



AMERICAN JOURNAL OF MULTIDISCIPLINARY RESEARCH AND INNOVATION (AJMRI)

ISSN: 2158-8155 (ONLINE), 2832-4854 (PRINT)

VOLUME 2 ISSUE 3 (2023)



PUBLISHED BY
E-PALLI PUBLISHERS, DELAWARE, USA

Climate Change Implication on Palestine: A Case Study Jenin Governorate

Eyad Yaqoub Yaqob^{1*}

Article Information

Received: March 24, 2023

Accepted: April 14, 2023

Published: May 22, 2023

Keywords

*Climate Change, Climate
Variability, Adaptation,
Resilience*

ABSTRACT

Climate change negatively affects sustainable development in Palestine, especially Jenin Governorate, which is the food basket for Palestine. This study identified climate change variables in Jenin Governorate for more than 100 years, especially temperatures and precipitation, derived from historical data to study the manifestations of climate change and its impact on water re-sources and the agricultural sector. The impact of climate change on groundwater wells is an un-derstatement. The majority of Jenin's water wells, which number about 66 (including 22 agricul-tural wells), are located in the northeastern basin. By analyzing the data for the average annual total recharge of this basin, it was evident that the recharge had decreased from about 151 million cubic meters/year from 1976-1992 to about 134 million cubic meters/year during 1993-2009. (about 11.3%). This is because of the general solid decrease in rainfall in the Jenin area due to the effects of climate change. The decrease in recharge, coupled with increased groundwater pump-ing, has drained the reservoir stock and deteriorated the groundwater quality. The other source of water in Jenin Governorate is springs. Jenin Governorate has 42 streams largely used for small-scale agricultural and household needs. The research showed that the discharge of the springs increases from 2014 to 2020 (average discharge 0.48 MCM/yr.) compared to the period 2001 to 2011 (average discharge 0.48 MCM/yr.). years due to the increase in the amounts of discharge from the springs and the start of relying on them more, as Jenin governorate is facing water scarcity recently. In the future, climate change will considerably impact water resources, altering surface and underground water supplies for residential and commercial purposes, irriga-tion, in-stream ecosystems, and aquatic leisure.

INTRODUCTION

Global warming is already affecting the earth's climate, according to the Intergovernmental Panel on Cli-mate Change. Its impacts are felt in all sectors of society, through changes in temperature and precipita-tion as well as through changes in the frequency and intensity of climatic extreme events (Ana, I., Ra-oudha, M., Marta, M. and Sonia, Q. 2010). Climate change is anticipated to impede ongoing development in Palestine, especially the Jenin district, in several crucial sectors like agriculture and food security, wa-ter resources, coastal zones, public health, climate-related catastrophe risk management, and natural re-source management. As a result, climate change will limit the Palestinian government's capacity to achieve poverty reduction and sustainable development goals.

Climate change will exacerbate the global hydrological cycle, with significant implications for local water supplies, including surface and groundwater supply for residential and commercial use, irrigation, in-stream ecosystems, and water-based leisure. (Dai, A., and Trenberth, KE. (2004). Changes in the total amount of precipitation and its frequency and intensity directly affect the magnitude and timing of runoff and the intensity of floods and droughts (IPCC 2007). Climate change is expected to have a considerable impact on global agricultural conditions like temperature and precipitation. (Dai, A., Trenberth, KE. and Qian, T. (2004). Climate change is expected to have a considerable impact on global agricultural condi-tions like temperature and precipitation. Agriculture is still

heavily reliant on the weather because heat, sunlight, and water are the primary drivers of agricultural development. While certain parts of climate change may be beneficial, such as extending the growing season and hot weather, it will also have several negative consequences, such as lower water availability and more severe weather events. These effects may put agricultural activities in danger, especially at the level of land ownership owners and farm hold-ings. (Goldshtof, I. and Shaliv, G. (1979). The State of Palestine is located on the southwest tip of the Asian continent, in the eastern basin of the Mediterranean Sea. The country lies at a latitude between 29° and 33° north of the Equator, 97.6% of which is land and 2.4% of which is marine (Sea of Galilee and the Dead Sea). The rainfall regime is the most important aspect of Palestine's weather that must be studied.

Variations in rainfall regimes, such as yearly amount, amount of rain periods, seasonal distribution, intensity, and timings, all have a significant impact on the country's water supplies.

