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# A FINANCIAL AND MACROECONOMIC OVERVIEW OF "WATER": THE CASE OF PALESTINE

# "SU"YA FİNANSAL VE MAKRO EKONOMİK BİR BAKIŞ: FİLİSTİN ÖRNEĞİ

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**Abstract**

The purpose of this paper is to determine whether the current water supply can aid in achieving economic growth in Palestine through the agricultural sector. Thus an attempt was made to answer the question whether it is worthwhile for the Palestinian Authority (PA) to invest in the agricultural sector to achieve a certain level of sustainable development.

A time-series regression analysis is performed to investigate whether the current amount of water can sustain economic growth in Palestine for 1998-2018. Findings have indicated that there is no relationship between the agricultural sector and the two sources of water. Meanwhile, there is a cointegration relationship between the agricultural sector and the spring water.

Accordingly, water is not achieving economic growth in Palestine due to a shrinking agricultural sector. Moreover, the Palestinian agricultural sector faces several challenges during the expansion period, most importantly in terms of the insufficient subsidies provided to the Palestinian farmers by the PA.

**Key Words:** Palestine, Water, Economic Growth, Agricultural Sector, FMOLS.

**JEL Codes:** C22, C50, O11, O13, Q25.

**Öz**

Bu çalışmanın amacı, Filistin'de su arzının tarım sektörü bağlamında ekonomik büyümeye yol açıp açmadığını ortaya koymaktır. Böylece Filistin Yönetimi için belirli bir sürdürülebilir gelişim düzeyini yakalayabilmek için tarım sektörüne yatırım yapmaya değip değmeyeceği sorusuna cevap verilmeye çalışılacaktır.

Çalışmada, 1998-2018 dönemi için Filistin'deki mevcut su miktarının ekonomik büyümeyi sürdürüp sürdüremeyeceğini araştırmak amacıyla bir zaman serisi analizi uygulanmıştır. Bulgulara göre, tarım sektörü ile iki su kaynağı arasında bir ilişki tespit edilememiştir. Bununla birlikte, tarım sektörü ile kaynak suyu arasında bir eşbütünleşme ilişkisi tespit edilmiştir.

Sonuç olarak, suyun Filistin'de küçülen tarım sektörü dolayısıyla ekonomik büyümeye katkı sağlayamadığı söylenebilir. Ayrıca, Filistin tarım sektörü özellikle Filistin Yönetimi tarafından çiftçilere sağlanan yetersiz teşvikler dolayısıyla genişleme dönemlerinde birçok zorlukla başa çıkmak zorunda kalmaktadır.

**Anahtar Kelimeler:** Filistin, Su, İktisadi Büyüme, Tarım Sektörü, FMOLS.

**JEL Sınıflaması:** C22, C50, O11, O13, Q25.

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# 1.Introduction

Water is the essence of life, and wars were fought to control sources of water. Water is considered both an economic and social good. Humans need water to survive and it is an input for food production. Thus, the demand for water is derived from the different major sectors of the economy such as the domestic sector, agricultural sector, and the industrial sector. The increase in the world population had shifted the demand curve for agriculture and food to the right, i.e. increased the demand for agriculture and food production. "Agriculture takes the highest share among water user sectors in low- and middle-income countries" (Pereira, Cordery, and Iacovides, 2002: 10). Since the demand for food is inelastic and water is a necessary commodity the demand for water is inelastic. Since Palestine falls in the range of low to middle-income countries, most of its water supply is geared towards agriculture. "Although agriculture consumes most of the water" (Nazer et al., 2010: 1). The problem is, can the current water supply sustain the Palestinian population and achieve economic growth through the agricultural sector. The purpose of this paper is to determine whether the current water supply can aid in achieving economic growth in Palestine through the agricultural sector. Thus is it worthwhile for the Palestinian Authority (PA) to invest in the agricultural sector to achieve a certain level of sustainable development?

It is well-known that today the scarcity and inequal distribution of water sources all over the world makes it a matter of concern for the whole humanity and the next generations. As stated by Duarte, Sanchez-Choliz and Bielsa (2002), of all the water resources, the share of fresh water is only 2.5% and its spatial and time distribution is rather irregular. Cole (2004), even reports the claims made by the World Bank in 1995 and UNESCO in 1999 that the world would face many water crisis and wars because of water scarcity in the century we now live in. Bijl et al. (2015) also quoted that water scarcity would be a threat to ecosystems, food production and rural livelihoods and electricity production in the next decades besides the possibility of hindering industrial development and economic growth. It is also expected that as competition for water increases between agricultural, urban and commercial sectors, water scarcity would grow more dramatically in some regions and at least 17 countries are likely to face 'absolute' water scarcity, and an additional 24 countries may face economic water scarcity by the year 2025 (Barbier, 2004: 1-3). Moreover, as stated by Abualtayef et al. (2019) because of the reasons such as the repetition of conflicts, the political instability, the lack of local available resources, the weak institutional framework, the dependency on external funding, and the difficulty to import materials and equipment, the water in the Gaza Strip is much more important. Despite the fact that Palestine is rather rich inwater resources, Palestinians struggle for basic water access because of unequal water distribution that Israeli settlers benefit from. Solutions to this issue vary from purchasing expensive tankered water to collecting water from unprotected springs or harvesting rainwater during the winter (Koppelman and Alshalalfeh, 2012: 4).There have been many agreements on water rights and distribution between both side such as the First Gaza Jericho Agreement in 1994 and the Interim Agreement in 1995. However, none of them seems to provide an absolute solution as we consider the negative effects of inequal and insufficient water on Palestinian socio-economic development. Hence, the issue of water, its interaction with the economic growth, and allocation of water resources rationally is even more severe for PA given the restrictions they are exposed to and the economic livelihoods faced by Palestine.

