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A Comparative Study of Water Data Across Israel, West Bank, and Jordan

Water Resources Action Project (WRAP)

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Introduction

Water is necessary for the long-term functioning of any society, as it provides for the basic needs of drinking, sanitation, and irrigation. In Israel, West Bank, and Jordan water is a scarce resource.[1] This region of the world experiences an arid climate where rainfall is scant and intermittent. Furthermore, the available water resources that do exist are deteriorating. Rivers are increasingly polluted and are losing much of their normal flow. As available water resources are diminishing, the demand for water is rising. Israel, West Bank, and Jordan are already ever-exploiting their water resources by 10-20%.[2] According to the United Nations Population Division, the current population estimates in Israel, West Bank, and Jordan (7.1, 6.2, and 2.4 million people, respectively) are expected to grow to 10.5, 10.1, and 10.3 million people, respectively, by 2050.[3] As a result, these three territories are going to have to search for alternative sources of water that do not draw upon conventional resources such as surface and groundwater.

While the water situation in Israel, West Bank, and Jordan may seem dire, there are groups within this region that are finding innovative and alternative mechanisms to supply water. The rain harvesting systems that the Water Resource Action Project (WRAP) sponsors, designs, and constructs are one of these mechanisms. The rain harvesting systems provide water to schools in underserved communities in Israel, West Bank, and Jordan that is not drawn from strained municipal resources. Rain harvesting systems are a proven and effective tool, providing schools with water to maintain adequate standards of sanitation. This report seeks to inform WRAP's efforts by looking at trends in climate and rainfall patterns, as well as water supply, usage, and infrastructure across Israel, Jordan and the West Bank. This information is intended to assist members, donors, and beneficiaries of WRAP in their understanding of the overarching issues that affect underserved communities in Israel, West Bank, and Jordan, while at the same time informing WRAP's decision-making process on project location and priority.

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[1] Jonathan Chenoweth, 2010, "Will the water resources of Israel, Palestine and Jordan remain sufficient to permit economic and social development for the foreseeable future?," *Water Policy* 13, no. 3.

[2] Jim Kundell, ed., 2012. "water profile for Jordan," in *The Encyclopedia of Earth*.

[3] Jonathan Chenoweth, 2010, "Will the water resources of Israel, Palestine and Jordan remain sufficient to permit economic and social development for the foreseeable future?," *Water Policy* 13, no. 3.

Climate and Rainfall

In order to analyze water availability and usage in Israel, West Bank, and Jordan, it is first important to understand climate. Climate is an important determent of water supply; influencing the ways countries manage their water resources. The climate in Israel, West Bank, and Jordan varies across the region. The northern and coastal regions of Israel and the western edge of Jordan are characterized by a Mediterranean climate with long, hot, dry summers and cool, rainy winters. In contrast, the West Bank, the southern and eastern regions of Israel, and the central and eastern regions of Jordan are characterized by an arid climate. These areas experience extended hot and dry seasons. The varied climate in this region results in temporal and spatial disparities in rainfall.

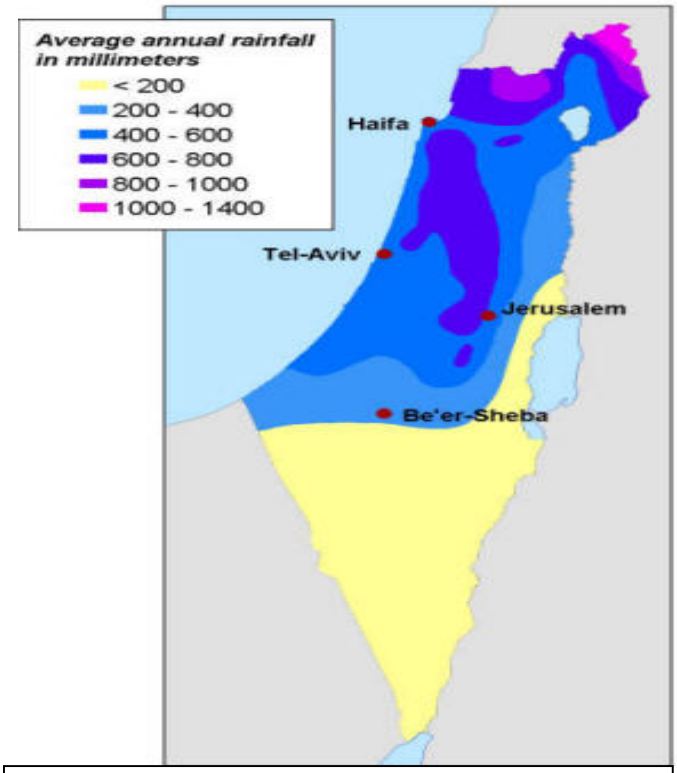

Fig. 1 Average Annual precipitation, 1961-1990 in Israel. Source: "Israel Water Context"