Palestine a wide range of ecosystems, from the humid Mediterranean coast to the arid desert, are vulnera-ble to climate change. As temperatures increase, conditions become drier and storms become stronger, critical resources will become more vulnerable (Guttman, J. and Tzukerman, H. (1995). Climate change will have an impact on almost every sector of the Palestinian economy, but one of the most significant casualties will be water supply and quality. First, freshwater resources –

¹ Centre of Excellence for Climate Change, Arab American University, Palestine

* Corresponding author's e-mail: eyad.yaqoub@aaup.edu

surface and groundwater – will become scarcer as rainfall decreases (Trenberth KE, Fasullo J (2007). This will make replenishing aquifers more difficult during periods of rapid population increase, while also competitive pressures for water from Palestinian agriculture, illegitimate Israeli colonies, and industry. Decreased rainfall will also cause water extraction more expensive and energy intensive. With the scarcity of treatment facilities, warm temperatures and more silt may endanger the quality of drinking water. Second, because climate change raises the probability of severe, short-term rainfall rather than an extended rainy season, flash floods are more likely.

The current infrastructure in the OPT is incapable of handling significant rains, which could result in drowning in urban areas due to poor sewer and drainage systems. Increases in worldwide ocean and atmosphere temperature, increasing worldwide sea levels, long-term maintained widespread reductions in the amount of ice and snow cover, and changes in atmospheric and ocean circulation, as well as regional weather patterns, have all been noticed over the twentieth century (Gu., G., Adler, RF, Huffman, GJ, and Curtis, S.) (2007).

These shifts occur because of excessive temperatures in the climate system as a result of the addition of greenhouse gases to the atmosphere. Human activities are the primary source of these additional greenhouse gases. While the weather might change in a couple of hours, the environment changes over time. Climate change is characterized by an important change in typical weather patterns, such as growing warmer, wetter, or drier over many years or even decades. This study would

identify the climate change variables in Jenin district for more than 100 years especially temperatures and rainfall derived from observed, historical data to show if there is an existence of climate change. There has been a large decrease in rainfall and a noteworthy increase in temperature over this time frame. Extreme weather conditions, such as increased droughts or severe rainfall leading to floodwaters, may harm the agriculture industry, impacting both cool and heat-sensitive crops. (Isaac, J. *et al.* (1995).

METHODOLOGY

The descriptive and analytical approach was used, by collecting data from official bodies, papers published in journals, and books or papers presented at conferences. Previous literature review studies.

Data Collection

Data were collected from the official Palestinian and Israeli meteorological websites, reports issued by the Water Authority and the Ministry of Agriculture, and interviews with specialists.

Data Analysis Method

The survey data will be analyzed by Statistical Package for Social Sciences (SPSS 20), GIS, and Excel.

Study Area

Jenin is located in a temperate zone which is between 23.5° and 66.5° as the latitude is one of the climate change factors (Ministry of Local Government, 2018).

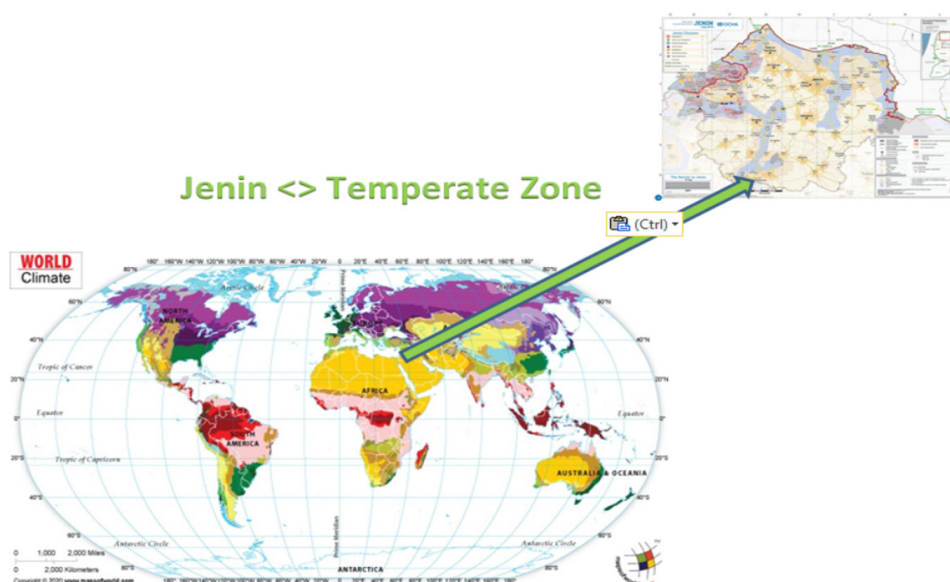


Figure 1: Latitude of Jenin District

Elevation

Jenin has a highest point is 750m above sea level at Jabel Hureish, 3.5 Km east of the Jaba'a village, while the lowest elevation is 90m above sea level at El Mukhabba

area, south of Muqabila village at the Israeli border. A Digital elevation model (DEM) with a pixel size of 100m was created for the Jenin district as shown in figure 2.