According to the World Bank, access level of the population to an improved water source which is defined as the percentage of the population that can obtain at least 20 liters per person per day from an "improved" source that is within one kilometer of the user's dwelling has been nearly 1% since 2009. However, the level of population being able to use at least basic drinking water services has been above 90% and increasing since 2009 too (World Bank Data Bank, 2020).

The World Water Council reports that today nearly 1.1 billion people cannot get clean drinking water and the world population would increase by another 40 to 50% within the next fifty years and such an increase, besides industrialization and urbanization, would result in a serious increase for water demand (World Water Council). On the other hand, The World Bank estimates that the population would increase to over 10 billion by 2050. Combined with population increase, urbanization and climate change are expected to increase competition for water with a particular effect on agriculture. Moreover, while currently agriculture accounts nearly 70% of all freshwater withdrawals globally, the allocation of water will move from agricultural to urban, environmental, and industrial users (World Bank, 2020).

There are three main sources of water in the Palestinian Territories, they are Pumped groundwater, that is water (fresh or brackish) beneath the surface of the earth usually stored in aquifers supplying the wells and springs; spring water discharge; and water purchased from the Israeli water company (Mekorot). Note aquifers are underground geologic formations or groups of formations that contain groundwater that supply wells and springs. Table 1 shows the amount of water consumed by the Palestinians from the different sources of water.

Looking at Table 1, the highest amount of water is extracted from the ground, followed by the Israeli company, and finally the spring water. What is alarming is the increasing amount of water purchased from the Israeli company.

**Table 1:** Water Supply for the Palestinian Territories from the different Water Sources for the Period 1998 to 2018

| Year | Quantity of Water Pumped from Groundwater (Millions of meters cube) | Discharge of Spring Water (Millions of meters cube) | Purchased Water from Israeli Water Company (Mekorot) (Millions of meters cube) |
|---|---|---|---|
| 1998 | - | **64.2** | 37.9 |
| 1999 | - | 28.3 | 36.5 |
| 2000 | 197.9 | 36.4 | 38.1 |
| 2001 | 181.2 | 25.9 | 37 |
| 2002 | 203.4 | 38.1 | 38.4 |
| 2003 | - | 60.4 | 43.1 |
| 2004 | 196.1 | 52.7 | 42.6 |
| 2005 | 214.7 | 53.6 | 42.2 |
| 2006 | 223.5 | 51.7 | 43.9 |
| 2007 | 241.2 | 44.8 | 49.6 |
| 2008 | 225.7 | 25.2 | 52.7 |
| 2009 | 227.2 | 30.6 | 57.4 |
| 2010 | 244 | 26.8 | 60.3 |
| 2011 | 245.5 | 21.4 | 57 |
| 2012 | 253.3 | 39.3 | 56.6 |
| 2013 | 262.9 | 39.5 | 63.3 |
| 2014 | 246.3 | 28.2 | 63.5 |
| 2015 | 250.5 | 40.7 | 70.2 |
| 2016 | 251.6 | 29.0 | 79.1 |
| 2017 | 264.5 | 23.5 | 83.2 |
| 2018 | 274.2 | 25.5 | 85.7 |

**Source:** The Palestinian Central Bureau of Statistics www.pcbs.gov.ps, Accessed: 16.09.2020

The Israeli authorities control the limited water resources in the Palestinian Territories. Besides, the Israeli occupation deprives the Palestinians of their legal share of water. Israelis took control of all the shared water resources such as the underground mountain aquifer –comprising of the Eastern, North-Eastern and Western basins- since the 1967 war. The restrictions that the Palestinians have on water allocation are the principal cause of the water shortages in the West Bank (Palestinian Water Authority, 2011: 5). However, this water shortage does not apply to the Israeli settlements in the West Bank. Given that settlements are usually built on water sources to control the supply and ensure the smooth expansion of the settlement with secured natural resources. Thus the settlements are a vital tool to entrench and solidify the occupation of the Palestinian territories (Samara and Talalweh, 2019: 42).

As for Gaza, poor water quality is the problem. Given Gaza is under a land, air, and sea blockages imposed by the Israeli authorities; the Palestinians in Gaza must rely on the Coastal Aquifer as their primary water supply. This aquifer is considered a transboundary water resource since it runs along the Mediterranean Coast and under Gaza into North-Western Egypt. Nevertheless, the aquifer is inadequate to meet its most basic water needs. Therefore, they pump almost three times the aquifer's sustainable yearly recharge (Ibrahim Abu-Lughod Institute of International Studies, 2013: 10). According to a recent survey conducted on 380 households in Khan Younis city, households are obliged to get water from alternative resources in a costly way not only because of water shortage but also the low quality of the one provided by the municipality while 38.4% of them have low ability to pay, and 5.3% of the respondents suffer from water shortage (Abualtayef et al., 2019: 5).