Similarly, rainfall patterns also differ across the region. Israel receives the most rain with an average annual rainfall of 429 mm.

In Jerusalem, on the border between the West Bank and Israel, the average annual rainfall was recorded to be 490.1 mm in 2012.[4] On the other hand, more than 90% of Jordan's territory receives a scant 200 mm or less of rainfall per year.[5] Cumulative statistics do not tell the entire story, however. For example, the northern and coastal regions of Israel receive rain, on average, 70 days each year as opposed to only a few days in parts of the southern region. Similarly, the northern regions in Israel receive close to twice as much rain as the wettest regions of the West Bank and Jordan (Figure 1 and 2).

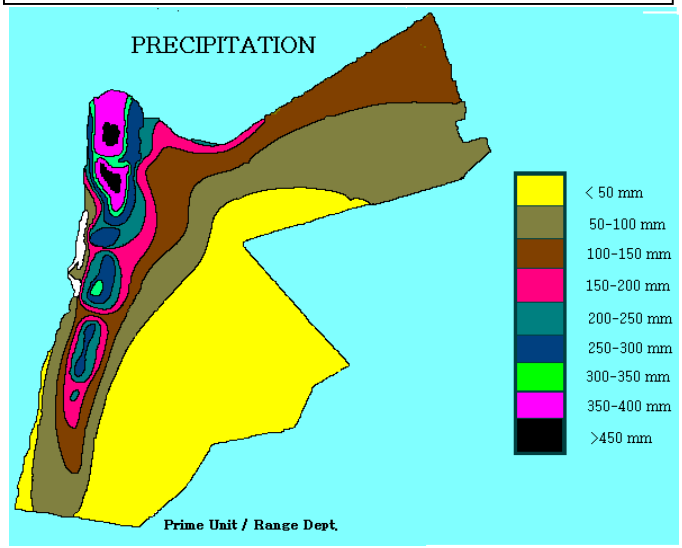

Fig 2. Average annual precipitation in Jordan. Source: fao.org

[4] Mathew Richard and Dr. Jad Issac, 2012, "Analysis of climatic variability and its environmental impacts across the occupied Palestinian territory," *Applied Research Institute - Jerusalem*. Water and Environmental Research Department: 11.

[5] Ali Ahmad Ghanem, 2013, "Case Study: Trends and Early Prediction of Rainfall in Jordan," *American Journal of Climate Change* 2.

While absolute amounts differ, the seasonality of rainfall across Israel, West Bank, and Jordan is very similar. Figures 3 and 4 illustrate that the rainy season starts in October and ends in May. Areas that depend heavily on rainwater as a source of water suffer the most during the dry summers (June-September). Some studies on the long-term annual rainfall trends have found that the rainy season is gradually shortening. In his study to identify trends in the rainfall regime over Israel between 1975 and 2010, Baruch Ziv discovered that the spring rainy season is shortening on average three days per decade.[6] A shortened rainy season over time will contribute to the distress of an already drought-stricken area.