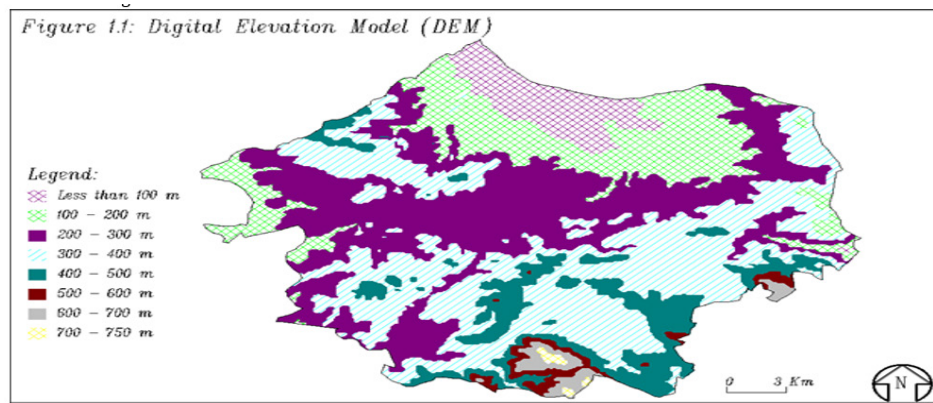


Figure 2: DEM of Jenin District, which is themed using the threshold table with an interval of 100m

Topography

The Jenin district's topography is separated into three sections: eastern hills, mountain crests, and western cliffs. Between the Jordan Valley and the middle mountain lie the eastern slopes. They are distinguished by steep slopes that lead to the formation of juvenile wadis. The

watershed line is formed by mountain peaks that split the eastern and western slopes.

The average elevation is 500 to 650 meters above sea lev-el. The western slopes, which have mild slopes, have elevations ranging from 100 to 400 meters above sea level as shown in figure 3.

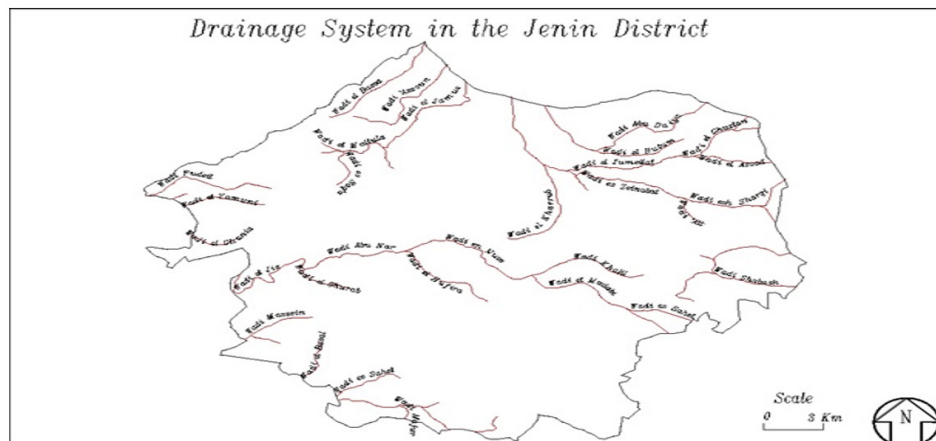


Figure 3: Drainage System in Jenin District

RESULTS

Observed Annual Mean Temperature 1901-2021

Statistics should be used to establish a good grasp of the existing climate conditions in Jenin in order to understand anticipated climate change and future climate scenarios.

An observed temperature would be used in this analysis, these observed data is taken from the climate knowledge portal world bank for over the last 100 years as shown in figure 4 and 5. These curves represent the annual mean temperature in Jenin over 100 years, from 1901 to 2021.