"Over-pumping has led to increased saline intrusion as the aquifer's water levels drop, allowing seawater from the Mediterranean, as well as saline groundwater in Israel, to infiltrate the aquifer in ever greater volumes. In the absence of adequate wastewater and sanitation infrastructure like wastewater treatment plants, raw or partially treated sewage also seeps into the aquifer from sewage collection ponds located on the surface." (Ibrahim Abu-Lughod Institute of International Studies, 2013: 10). This has led to the rapid deterioration of water quality.

According to the the World Bank's report, the current water supply and wastewater issue in Palestine can be summarized as follows (Water Global Practice, 2018: 2-5):

- Palestinian territories face significant and growing shortfalls in the water supply available for domestic use and till 2030 the domestic supply gap is projected to be about 92 and 79 million cubic meters for the West Bank and Gaza respectvely. And this projection shows that the projected supply gap is expected to increase even more dramatically for Gaza.

- The water supply in Palestine is largely determined through negotiated agreements with Israel for groundwater abstraction and imports of additional supply.
- The water quality in Gaza is undrinkable and the groundwater quality is generally acceptable in West Bank.
- Palestinians are increasingly reliant on bulk water purchases from Israel.
- The inability of Palestinian Water Authorities to make payment for bulk water purchases increases Palestine's debts to Israel. Israel deducts this debt from the taxes collected on behalf of the PA.
- Options for desalination of seawater have not been fully used while desalination is critical for Gaza given the condition of the aquifer.

On the other hand, financial viability of water services is seen as another issue to be considered. The tariffs are low and they cover around two-thirds of costs. Average service provider covers less than 24% of its costs in Gaza. When it comes to West Bank, average tariff covers operating cost barely and while service providers collect around 68% of the bills issued they use part of this collection in other municipal expenditures (Water Global Practice, 2018: 2-5).

Hence, it is seen that, water is a real issue to be dealt with not only because of its scarcity and vitality nature in Palestine but also in the context of its role in the economy and financial management of the costs and tariffs regarding water.

Table 2 shows the population and agricultural sector production for Palestine. The major consumption of water comes from these two sectors.

**Table 2:** Value-added from Agricultural Sector and GDP for Palestine in constant Prices (2015 base year)

| Year | Population (person) | Value Added from the Agricultural Sector (in USD million) | GDP (in USD million) |
|---|---|---|---|
| 1998 | 2,871,568 | 842.1 | 7189.1 |
| 1999 | 2,962,226 | 829.1 | 7784.4 |
| 2000 | 3,053,335 | 689.1 | 7118.4 |
| 2001 | 3,138,471 | 546.9 | 6455.6 |
| 2002 | 3,225,214 | 453.8 | 5649.4 |
| 2003 | 3,314,509 | 449.6 | 6441.2 |
| 2004 | 3,407,417 | 492.5 | 7107.4 |
| 2005 | 3,508,126 | 412.8 | 7874.9 |
| 2006 | 3,611,998 | 412.4 | 7567.7 |
| 2007 | 3,719,189 | 517.9 | 8066.5 |
| 2008 | 3,820,801 | 536.2 | 8556.9 |
| 2009 | 3,922,130 | 555.0 | 9298.1 |
| 2010 | 4,023,462 | 561.2 | 10051.2 |
| 2011 | 4,124,795 | 674.2 | 11298.9 |
| 2012 | 4,226,410 | 558.6 | 12008.9 |
| 2013 | 4,327,751 | 509.0 | 12275.2 |
| 2014 | 4,429,084 | 476.0 | 12252.9 |
| 2015 | 4,530,416 | 450.1 | 12673.0 |
| 2016 | 4,632,025 | 418.8 | 13269.7 |
| 2017 | 4,733,357 | 390.2 | 13686.4 |
| 2018 | 4,854,013 | 427.6 | 13810.3 |

**Source:** Palestinian Central Bureau of Statistics, www.pcbs.gov.ps, Accessed: 16.09.2020

We notice that the population had almost doubled from 1998 to 2015. Nevertheless, the agricultural sector had decreased from $430.8 in 1998 to $265.7 in 2015, while, the GDP had increased. Thus the agricultural contribution to the GDP had decreased.

Table 3 shows the contribution of the different economic sectors to the GDP. Looking at the table above we notice that the values added from the agricultural sector had decreased, meanwhile, both the manufacturing and service sectors had increased.

**Table 3:** Value Added by Economic Activities for the Palestinian Economy for Years 1994 and 2016 at Constant Prices (Base Year 2004) (in Million USD)

| Economic Activity | 1994 | 2016 |
|---|---|---|
| Agriculture, Forestry, and Fishing | 361.2 | 236.6 |
| Mining and Quarrying | 23.8 | 28.4 |
| Manufacturing | 593.5 | 887.2 |
| Electricity, Gas, Steam, and Air Conditioning Supply | 41.3 | 123.4 |
| Water Supply, Sewerage, Waste Management, and Remediation | 47.3 | 75.5 |
| Construction | 218.7 | 601.1 |
| Wholesale and Retail Trade, Repair of Motor Vehicles and Motorcycles | 476.2 | 1383.9 |
| Transportation and Storage | 147.1 | 180.1 |
| Financial and Insurance Activities | 30.5 | 320.7 |
| Information and Communication | 3.0 | 443.3 |
| Services | 907.3 | 1652.5 |
| Public Administration and defense | 225.9 | 1034.1 |
| A household with Employed Persons | 4.0 | 4.0 |

**Source:** Palestinian Central Bureau of Statistics (2015), www.pcbs.gov.ps, Accessed: 16.09.2020

Table 4, shows the value-added for the economic activities as a percentage of the GDP for the years 1994 and 2016 for the Palestinian economy.