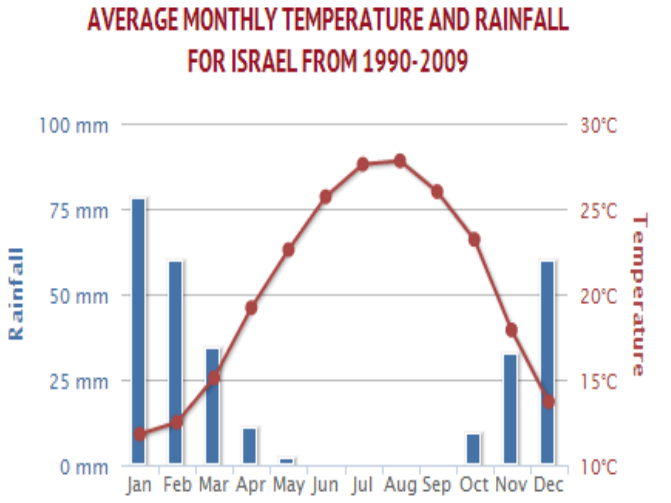

Fig. 3 Source: World Bank

Overall, long-term trends suggest that annual rainfall fluctuates. Figure 5 illustrates the variation in annual rainfall averaged over the region in Israel with >100mm of annual rainfall from the 1952-1953 rainy season to the 2009-2010 rainy season. The curve shows a negative linear trend of -0.1% and -0.5% per decade.[7] While the negative trend is small, it has made a significant impact. The Applied Research Institute has accumulated rainfall data in Jerusalem since 1845. It reports that, between 1845 and 2012, annual rainfall has decreased at an average rate of 1.4 mm – translating to a reduction of 233.8 mm in total annual rainfall since 1845. The steady decline has caused the landscape in Israel to become increasingly arid. If these trends continue, it will negatively impact the availability of surface and groundwater and the ability to collect water through rain harvesting systems.

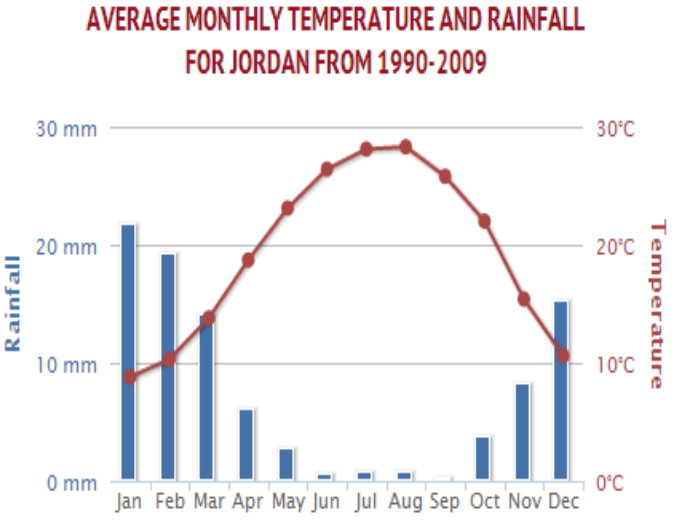

Fig. 4 Source: World Bank

[6] Baruch Ziv et al., 2013, "Trends in rainfall regime over Israel, 1975-2010, and their relationship to large-scale variability," *Regional Environmental Change* 13, no. 1: 1.
[7] Ibid., 5.

Water Supply

The primary sources of water in Israel, West Bank, and Jordan are a combination of surface water rivers and seas, groundwater reservoirs, and desalinization plants. Surface water accounts for 30% of Israel's supply, totaling 550 million m^3/year (MCM/yr).[8] Major sources of surface water include the Sea of Galilee and the Jordan River. However, the Jordan River has become polluted and has lost 90% of its normal flow (Belt). Israel also sits on a series of major aquifers, which yield 850 MCM/yr. Furthermore, Israel has initiated a major project to develop several large desalination plants with the capacity to supply approximately 500 MCM/yr by 2015.

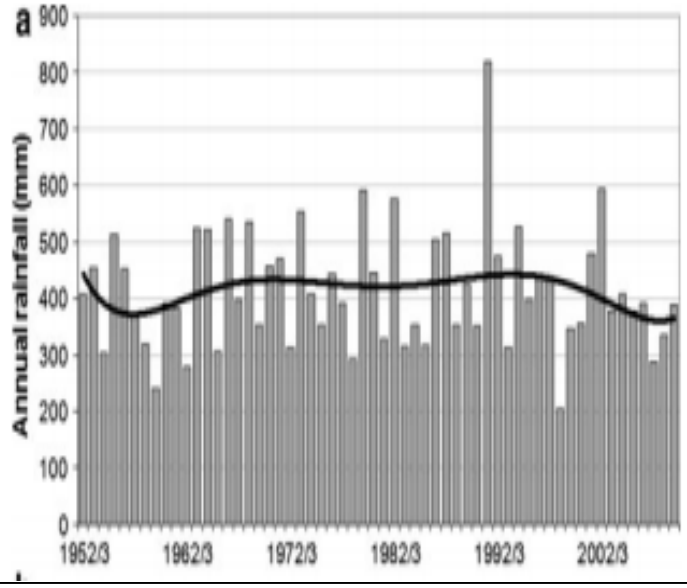

Fig. 5 Inter-annual variations of the annual rainfall averaged over the region with >100 mm, together with the linear trend (black) for the study period (1952-2009).