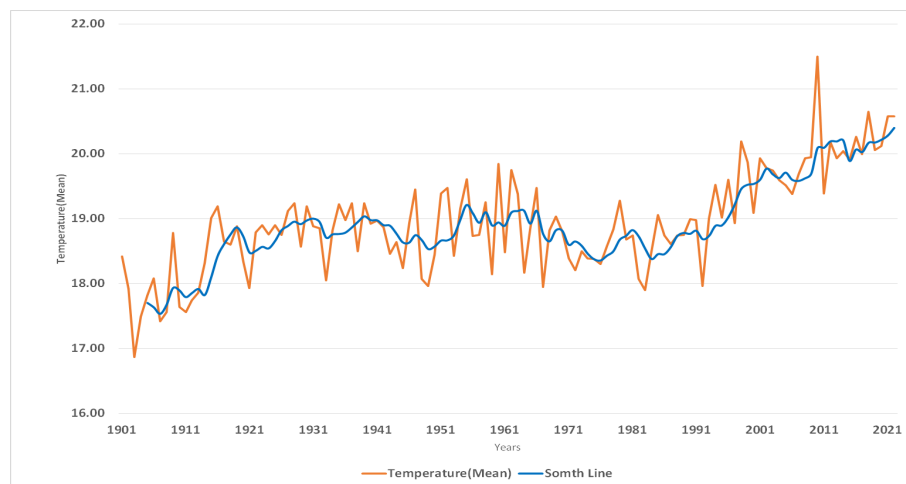


Figure 4: Observed Annual Mean-Temperature 1901-2021, Jenin

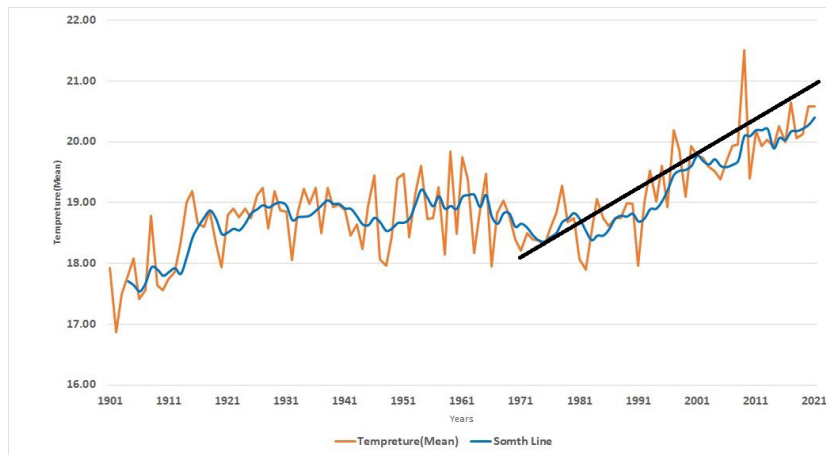


Figure 5: Observed Annual Mean-Temperature

The curve shows the natural variability in temperature from 1901 to 1970, but after 1970, it shows an accelerating increase in temperature, not just mean readings, but also an increase in magnitude and frequency. This led to a result that this is due to climate change which mainly happened due to human interventions, especially after the industrial revolution. In addition, we can notice the increase in mean temperatures of around 2 Celsius within 100 years.

Observed Annual Max., Min, and Mean-Temperature 1901-2021, Jenin

In order to check the variation in also maximum and minimum temperature, temperature data is being analyzed. All the data, maximum temperature, minimum temperature, and mean temperature is observed data. The minimum temperature is usually measured from eight mornings to the next day eight mornings. On the other hand, the maximum temperature is usually measured from

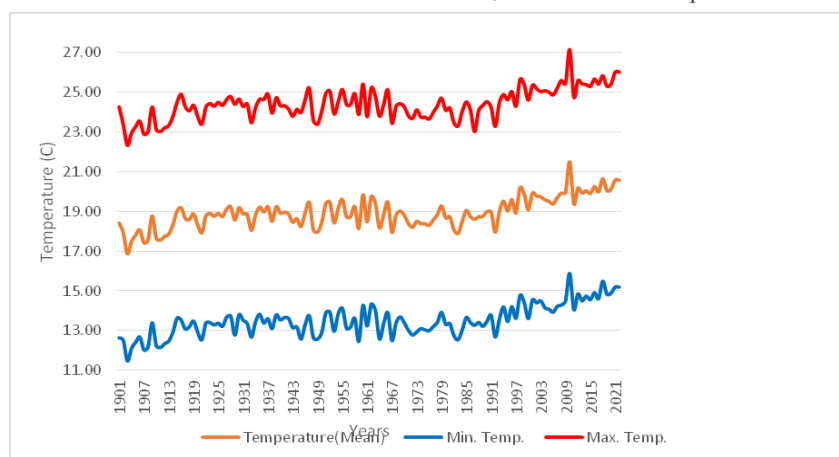


Figure 6: Observed Annual Max., Min, and Mean-Temperature

eight evening to the next day eight evening. The mean temperature usually measured every eight hours a day, then take the observation average as shown in figure 6. The figure shows the observed annual maximum,