**Table 4:** Percentages of Value Added by Economic Activities for the Palestinian Economy for Years 1994 and 2014

| Economic Activity | 1994 (%) | 2016 (%) |
|---|---|---|
| Agriculture, Forestry, and Fishing | 13.3 | 2.9 |
| Mining and Quarrying | 0.7 | 0.4 |
| Manufacturing | 18.8 | 11 |
| Electricity, Gas, Steam, and Air Conditioning Supply | 1.2 | 1.5 |
| Water Supply, Sewerage, Waste Management, and Remediation | 1.2 | 0.9 |
| Construction | 11.1 | 7.5 |
| Wholesale and Retail Trade, Repair of Motor Vehicles and Motorcycles | 14.2 | 17.2 |
| Transportation and Storage | 3.4 | 2.2 |
| Financial and Insurance Activities | 1 | 4 |
| Information and Communication | 0.1 | 5.5 |
| Services | 25.1 | 20.6 |
| Public Administration and defense | 9.6 | 12.9 |
| A household with Employed Persons | 0.2 | 0.05 |

**Source:** Palestinian Central Bureau of Statistics (2015). www.pcbs.gov.ps, Accessed: 16.09.2020

Historically Palestine was part of the "Fertile Crescent", considered to be the cradle of human civilization and the starting point of agriculture. So it is ironic that this land is losing its contributing agricultural sector to the well-being of its citizens.

This paper is organized as follows. The next part is the literature review that both includes the studies dealing with water use from economic perspective and the studies takin water as an economic good for the Palestine. The data and methodology section sets the framework for the time series analysis and the Findings section reports the results obtained by the analysis. Finally, the Conclusion part summarizes and evaluates the findings and sets suggestions for the PA.

## 2. Literature Review

Water is considered both a social and economic good (Gleick, Wolff, Chalecki, and Reyes, 2002: 7-8). So water must be managed efficiently to meet both social and economic needs.

Gleick (2004) studied the interdependent relationship between water use and the economy. In this study, California was taken as a targeted point of the study. The study had concluded that "There are gross disparities in the "economic productivity" of water use. Even modest reallocations of water from one sector of our economy to another can produce significant changes in job availability and gross state product, but such reallocations must take account of regional economic priorities, job displacement and retraining issues, equity, and environmental side-effects" (Gleick, 2004: 1).

Some of the studies in the literature deals with the interaction between water consumption and income in the context of Environmental Kuznets Curve (EKC) in which the relationship between per capita industrial water consumption and GDP exhibits an inverted U-shape, and it is seen that many of them set forth compatible findings. In a study examining the relationship between water use and economic growth for China, Yue, Alun and Bolin (2017) detected a significant relationship between industrial water consumption and economic growth that is consistent with the EKC. They conducted unit root test and cointegration test to analyze the data from 2002-2014. They concluded that, industrial water consumption should be addressed by adjusting industrial structure, raising water use efficiency, and developing cutting-edge technology in order to reach the turning point of the EKC soon. Cole (2004) similarly found that per capita water consumption has a systematic relationship with per capita income. It is reported that water consumption increases at a decreasing rate with income until eventually reaching a peak, and afterwards falling. Another study testing the Kuznets curve in industrial water use is conducted by Jia et al. (2006). According to the multiple regression analysis conducted on the data taken from 20 OECD countries, relationship between industrial water consumption and income comply with the EKC, in other words; industrial water use first increases, followed by a leveling off and then decreases as income rises. Hence they suggest that the findings indicate the importance for developing countries to search for alternative ways of water use to reduce the demand for additional water in the process of industrialization. Barbier (2004) sets forth a statistically significant relationship between growth and the water utilization for the panel data of 163 countries. Findings support the hypothesized inverted-U relationship between economic growth and the rate of water utilization across countries and according to the estimations in the analysis period rates of fresh water utilization in the vast majority of countries are not constraining economic growth yet.

There are also many studies investigating water for the Palestine individually. However, it is seen that none of them had treated water as an economic good and tried to test its impact on the economic growth of the Palestinian economy. Since water is a constraint resource it is important to look at how water is distributed in Palestine. Nazer et al. (2010), evaluated domestic water management to achieve sufficiency in the house of tomorrow. Many options were evaluated economically, environmentally, and socially using the concept of the life cycle impact of assessment. The study had indicated that utilizing a combination of options for domestic water management can reduce domestic water consumption by more than 50%. Nonetheless, this study was limited to the West Bank.

