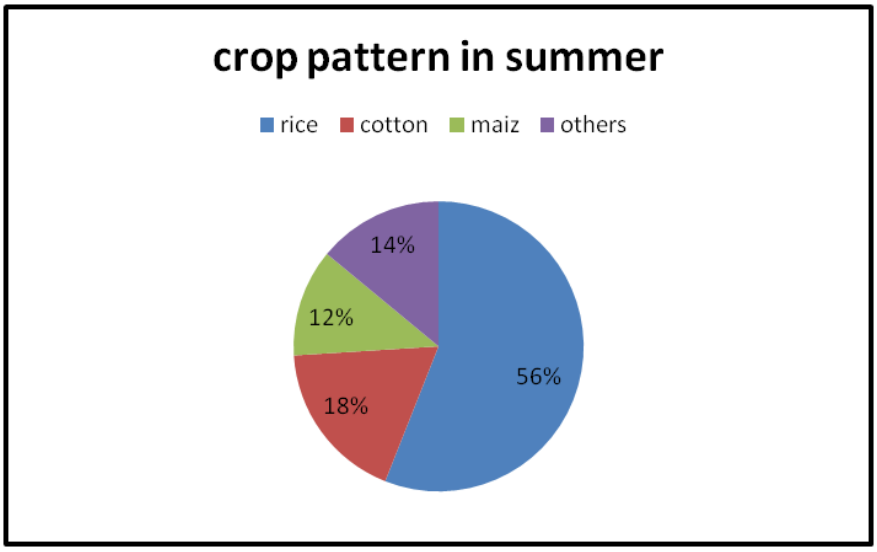

Fig. (3); The crop pattern in summer

Fig. (4); 500gm of rice need1,700 liters of water

When we replace 50% of maize crop by corn we will save 500m^3/feddan where corn crop consume 2,400 m^3/fed but maize consume 2,900 m^3/feddan so each Fadden save 500 $m^3$of water so if we reduce area cultivated by maize to 50% and replace it by corn crop it will save 32.204 *10^6 m^3/feddanof water as follows:

50% *128,816 =64,408 feddan

64,408*2,900 =186.783*$10^6$$m^3$ for maize

64,408*2,400 = 154.579 *10^6 m^3 for corn

The amount of water saved= (186.783- 154.579) *10^6 =32.204 *10^6 m^3which mean that each Fadden save 2,400/2,900 =82% =(1-82%)=18% of water amount.

For rice crop the total cultivated area in Egypt =1.1 Million feddan while Sharkia governorate cultivate 238350 feddan in 2018.as rice is a strategy crop and essential mail for all Egyptians, the governorate reduce cultivated area of rice to820000 ton at 2019 and import 130000 ton to save water if we know that one Million feddan product 2.5 million ton of white rice, also start cultivates new kind of rice which consume less Water. Ministry of Irrigation corporate with Ministry of Trade to import some essential goods for all country as in table (3&4). From table (2) the total water requirement for five important crops =17197.76 *10^6 m^3. As the total population of Egypt at 2017 was 100 million capita and Sharkia governorate was 10 million capita, so that 10% of this amount belongs to Sharkia governorate.

10% * 17197.76 =171.9* 10^6 m^3 of waterso that Sharkia governorate import goods with water content =1.72 BCM of water which is a huge number. Table(5) represent 5 essential crops which the governorate imported at 2018,and their water content = 1.4 BCM

Although Sharkia governorate has limited water resources, it imports some strategic products to manage water demands.

Table(3) the total water requirements of 5 crops importsto Egypt[13]

Crop	Import 2018 (ton*10^6)	Import 2019 (ton*10^6)	Water req. m^3/fed	Area cultivated Fed	Total water req. (m^3)*10^6
Wheat	3.45	3.45	1670	3049000	5091.83
Maize	2.25	2.11	2900	1482000	4297.8
Sugar	0.06	0.04	9000	325000	2925
Rice	0.130	0.820	4370	1100000	4807
Soya bean	0.094	0,083	330	23000	76.13
Total					17197.76

Table (4) total money need to import some essential food goods to Egypt at 2017 [14]

Good	Import cost $*$10^6$
Meat	1.393
Bean	0.02264
Milk	0.046825
Maize	1.745
Rice	0.0050480
Sugar	.0788
Soya bean	0.0855
Wheat	2.53
Fish	0.056225
	5.884238