minimum, and mean temperature for Jenin. We can notice the consistency between the three curves, and the three of them are increasing at approximately the same rate as shown in figure 7.

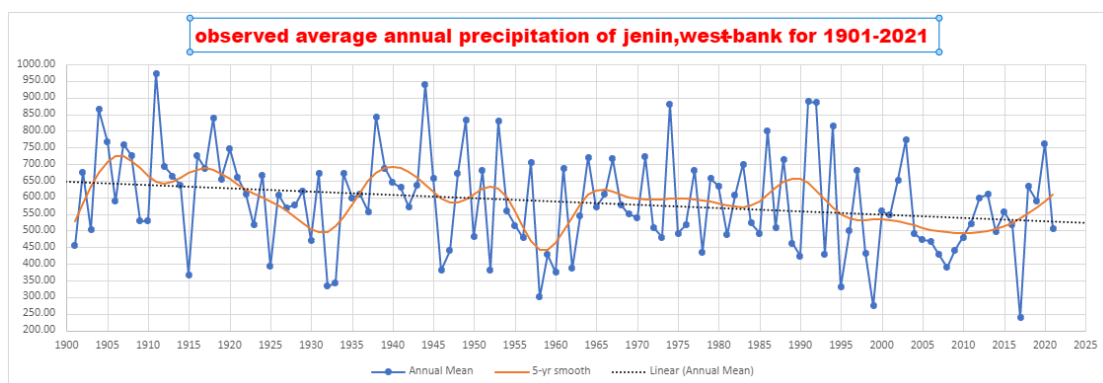


Figure 7: Observed annual average precipitations 1901-2021, Jenin

Observed Annual Precipitations 1901-2021, Jenin

As we can see in the graph, the average amount of rainfall in 1901 was 650 mm and nowadays in 2021 it reached 508 mm. This graph shows the annual difference, which is reduced annually by 1.42 mm, meaning 0.2%. Also,

we see that there are no big differences unless we study the state of rainfall in the long run. So the decrease in precipitation is a result of climate change (Ministry of Agriculture, Agricultural Extension Strategy 2014-2018, 2014) as shown in figure 8 and 9.