In Jordan, surface water accounts for 37% of total water supply and 400 MCM/yr. The Yarmouk River and the Dead Sea are the primary sources of surface water for Jordan. Like the Jordan River, the Yarmouk's flow has declined significantly, in part due to Syrian dam projects. Jordan also draws water from underground aquifers totaling 500 MCM/yr. Groundwater accounts for 54% of total water supply.[9] Also, Israel has made an agreement with Jordan, outlined in the 1994 peace treaty, to provide Jordan with an additional 215 MCM of water every year.

The West Bank primarily depends upon the Mountain Aquifer situated under the West Bank and Israel. In 2010, the West Bank withdrew under 98 MCM of water, which is less than 15% of the "estimated potential."[10] On the other hand, Israel overdraws by

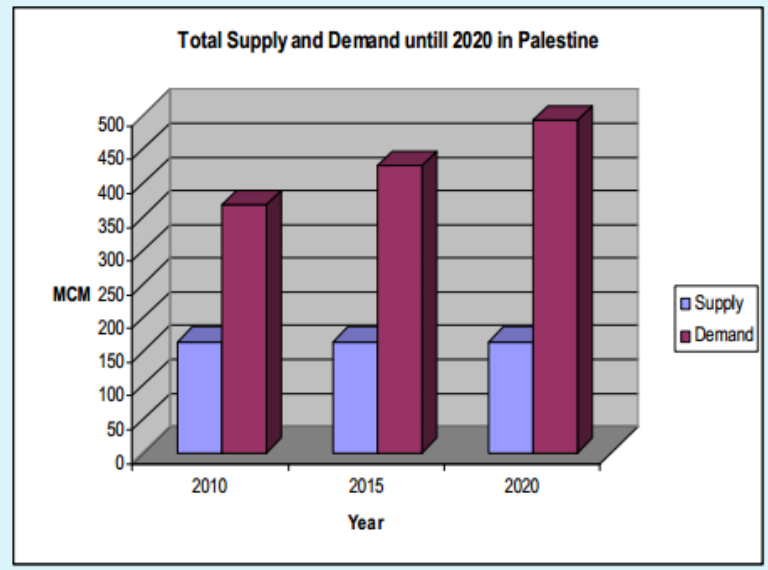

Fig. 6 Projected supply and demand between 2010 and 2020 in Palestine.

[8] EMWIS, 2008, "Israel Water Context," *Euro-Mediterranean Information System on know-how in the Water sector*.

[9] Jim Kundell, ed., 2012. "water profile for Jordan," in *The Encyclopedia of Earth*.

[10] Palestinian Water Authority, 2012, 8.

over 50% of the "estimated potential" annually. The West Bank's ability to extract water has been severely reduced due to Israel's control over available resources, restrictions on development of water projects, and drought.

Because the majority of Israel, West Bank, and Jordan exist in an arid climate and are experiencing a decline in both the amount of rainfall and the quality and quantity of water resources, this region struggles to find sufficient amounts of water to supply the demand. Figure 6 illustrates an uneven trend of a steady water supply and increasing demand over 10 years in Palestine. As the population grows, the West Bank will have to find ways to provide for the needs of its population. Figure 7 illustrates that water deficits exist in many of the West Bank's governorates (indicated by the red bars). In Java (the left-hand column) there is almost a 60% water deficit. Similarly, Figure 8 shows a water deficit of 638 MCM in 2007 in Jordan. Water is becoming increasingly scarce in this region of the world and Israel, West Bank, and Jordan will be forced to search for other water supply alternatives.