Another study considered water management in Southern Palestine is conducted by Al-Salaymeh, Al-Khatib, and Arafat (2011). The study, however, had concentrated on the quality of rainwater and the environmental management of rainwater. Haddad, Mcneil, and Omar (2014), also concentrated on the quality of water in the supply system of the city of Nablus. A third study (Celik, Tamimi, Al-khatib, and Apul, 2017) indicated that there was a correlation between the observations in the poor quality of water stored in the system and surrounding environment and the water-related diseases. Frequently emptying the septic tanks will improve the water quality.

Shadeed (2013), assessed the situation in Palestine and rated Faria located in the northeastern part of the West Bank as an Arid region. Thus it assigned this region as a water-scarce and low-per capita water allocation. This situation is further exacerbated when these regions are agriculturally dominated and there are high-density residential areas.

We can assert that the water shortages in Palestine are due to the Israeli occupation and a political approach to solving the problem was taken (Daibes, 2000; سلامة، 2014); (جبارة، 2014). The Israeli occupation had hampered the efforts of sustainable development in Palestine. The Israeli Segregation Wall and land confiscation affected biodiversity and environmentally sustainable development (Abdallah and Swaileh, 2011).

Furthermore, there are other studies dealing with the interaction of "water" and economic growth for other countries or by considering various other factors as well. For example, Tao (2021), investigates the relationship between water resources usage and economic development in Beijing for the period of 2011 and 2019, and sets forth that water resources utilization and economic development has been decoupled anc concludes that the government could make more effort in order to promote the coordination of water resources and economic development.

Xu et al. (2020) studied the coupling coordination relationship between water-use efficiency and economic development in Jinan for the period of 2008 and 2017. Accordingly, both the the water-usage efficiency system and the economic development system in Jinan increased greatly during the analysis period. They conclude that, the utilization of water resources was guided toward high efficiency, and the water-use structure was optimized to produce greater economic benefits in Jinan.

Haseeb et al. (2021) investigated the relationship between natural resources and economic growth in five Asian countries namely China, India, Malaysia, Indonesia and Thailand from 1970 to 2018 by the quantile-on-quantile regression method. They found out that there is a positive and significant effect of natural resources on economic growth in four of the countries but India. Accordingly, natural resources have a negative and significant impact on economic growth in India.

Ozcan, Tzeremes and Tzeremes (2020) examines the interaction between energy consumption, economic growth and environmental degradation for the sample taken from 35 OECD countries over the period 2000-2014 by the Generalized Method of Moments (GMM) Panel Vector Autoregressive Regression (PVAR) method. They emphasize the conflicting findings in the existing literature and set forth that economic growth and the patterns of energy consumption can contribute to the improvement of environmental performance in the countries considered. They also conclude that increasing scales of economic activities resulted from the production process demand more natural resources, such as soil, land, water and energy.

Grabara et al. (2021), investigated the relationship between renewable energy consumption, economic growth and foreign direct investment for the period of 1992 and 2018 in Kazakhstan and Uzbekistan by the Granger causality test and Johansen cointegration test. It is reported that that among all investments aimed at protecting the environment in the total investment, the share for the protection and rehabilitation of soil, underground, and surface water is 8,9%. Findings indicate that there exists a bidirectional relationship and a cointegration relationship between the series.

Hence, in this paper, we will take a more economic approach to evaluate the impact of water on economic growth. Hanemann (1997) incorporated the "water requirements approach" to forecasting industrial water usage. However, we do not have the required data set to follow that same approach. This is why we will use the same approach utilized by Hussin and Ching (2013). The study asserted the contribution of economic sectors to economic growth for both Malaysia and China. The study had concluded that the biggest contributor to the rapid economic growth in Malaysia was the service sector. Meanwhile, the biggest contributor to the rapid economic growth in China was the manufacturing sector (Hussin and Ching, 2013: 46).

## 3. Data and Methodology

Water is considered as an input in the economic production theory. The demand for water is the demand for a social final good that is consumable for daily activities and life necessities –for example, drinking water or any other household activity- and an input for the production of any other commodity for the different sectors of the economy. The price for water as an economic good is determined by the supply and demand for the consumers of that input. The producers of products that require water as input demand water based on the demand for the final good. Thus the demand for water is a derived demand. As an economic commodity, its demand is derived from the demand of the final commodities of the different sectors of the economy (Berrittella, Hoeksrra, Rehdanz, Roson, and Tol, 2007: 1804-1809). So the derived demand is dependent on the tastes and preferences for the final product.

The aim of this research is to use the time series analysis in order to determine whether there is a relationship between the amount of water supply and the agricultural sector. The data is provided from the Palestinian Central Bureau of Statistics and Palestine Monetary Autority Depending on PCBS and MOF Data for the period of 1998 and 2018. All the variables used for the research are shown in Table 5. The data is analyzed by the Ms Excel and E-views 10 package softwares.