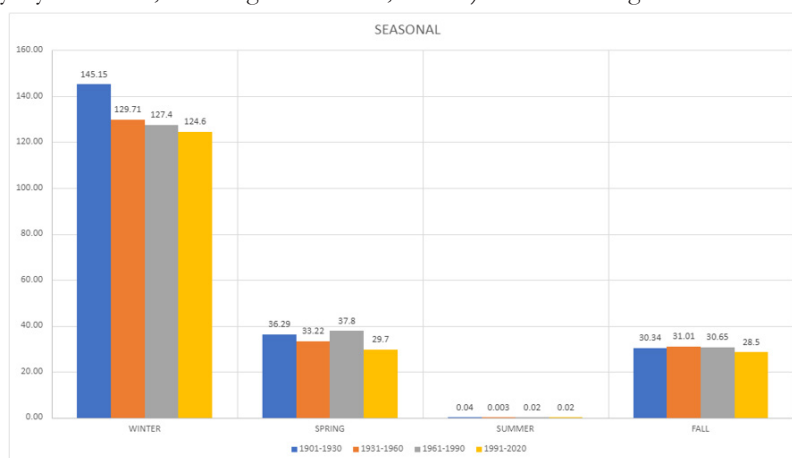


Figure 8: Observed seasonal precipitations 1901-2021, Jenin

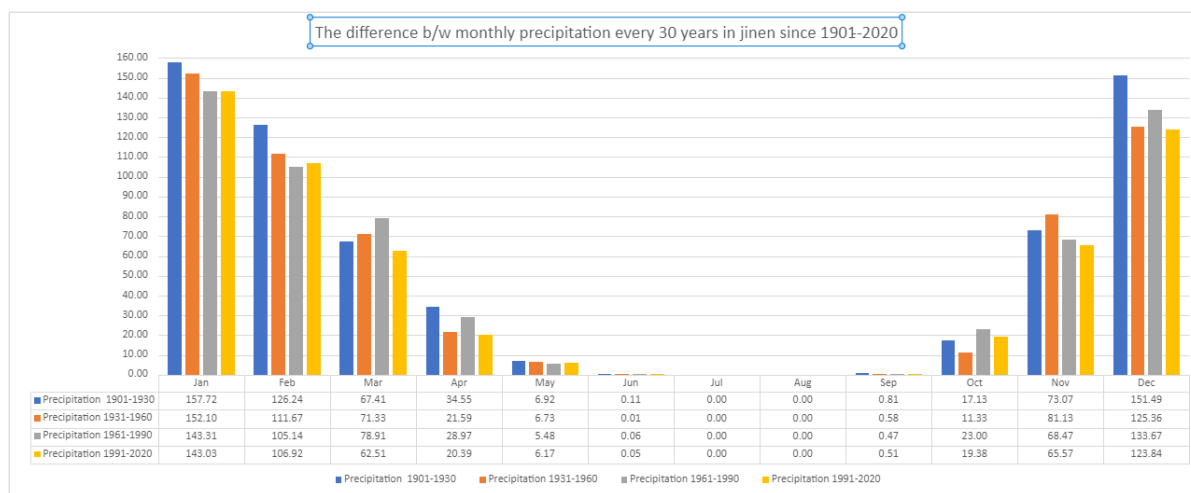


Figure 9: monthly precipitation every 30 years 1901-2021, Jenin

Observed Seasonal Precipitations 1901-2021, Jenin

There is a clear difference between the amount of rainfall in the winter of 1901-1931 and the winter of 1991-2020 where it decreased from 145.15 mm to 124.6 mm. The difference between the amount of rain-fall in the spring of 1901-1931 and the spring of 1991-2020 decreased from 36.29 mm to 29.7 mm.

The difference between the amount of rainfall in the summer of 1901-1931 and the summer of 1991-2020 where decreased from 0.04 mm to 0.02 mm. The difference between the amount of rainfall in the autumn of 1901-1931 and the autumn of 1991-2020 where decreased from 30.34 mm to 28.5 mm.

Groundwater and Time-Phased Discharge Quantities

Amount of groundwater and time-phased discharge: The primary water supply in Jenin is groundwater, which is provided by both wells and springs. The Jenin district has 66 wells that are used for farming as well as domestic purposes. The Palestinian private sector owns 58 of these

wells, which are utilized for ir-rigation. The remaining five wells are public, either owned by Palestinian municipalities (Jenin and Ya'bad municipal wells) or by the Israeli Mekorot water business (Arraba, Qabatiya, and Sanur wells) and utilized for household purposes (PCBS) (2019). Apart from the Jenin municipality well, all irrigation wells are tapping the Eocene shallow watershed, whereas domestic wells are tapping the Upper Cenomanian aq-uifer.

Jenin is located in the North Easter basin which is the section of the broader Mountain Aquifer (which also includes the Western and Eastern Aquifers) with groundwater flowing predominantly north-northeast and emerging in numerous notable springs. The basin is a vital supply of clean water for the Palestinian people of Jenin. The recharge to the Northeast basin is calculated by application of empirical recharge Coefficients obtained in previous calibrations for less detailed models (Guttman and Tzukerman, 1995; Goldshtof and Shaliv, 1979) which could be an important indicator of how the impacts of

climate change effect on the recharge of groundwater. The figure below shows that there is a significant decrease in recharge which lead to reducing the flow of water wells including wells used for irrigation purposes as shown in figure 10.

The overall average refill to the basin has declined from roughly 151 mcm/year (around 11.3%) between 1976 and 1992 to about 134 mcm/year (around 11.3%) between 1993 and 2009.