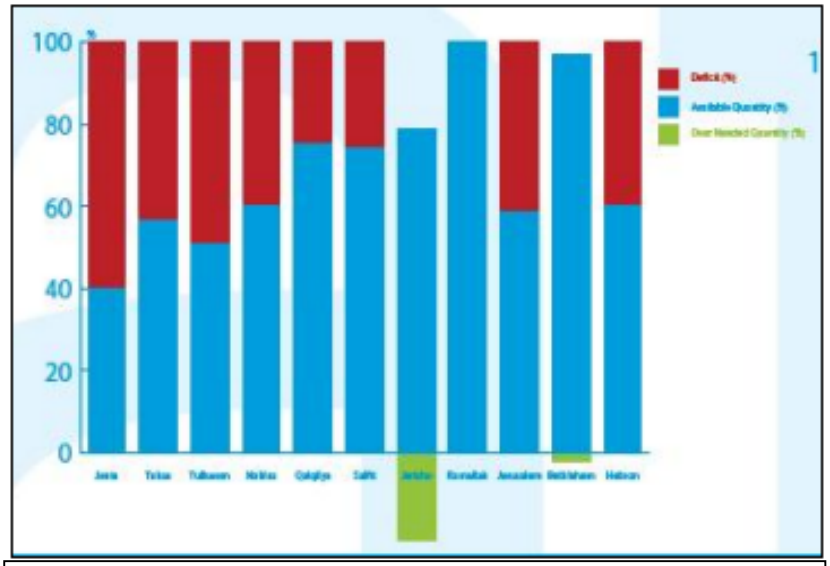

Fig. 7 Deficit quantities in meeting the needed amounts (for an average of 150 l/c/d) in the West Bank. Deficits are marked in red, available quantities in blue, and over needed quantities in green. Source: Palestinian Water Authority

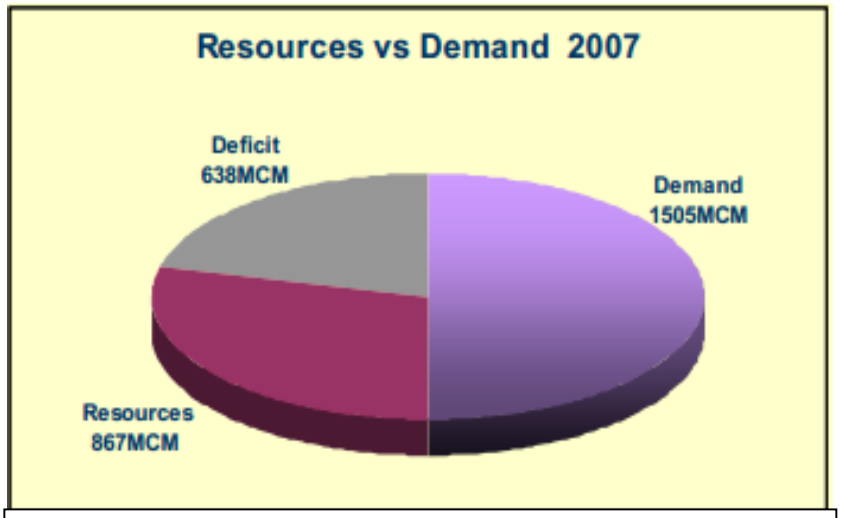

Fig. 8 Available water resources compared to demand and the resulting deficit in 2007 in Jordan. Source: "Water for Life"

Water Use

Israel, West Bank, and Jordan delegate the majority of their water to agriculture and irrigation. Figures 9 and 10 depict the amount of water allotted to various sectors. In Israel and Jordan, 48% and 64%, respectively, of the total water supply is provided to the agricultural sector, leaving 35% of the total water supply in Israel and 30% in Jordan for the domestic sector. Figure 11 compares the ways in which Israel, Jordan, and Palestine delegate their water for agricultural, domestic, and industrial purposes. Israel, with the largest water supply, delegates around 900 MCM/yr to the agricultural sector and about 600 MCM/yr to the domestic and industrial sectors. Jordan allots slightly over two-thirds of the amount Israel gives to the

agricultural sector and under half of the amount given to the domestic and industrial sectors. The amount of water Palestine has to give to the agricultural, domestic, and industrial sectors pales in comparison, with less than 100 MCM/yr allotted to the domestic and industrial sectors combined. With most of the region's water resources allocated to agricultural and domestic sectors, finding alternative sources of water in each of these sectors will have the greatest impact in preserving and extending water resources into the future.