**Table 5:** Variables Used in the Analysis

| **Code** | **Variable Name** | **Type** | **Explanation** |
|---|---|---|---|
| GW | Ground water | independent | Quantity of water pumped from groundwater (millions of meters cube) |
| SW | Spring water | independent | Discharge of spring water (millions of meters cube) |
| PW | Purchased water | independent | Purchased water from Israeli water company (mekorot) in millions of meters cube |
| AGF | Agriculture and fishing | dependent | Value in million USD in the real GDP |
| RGDP | Real GDP | - | Real GDP at 2015 prices, in million USD. This data is used in order to calculate the total value added of AGF in real GDP. |

Before conducting the time series analysis, the Augmented Dickey-Fuller test will be utilized to show whether the variables are stationary or non-stationary. Thus we will test the null hypothesis that a variable has a unit root against the alternative hypothesis that the variable has no unit root. Using $\alpha = 0.05$ and the p-value of the t-test for the Augmented Dickey-Fuller test thus $\alpha >$ p-value, we reject the null hypothesis.

If two variables are cointegrated then there exists a long-run relationship between the two variables were the two variables drift together. This relationship differs from the short-term dynamics measured by the relationship between the deviations of $y_t$ and $x_t$ from their long-term trends. However, the cointegration test does not determine the direction of the causality (Greene, 1995: 567).

In the study we will also develop a FMOLS model that identifies the relationship between the agricultural sector and three waters sources. FMOLS approach, which was first introduced and developed by Philips and Hansen's study in 1990, can produce more reliable estimates for small samples. Furthermore it enables a check for robustness of the findings (Bashier and Siam, 2014: 88-89).

The analysis will utilize the following model by taking log of all the variables:

$$\log(AGF) = \alpha + \beta_1 \log(GW) + \beta_2 \log(SW) + \beta_3 \log(PW) + \varepsilon \quad (1)$$

Here $\alpha$, $\beta_1$, $\beta_2$, and $\beta_3$, are the parameters to be estimated and $\varepsilon$ represents the random error term that is assumed to be normally distributed with a mean of 0 and a constant standard deviation.

## 4. Findings

The data was collected from the Palestinian Central Bureau of Statistics for the period from 1998 to 2015 for the water supply. Meanwhile, the data regarding the GDP per capita, value-added from the agricultural, mining, manufacturing, and service sectors covered the period from 1994 to 2016. The Eviews and Statistical Analysis Systems (SAS) software were used to perform the different statistical analyses.

Descriptive statistics regarding the data utilized is shown in Table 6. Accordingly, annual average quantity of the ground water (GW) which is pumped is 233.54 million meters cube, while this amount is quite low for spring water (SW: 37.42 million meters cube) and purchased water (PW: 54.20 million meters cube) during the 1998-2018 period. Moreover, real GDP (RGDP) is seen as 9,544.57 million USD for the 1998-2018 period in average and the average value added from the agriculture and fishing (AGF) is 533.49 million USD. Hence as seen, while AGF makes an important contribution and has a big share in the RGDP during the 1998-2018 period (Table 6).

**Table 6:** Descriptive Statistics

| | **GW** | **SW** | **PW** | **RGDP** | **AGF** |
|---|---|---|---|---|---|
| **Mean** | 233.5389 | 37.41905 | 54.20476 | 9544.566 | 533.4919 |
| **Median** | 242.6000 | 36.40000 | 52.70000 | 8556.857 | 508.9745 |
| **Maximum** | 274.2000 | 64.20000 | 85.70000 | 13810.30 | 842.1312 |
| **Minimum** | 181.2000 | 21.40000 | 36.50000 | 5649.354 | 390.1806 |

| | | | | | |
|---|---|---|---|---|---|
| **Std. Dev.** | 26.37874 | 12.82952 | 15.57971 | 2719.820 | 128.2570 |
| **Skewness** | -0.431463 | 0.655272 | 0.650744 | 0.278521 | 1.231410 |
| **Kurtosis** | 2.167270 | 2.245200 | 2.324229 | 1.556777 | 3.683831 |
| | | | | | |
| **Jarque-Bera** | 1.078562 | 2.001343 | 1.881719 | 2.094040 | 5.716472 |
| **Probability** | 0.583167 | 0.367633 | 0.390292 | 0.350982 | 0.057370 |
| | | | | | |
| **Sum** | 4203.700 | 785.8000 | 1138.300 | 200435.9 | 11203.33 |
| **Sum Sq. Dev.** | 11829.24 | 3291.932 | 4854.550 | 1.48E+08 | 328997.1 |
| | | | | | |
| **Observations** | 18 | 21 | 21 | 21 | 21 |

The correlation coefficients and the significance levels between the variables are shown in Table 7. Accordingly, there are negative correlation between all the water sources (GW, PW, SW) and AGF. However this interaction is not strong and statistically significant. Moreover, considering the correlation between the three water sources it is seen that there is a positive, strong and statistically significant correlation between the purchased water (PW) and ground water (GW). The correlation is between purchased water (PW) and spring water (SW) is also statistically significant but it is negative and not that strong as those of PW and GW.

**Table 7:** Correlation Coefficients

| | AGF | GW | PW | SW |
|---|---|---|---|---|
| **AGF** | 1.000000 | | | |
| **GW** | -0.268930 | 1.000000 | | |
| **PW** | -0.387377 | 0.882601* | 1.000000 | |
| **SW** | -0.276614 | -0.327313 | -0.494026** | 1.000000 |
| *, and ** indicates the significance levels at 1% and 5% respectively. | | | | |

As the next step, the unit root test is conducted in order to determine whether the variables are stationary or non-stationary at the first difference. Hence, the null and alternative hypotheses are set as below:

$H_o$: The related variable has a unit root

$H_A$: The related variable has no unit root

Considering the significance levels, all the variables are stationary at I(1), at the first difference (Table 8).