This is owing to the over-all consistent reduction in

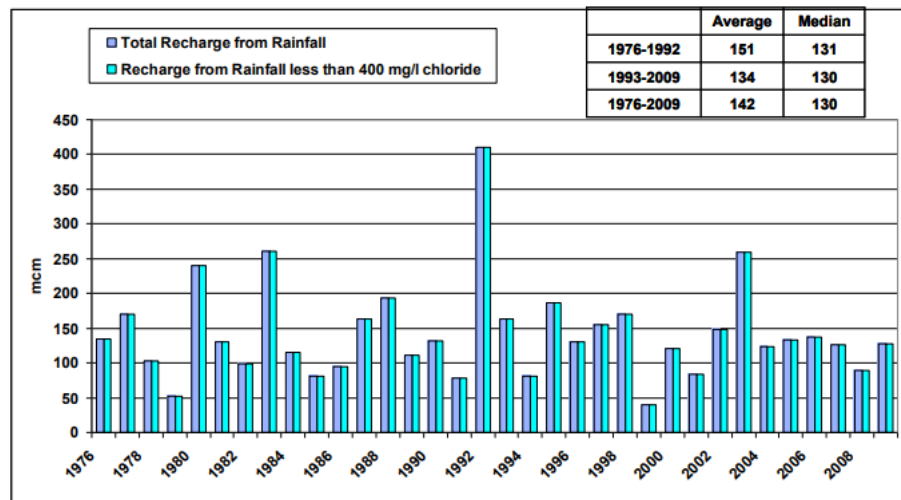


Figure 10: Annual average recharge from rainfall in the North East Basin

precipitation in Jenin District, as indicated in the rainfall statistics report for the last 30 years. Reduced recharge and increased groundwater pumping have depleted aquifer storage and worsened groundwater quality.

Springs

The Jenin district has 42 springs; however, the majority lose water from leakage, are irregular, and are vulnerable to the drought consequences of climate change. Springs

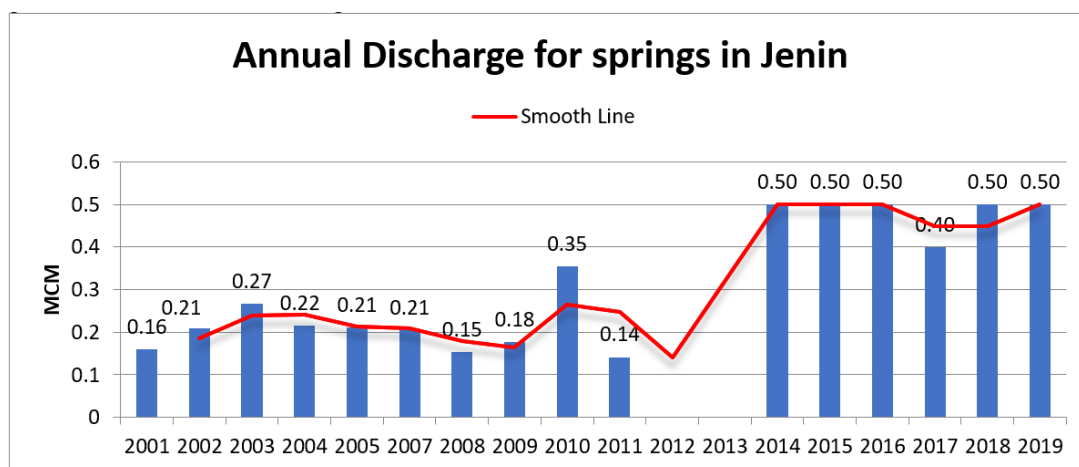


Fig 11: The Annual Discharge for springs in Jenin District

are often employed on a small scale for agricultural and home reasons. The West Bank Water Department (WBWD) monitors six springs with discharge rates greater than 0.1 l/sec. as shown in figure 11.

There are 42 springs in the Jenin district, but the majority loses water through seepage, is seasonal, and is subject to drought effects of climate change. Springs are often utilized on a small scale for agricultural and home reasons. The (Arab Organization for Agricultural Development, 2014). However, data from six springs which are monitored by the West Bank Water Department (WBWD) was analyzed (PCBS, 2002-2020). It is shown that the discharge of springs is increasing from 2014 to 2020 (the average dis-charge is 0.48 M CM/year) compared to

the period 2001 to 2011(the average discharge is 0.48 M CM/year). It could be happened because of the increase of discharge quantities from springs and the start of relying on them more as Jenin district faces water scarcity recently. Furthermore, the reliability of data should be checked and the number of discharge-controlled springs should be increased.