Table(5) the total water requirements import for 5 crops toSharkia governorate

Crop	Import 2018 (ton)	Sharkia import 2018(ton)	Water req. m^3/fed	Total water req. (m^3)
Wheat	3450000	345000	1670	576150000
Maize	2250000	225000	2900	652500000
Sugar	60000	6000	9000	54000000
Rice	130000	13000	4370	56810000
Soya bean	94000	9400	330	3102000
Total				1342562000

From table(4) we can concluded that Sharkia governorate import 5 food products in 2018 with 0.1*5.8= 0.58Million Dollars

III. Data Analysis And Results

Sharkia governorate face water shortage problem so that integrated water resource management should take place with new strategies of water management to overcome this problem. Import some strategic crops is more useful than cultivate it and replace water intensive crops by less water crops like wheat and quinoa will be more effective in reducing water deficit amount.Decrease area cultivated by rice and cultivate new kind of rice which consume less water amount like rice affected by salinity, dry rice and rice on drains.The actual water requirement for all agricultural land in Sharkia governorate = 5.7 BCM and it imports water as a goods = 1.72 BCM so it consume water amount = 5.7+1.72 = 6.42 BCM where its total water resources = 4.851BCM ,So it imports 1,72/4,851*100 = 35% of its natural water resources as food goods to save water. The governorate also imports 5 essential products with more than 500000 dollar annualy.

IV. Conclusion

Virtual water strategy is an effective policy to manage water resources and demands. replace 30% of wheat by quinoa the water consumption will reduce by (40%) and if we replace 50% of maize area by corn, we will save 18% of amount of water for each feddan, we could apply this strategy on other crops like sugar cane, cotton and rice. We advise to improve a plant strain for strategic crops to consume less water amount.Import strategic goods is more effective than product it to save water.

References

[1]. A.Y. Hoekstra and P.Q. Hung, "*Virtual water trade*",,VALUE OF WATER RESEARCH REPORT SERIES NO. 11, 2601 DA DELFT, September 2002,THE NETHERLANDS

[2]. Daniel Bacon, "*The MENA region, the Virtual Water Trade, and the Opportunity Cost of Agriculture*",Bachelor thesis, Faculty of Humanities,Lriden University2017.

[3]. Shathe governorate also khawat Chowdhury, Fayzul Kabir, Imran Rahman , And Maria P. Papadopoulou, "*Importing and Exporting Agricultural Crop Products: An Assessment of Virtual Water Flow (VWF) in Saudi Arabia*", Arabian Journal for Science and Engineering, 09 November 2018

[4]. "*Virtual water trade"*Report, Mekonnen, M.M. and Hoekstra, A.Y. (2011). Series No.50, UNESCO-IHE, Delft, Netherlands, National water footprint network.

[5]. A.Y.Hoekstra and P.Q.Hung, "*Globalization of water resources:international virtual water flows in relation to crop trade*", Global Environmental ChangeVolume 15, Issue 1, April 2005, Pages 45-56

[6]. Jing Ma, Arjen Y Hoekstra, Hao Wang, Ashok K Chapagain and Dangxian Wang, "*Virtual versus real water transfers within China*" Published:20 October 2005https://doi.org/10.1098/rstb.2005.1644.

[7]. Unpublished reports, Ministry of Agriculture (Al Sharkia Sector), Egypt.

[8]. Unpublished reports, Ministry of Water Resources and Irrigation (MRRI), Egypt.

[9]. Allan, J.A. (2001) "The Middle East water question: Hydro politics and the global economy", I.B. Tauris, London.

[10]. Wichelns, D. (2001), "*The role of 'virtual water' in efforts to achieve food security and other national goals, with an example from Egypt*", Agricultural Water Management 49:131-151.

[11]. M. BadrulMasud and ET.al"*Global implications of regional grain production through virtual water trade*"Science of The Total Environment, Volume 659, 1 April 2019, Pages 807-820

[12]. **S.K.Sun and ET.al"***Evaluating the impacts of socio-economic factors on regional grain virtual water flows in China using a structural equation modeling approach*". Journal of Hydrology, **Volume 571, April 2019, Pages 132-141**

[13]. www.zawya.com
https//mfyoum.com/2019

G. Mostafa. "Use Virtual Water Strategy to Reduce Water Deficit in Sharkia Governorate." IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) , vol. 16, no. 3, 2019, pp. 48-52