**Table 8:** Augmented Dickey-Fuller (ADF) Test Findings

| Variable | Stationary Level | Intercept | | | Intercept & Trend | | | None | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *Test Statistics* | *Critical Value* | | *Test Statistics* | *Critical Value* | | *Test Statistics* | *Critical Value* | |
| GW | I(1) | -5.245004 | %1 | -4.004425 | -3.015267 | %1 | -5.295384 | -4.179360 | %1 | -2.740613 |
| | | | %5 | -3.098896 | | %5 | -4.008157 | | %5 | -1.968430 |
| | | | %10 | -2.690439 | | %10 | -3.460791 | | %10 | -1.604392 |
| SW | I(1) | -4.317742 | %1 | -3.959148 | -4.051639 | %1 | -4.728363 | -6.661969 | %1 | -2.692358 |
| | | | %5 | -3.081002 | | %5 | -3.759743 | | %5 | -1.960171 |
| | | | %10 | -2.681330 | | %10 | -3.324976 | | %10 | -1.607051 |
| PW | I(1) | -3.592046 | %1 | -3.831511 | -3.940261 | %1 | -4.532598 | -2.420130 | %1 | -2.692358 |
| | | | %5 | -3.029970 | | %5 | -3.673616 | | %5 | -1.960171 |
| | | | %10 | -2.655194 | | %10 | -3.277364 | | %10 | -1.607051 |
| AGF | I(1) | -3.182535 | %1 | -3.831511 | -3.364779 | %1 | -4.532598 | -3.078757 | %1 | -2.692358 |
| | | | %5 | -3.029970 | | %5 | -3.673616 | | %5 | -1.960171 |
| | | | %10 | -2.655194 | | %10 | -3.277364 | | %10 | -1.607051 |

As the variables are stationary at I(1) level, Johansen cointegration test is applied in order to determine whether there is any long run equilibrium relationship between the variables. Within the frame of the analysis, existence of bivariate cointegration between AGF and GW, SW, and PW is investigated respectively. Before conducting the cointegration test VAR estimation is utilized for detecting the proper lag length. According to the findings, 1 lag is the optimal. Findings are summarized in Table 9. According to the findings there is no cointegration between the AGF and the variables except the SW. There is only one cointegration relationship between the AGF and SW at 10% significance level.

**Table 9:** Bivariate Johansen Cointegration Test Findings for the AGF

| **Unrestricted Cointegration Rank Test (Trace) for GW** | | | | |
|---|---|---|---|---|
| Hypothesized | | Trace | 0.05 | |
| No. of CE(s) | Eigenvalue | Statistic | Critical Value | Prob.** |
| None | 0.281335 | 6.394756 | 15.49471 | 0.6489 |
| At most 1 | 0.118745 | 1.769722 | 3.841466 | 0.1834 |
| **Unrestricted Cointegration Rank Test (Maximum Eigenvalue) for GW** | | | | |
| Hypothesized | | Max-Eigen | 0.05 | |
| No. of CE(s) | Eigenvalue | Statistic | Critical Value | Prob.** |
| None | 0.281335 | 4.625033 | 14.26460 | 0.7882 |
| At most 1 | 0.118745 | 1.769722 | 3.841466 | 0.1834 |
| | | | | |
| **Unrestricted Cointegration Rank Test (Trace) for SW** | | | | |
| Hypothesized | | Trace | 0.05 | |
| No. of CE(s) | Eigenvalue | Statistic | Critical Value | Prob.** |
| None | 0.418496 | 13.15436 | 15.49471 | 0.1093 |
| At most 1 | 0.139461 | 2.853737 | 3.841466 | 0.0912 |
| **Unrestricted Cointegration Rank Test (Maximum Eigenvalue) for SW** | | | | |
| Hypothesized | | Max-Eigen | 0.05 | |
| No. of CE(s) | Eigenvalue | Statistic | Critical Value | Prob.** |
| None | 0.418496 | 10.30062 | 14.26460 | 0.1929 |
| At most 1 | 0.139461 | 2.853737 | 3.841466 | 0.0912 |
| | | | | |
| **Unrestricted Cointegration Rank Test (Trace) for PW** | | | | |
| Hypothesized | | Trace | 0.05 | |
| No. of CE(s) | Eigenvalue | Statistic | Critical Value | Prob.** |
| None | 0.438141 | 11.98877 | 15.49471 | 0.1575 |
| At most 1 | 0.053026 | 1.035181 | 3.841466 | 0.3089 |
| **Unrestricted Cointegration Rank Test (Maximum Eigenvalue) for PW** | | | | |
| Hypothesized | | Max-Eigen | 0.05 | |
| No. of CE(s) | Eigenvalue | Statistic | Critical Value | Prob.** |
| None | 0.438141 | 10.95359 | 14.26460 | 0.1566 |
| At most 1 | 0.053026 | 1.035181 | 3.841466 | 0.3089 |
| Trace test indicates no cointegration at the 0.05 level | | | | |
| Max-eigenvalue test indicates no cointegration at the 0.05 level | | | | |
| * denotes rejection of the hypothesis at the 0.05 level | | | | |
| **MacKinnon-Haug-Michelis (1999) p-values | | | | |

Finally, Fully Modified Least Squares (FMOLS) is conducted in order to analyze the relationship between the variables. Since there is found only one cointegration relationship between AGF and SW, the FMOLS is conducted on only these two variables (Table 10). Findings indicate that change in SW negatively affects change in agriculture and fishing. However this effect is not statistically significant. Besides, this model has an $R^2$ of 0.0159, thus only 1.59% of the variations in the AGF are explained by the model (Table 10).