CONCLUSION

According to the observed average annual temperatures, during the past 120 years, the average annual temperature in Jenin Governorate increased by about two degrees Celsius, and the noticeable increase was between 1970 and 2021. The increase was similar between the maximum,

minimum, and average temperatures during the period. The results showed that the average annual rainfall during the same period decreased by 142 mm, or approximately 22%, meaning that the annual decrease amounted to 1.18 annually. Where the average precipitation in 1901 was 650 mm, while in 2021 it became 508 mm. The results also showed that the average annual rainfall in the northeast of the basin decreased by 11.3% during the period between 1976-2009, and therefore agricultural wells and drinking wells were affected by that. Because of the low level of groundwater wells, farmers and residents tended to use springs to compensate for the resulting shortage.

Palestine is affected by climate change and based on the results, it is expected that the increase in the year 2050 will reach about 3.2 degrees Celsius at the same time, rainfall is expected to decrease to 177.5, or a 27 percent decrease, and this threatens food security, biodiversity, and human presence in the region. Decision makers should work from now on developing strategic and practical plans to adapt to climate change.

Acknowledgments

The Orange Knowledge Program-Institutional Collaboration Project, OKP-ICP-PAA-103455, funded by the Netherlands' Ministry of Foreign Affairs and managed by Nuffic, is acknowledged for financial support of Dr. Iyad Yacoub for a short research visit at Wageningen University & Research, the Netherlands.

Author Contribution Statement

Eyad Y. Yaqoub contributed to the design and implementation of the research, to the analysis of the results, and the writing of the manuscript.

Data Availability Statement

All relevant data are included in the paper or its Supplementary Information.

Conflict of Interest

The authors declare there is no conflict.

Funding

This research was funded by The Orange Knowledge Program-Institutional Collaboration Project, OKP-ICP-PAA-103455, funded by the Netherlands' Ministry of Foreign Affairs and managed by Nuffic.

REFERENCE

Ana, I., Raoudha, M., Marta, M. and Sonia, Q. (2010). Towards adaptation of agriculture to climate change

- in the Mediterranean. *Springer* (Suppl 1), S159–S166.
- Dai, A., and Trenberth, K. E. (2004). The diurnal cycle and its depiction in the Community Climate System Model. *J Clim*, 17, 930–951.
- Dai, A., Trenberth, K.E. and Qian, T. (2004). A global dataset of Palmer drought severity index for 1870–2002: relationship with soil moisture and effects of surface warming. *J Hydrometeorology*, 5, 1117–1130.
- Guttman, J. and Tzukerman, H. (1995). Yarkon Taninim – Be'er Sheva Basin. Establishment and calibration of a water-flow and solute-transport model. Report of Tahal, 01/95/72, Tel Aviv, 32.
- Gu., G., Adler, R.F., Huffman, G.J. and Curtis, S. (2007). Tropical rainfall variability on interannual-to-interdecadal/longer-time scales derived from the GPCP monthly product. *J Clim*, 20, 4033–4046.
- Isaac, J. *et al.* (1995). Water Supply and Demand in Palestine: 1990 Baseline Estimates and Projections for 2000, 2010, and 2020, Up-dated Version, Applied Research Institute - Jerusalem and Harvard Institute for International Development for Harvard Middle East Water Project.
- Isaac, J. *et al.* (1995). What is the Worth of Water, Applied Research Institute- Jerusalem (ARIJ) and McMaster University.
- Jenin's Industrial and Agricultural Commerce Office. Jenin Agricultural Department (1994). Agricultural Statistical Records for the Jenin District, Jenin.
- Knowles, N., Dettinger, M. and Cayan, D. (2006). Trends in snowfall versus rainfall for the eastern United States. *J Clim*, 19, 4545–4559.
- Lobell, D. B., Burke, M. B., Tebaldi, C., Mastrandrea M. D., Falcon, W. D. and Naylor, R. L. (2008). Prioritizing climate change adaptation needs for food security in 2030. *Science*, 319(5863), 607–610.
- Ministry of Agriculture, Agricultural Extension Strategy 2014-2018, 2014. www.chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://ershad.moa.pna.ps/uploads/file/Extension%20Strategy/Extension%20Strategy%202016-2019.
- Palestinian Central Bureau of Statistics (PCBS) (2019). About Water Wells Statistics. Ramallah: Palestini-an Central Bureau of Statistic.
- The Arab Organization for Agricultural Development (2014). The Yearbook of Arab Agricultural Statistics, 34.
- Trenberth K.E., Fasullo J. (2007). Water and energy budgets of hurricanes and implications for climate change. *J Geophysics Res*, 112, D23107. <https://doi.org/10.1029/2006JD008304>.