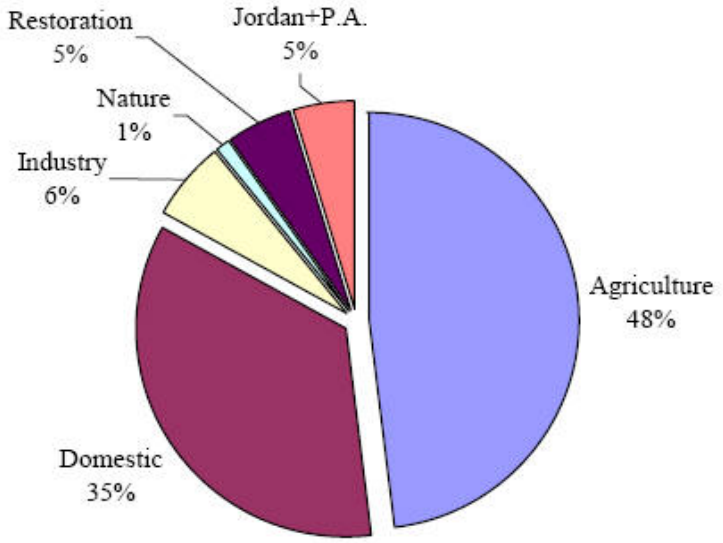

Fig. 9 Allocation of water resources of by sector in Israel. Source: "Israel Water Context"

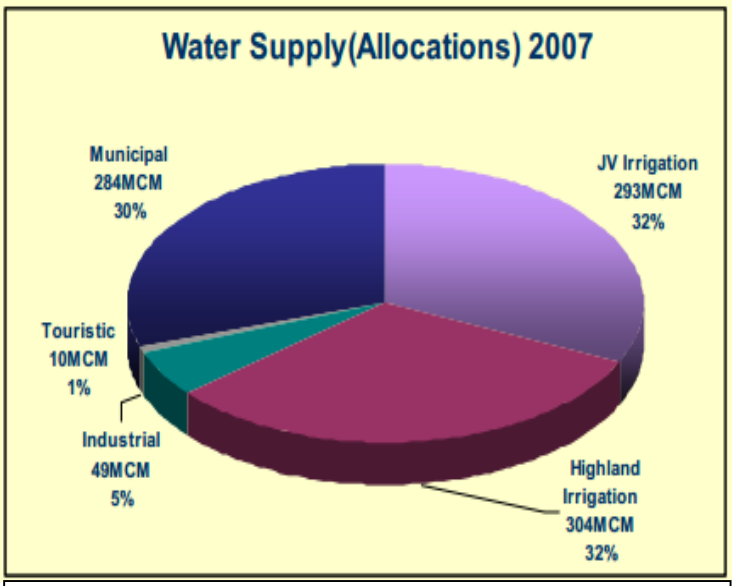

Fig. 10 Allocation of water resources by sector in Jordan. Source: "Water for Life"

Water Infrastructure

Israel, West Bank, and Jordan are developing new water infrastructure to better meet the needs of their people and to conserve water resources. In 2009, the national water company in Israel, Mekorot, embarked on a new project to construct a new National Water System. Mekorot invested NIS 2 billion in the project to develop a National Water Carrier that will take desalinated water from the Mediterranean Sea to the eastern and southern regions of the country. The old National Water Carrier system was not capable of supplying the water needs to Israeli citizens and primarily transported water from north to south instead of from west to east. The result today is that Israel has 31 desalination plants with the treatment capacity of about 1 MCM/day. Most Israeli residents drink desalinated water.[11] It must be noted, however, that desalinated water comes at a high price. The processes involved in water desalination are both energy intensive and expensive, which result in high water costs for consumers. Some processes of desalination are also polluting to the natural environment.

In the West Bank, the Palestinian Water Authority has implemented a number of projects to increase the percentage of served communities by extending 90 km of main water lines, constructing 500 km of internal water networks, and building seven reservoirs. As of 2010, the

[8] Mekorot, 2009, "After 45 years, Mekorot begins construction of a new National Water System," *Mekorot: Israel National Water Co.*, http://www.mekorot.co.il/Eng/NewsEvents/Pages/NewNationalWaterSystem.aspx.