**Table 10:** FMOLS Findings for the log(AGF) as Dependent Variable

| **Variable** | **Coefficient** | **Std. Error** | **t-Statistic** | **Prob.** |
|---|---|---|---|---|
| LOG(SW) | -0.019351 | 0.199721 | -0.096888 | 0.9239 |
| C | 6.290093 | 0.709413 | 8.866610 | 0.0000 |
| | | | | |
| **R-squared** | 0.015919 | **Mean dependent var** | | 6.231136 |
| **Adjusted R-squared** | -0.038752 | **S.D. dependent var** | | 0.194547 |
| **S.E. of regression** | 0.198281 | **Sum squared resid** | | 0.707677 |
| **Long-run variance** | 0.073010 | | | |

The time series analysis had indicated that there is statistically significant relationship between the agricultural sector and all of the sources of water. Meanwhile, there was a cointegration relationship only between the agricultural sector and the spring water at 10% significance level. This relationship is due to the simple fact that the values of both of these variables had decreased over time (Table 10).

## 5. Conclusion

Our time series analysis had indicated that spring water was the only relevant variable to the agriculture sector. However, there was a negative cause and effect relationship between the spring water and the value added for the agricultural sector. This indicates that it's not feasible for Palestinian farmers to use the spring water in order to increase their production in the agricultural sector. Thus using spring water in the agricultural sector is decreasing the value added to the GDP from the agricultural sector. This might be due to the fact that extracting spring water and transporting it to the farmers is costly and thus using it for agriculture makes farmers loose instead of gain. However, since the finding is not statistically significant, findings require cautious interpretation.

Meanwhile, groundwater and purchased water from the Israeli company Macarot, were not relevant to the agricultural sector. Because according to the Israeli military rule, Palestinians are not allowed to use ground water, as it is controlled by the Israeli authorities. According to the Oslo agreement, Palestinians are even not allowed to dig to extract groundwater. Thus the Palestinian government has no control in any way or shape over the groundwater. Therefore the ground water is not relevant to the increase or decrease in the value added of the agricultural sector. We conclude that ground water is not playing the role that it should be in increasing the value added from the agricultural sector. Thus Israel must give total control of the water resources to the Palestinian authority in order for water to contribute positively to the production of the Palestinian agricultural sector.

In addition, our paper had demonstrated that the agricultural sector had decreased, although the population had approximately doubled from 1998 to 2018. Thus the decrease in the agricultural sector did not result in a decrease in the demand for water. This is because the decrease in the demand for water due to the decrease in the agricultural sector was compensated by an increase in the population. The share of water for the Palestinians had more or less remained constant. The decreases in the amount of water extracted from the springs were compensated by an increase in the amount of water purchased from the Israeli water company. As a result, the Palestinian increase in population did not lead to economic growth through an expansion in the agricultural sector. This is due to the fierce competition from the Israeli farmers and the shortage of land in the Palestinian Territories.

We conclude that the Palestinian Authority should try and pressure the Israeli government to take total control of the ground water in order to invest in the agricultural sector as to achieve economic growth. However, water is not achieving economic growth in Palestine due to a shrinking agricultural sector. The reasons for this are the high cost of production especially the high labor costs; the high costs of living that are forcing the Palestinians to leave their farms and seek employment elsewhere; the capital scarcity imposing a constraint on the farmers; high competition from the subsidized Israeli farmers; unfair laws that allow the subsidized Israeli products in the Palestinian markets, meanwhile restricting Palestinian products to enter Israeli markets; and finally the lack of sufficient research that will aid the Palestinian farmers in becoming more productive and efficient.

We conclude, that it is worthwhile to invest in the agricultural sector in order to achieve economic growth, however, the current share of water will not be sufficient for both the future population increase and a growing agricultural sector. This is why more pressure should be placed on Israel from the international community to ensure the total control over groundwater, increase the Palestinian water share, and provide a more sustainable and fair allocation of water in order to enhance the region's socioeconomic conditions.

Comparing the findings of this study with the literature examined above, it is seen that the studies determined significant relationships between water, natural sources and economic growth. Despite it is statistically insignificant the negative relationship found in this study is similar to those of Haseeb et al. (2020) for India. The cointegration test findings are also similar to those of Grabara et al. (2021) considering the significant cointegration finding for the spring water. However, since access of Palestinian territories to water is limited and under control the research subject and findings need special attention and prevent us making clear comments. Hence, the subject and findings of this study need more support by further research. The subject is open to be examined by more sophisticated methods and more amount of and various data considering longer span of time and focusing on various sources of water. Moreover, new research can focus on how the limited water sources can be increased and used productively in terms of its potential contribution to economic growth and especially agriculture sector in Palestine.

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