Palestinian Water Authority needed to serve a total of 2,275,982 people across 490 communities. The total served population in the West Bank is more than 96% of the population. The remaining 4% live mainly in rural areas that need a piped network. Development of water projects in the West Bank has been challenging as a result of strict Israeli control. Mekorot owns many of the water wells in the West Bank and sells the water back to the Palestinian Water Authority.

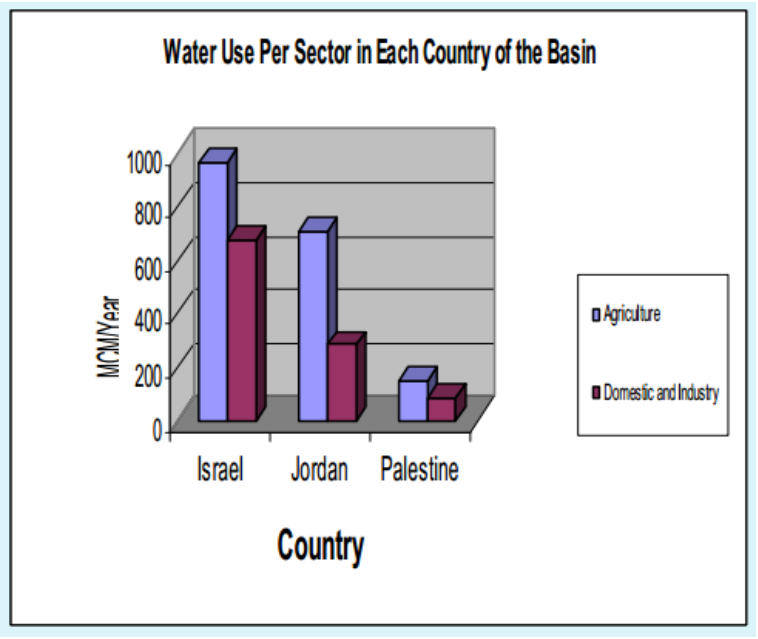

Fig. 11 Water use per sector in Israel, Jordan, and Palestine.

In Jordan, most surface water resources have been extensively developed by the government. Priority is given to the construction of dams and irrigation projects in the Jordan Valley. Since 1958, Jordan has implemented a number of irrigation projects including the 110.5 km King Abdullah canal, which diverts water from the Yarmouk River. Alternative water harvesting techniques have not been developed in Jordan, but there are small pilot projects underway in order to test whether these techniques would be useful in the country.[12]

Conclusion

This report identifies four general trends to further inform WRAP's efforts to employ rainwater harvesting systems at schools in underserved areas of Israel, West Bank, and Jordan. The first trend is the vast majority of people within this region reside in an arid climate where water is scarce. The second trend is long-term rainfall patterns illustrate a gradual reduction in annual rainfall in Israel, West Bank, and Jordan – and the spring rainy season is shortening, on average, three days per decade. The third trend is Israel, West Bank, and Jordan are struggling to find enough water to supply the demand. Both Jordan and the West Bank reported deficits in water resources, and as water sources are further exhausted and polluted, these particular areas will face additional challenges in finding usable water. The fourth trend is the agricultural and domestic sectors require the most water.

To conclude, alternative sources of water used to supply these sectors, as Israel has done with desalination, could make the greatest long-term impact. In the near-term, an alternative that is low-cost and employs basic technology is rainwater harvesting. WRAP's activities to collect and supply rainwater makes a significant impact both in the community and within the greater region. WRAP sponsors, designs, and constructs rainwater harvesting systems in schools that are located within an arid climate and suffer from water shortages. Rainwater is an alternate form of water supply that does not draw on strained municipal water resources. The majority of rainwater collected by WRAP's rainwater harvesting systems is used for toilet flushing. However, excess rainwater can be used to clean restrooms and projects such as a community garden (the collected rainwater is not used for drinking purposes). Since the municipal sector is

[12] Jim Kundell, ed. 2012, "water profile for Jordan," in *The Encyclopedia of Earth*.

the second largest user of water supply in the region, rainwater harvesting has the potential to make a large impact in conserving surface and groundwater resources. The importance of rainwater harvesting systems as an effective tool to meet local water needs and to conserve valuable water resources within the region is gradually growing within Israel, West Bank, and Jordan. However, much progress remains for rainwater harvesting and general water conservation.

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