The quality and sustainability of the water resources available to Arab villages to the west of the divide in the southern West Bank

D.J. Scarpa
Water and Soil Environmental Research Unit (WSERU), Bethlehem University, rue des Freres, P.O. Box 9, Bethlehem, Palestinian Authority (E-mail: dscarpa@bethlehem.edu)

Abstract Springs discharging to the Mediterranean Sea drainage systems provide domestic and irrigation water for a group of Palestinian villages in the southern West Bank. Analysis of the water sampled from 70 of these springs at three-monthly intervals from September 1998 to May 1999 determined its suitability for the various uses to which it is put, based on internationally accepted chemical and biological standards. The 1998–99 rainy season was one of the driest on record, causing hardship to those dependent on springs, which diminished in flow or completely dried up. The springs in the area selected have not received the attention their significance deserves. Some of these rural agricultural villages are little removed from subsistence farming. All of these springs are contaminated with bacteria, some dangerously. Chemical pollutants were also observed in many of the springs. There are some rain-fed cisterns, but these too are often contaminated. A few villages receive some water from the network. This study considers the steps which ought to be taken to improve the quality of water, especially drinking water, and suggests possibilities for increasing the amount of water available. It also seeks to determine to what extent these villages can survive as demands for water increase.

Keywords Palestinian villages; southern West Bank; sustainability; water quality

Introduction
Springs south of Jerusalem and draining towards the Mediterranean Sea have received scant attention. Published material on springs in the West Bank (Blake and Goldschmidt, 1947; Rofe and Raffety, 1963; Jordanian Natural Resources Authority, Hydrology Division, 1965; Israel Hydrology Service, 1978 (and subsequently), Ron, 1984; Rosental, et al., 1986 and Nuseibeh and Nasser Eddin, 1995) neglects any detailed study of the majority of the springs covered in this study. Abed Rabbo et al. (1997), in an extensive study of water quality throughout the West Bank, included some of these springs for the first time.

The Hebron Mountains trend north-south through the southern part of the West Bank, with the western limb of the anticlinal structure much steeper than the eastern. The Palestinian hill villages, south of Jerusalem and to the west of the hydrologic divide, Figure 1, have traditionally depended on the springs issuing from the surrounding hillsides where sheep and goats are pastured. Market garden, fruit and vegetable crops provide a subsistence economy for the villagers and are sold in local markets.

Moist air masses from the Mediterranean bring most of the rain that falls on the western slopes of the Hebron Mountains, which rises to 1,000 m. The rain falls between September and April, averaging about 600–700 mm/an in the main recharge area. However, there are significant variations from the mean. Only 135 mm of rainfall was recorded on the roof of Bethlehem University for the season September 1998 to April 1999. Other stations in the area recorded similar amounts, making this the driest season on record (1901–1999), (Scarpa, 1992). The effects of this season’s very low rainfall were obvious; springs with normally abundant flows were reduced to mere trickles or became completely dry. Wadis which usually carried seasonal surface water, remained dry.
<table>
<thead>
<tr>
<th>Town/Village</th>
<th>District</th>
<th>Number of springs sampled</th>
<th>Population PCBS (1996)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battir</td>
<td>Bethlehem</td>
<td>2</td>
<td>1,520</td>
</tr>
<tr>
<td>Beit Jala</td>
<td>Bethlehem</td>
<td>2</td>
<td>12,795</td>
</tr>
<tr>
<td>Housan</td>
<td>Bethlehem</td>
<td>3</td>
<td>3,470</td>
</tr>
<tr>
<td>Nahhalin</td>
<td>Bethlehem</td>
<td>2</td>
<td>3,634</td>
</tr>
<tr>
<td>Wadi Fukin</td>
<td>Bethlehem</td>
<td>3</td>
<td>685</td>
</tr>
<tr>
<td>Beit Ummar</td>
<td>Hebron</td>
<td>5</td>
<td>8,491</td>
</tr>
<tr>
<td>Halhul</td>
<td>Hebron</td>
<td>5</td>
<td>11,330</td>
</tr>
<tr>
<td>Beit Ula</td>
<td>Hebron</td>
<td>16</td>
<td>5,297</td>
</tr>
<tr>
<td>Beit Kahil</td>
<td>Hebron</td>
<td>2</td>
<td>2,577</td>
</tr>
<tr>
<td>Tarqumiya</td>
<td>Hebron</td>
<td>2</td>
<td>7,343</td>
</tr>
<tr>
<td>&quot;Alaqa Tahta*</td>
<td>Hebron</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>&quot;Alaqa Foqa*</td>
<td>Hebron</td>
<td>1</td>
<td>956*</td>
</tr>
<tr>
<td>Abda*</td>
<td>Hebron</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Dura</td>
<td>Hebron</td>
<td>10</td>
<td>12,853</td>
</tr>
<tr>
<td>Hebron</td>
<td>Hebron</td>
<td>5</td>
<td>94,758</td>
</tr>
<tr>
<td>Idna</td>
<td>Hebron</td>
<td>5</td>
<td>11,190</td>
</tr>
<tr>
<td>Taffuh</td>
<td>Hebron</td>
<td>4</td>
<td>4,649</td>
</tr>
<tr>
<td>Jaba’h</td>
<td>Hebron</td>
<td>1</td>
<td>521</td>
</tr>
<tr>
<td>Kurza</td>
<td>Hebron</td>
<td>1</td>
<td>1,807</td>
</tr>
<tr>
<td>Surif</td>
<td>Hebron</td>
<td>2</td>
<td>8,071</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>75</td>
<td>191,947</td>
</tr>
</tbody>
</table>

*in the census returns, these three villages are taken as one
Methods

Seventy-five of the springs from this area, Table 1, were sampled at three-monthly intervals to determine the water quality and sustainability of the water resources available to the Palestinian population dependent on them. The water was field tested for dissolved oxygen (DO), pH and temperature on a seasonal basis (September–December 1998, January–March and April–June 1999). Where possible, discharge rates were measured. The samples were brought to the WSERU laboratory in ice boxes to prevent bacterial growth or chemical change. Laboratory analysis included tests for total and fecal coliform, for the major cations (Ca++, Mg++, Na+, K+) and anions (HCO₃⁻, SO₄²⁻, Cl⁻, NO₃⁻), for hardness, SiO₂, F⁻ and for heavy metals (Fe, Cu, Mn, Cd, Pb and Zn).

Results

The most significant observation of the field tests was the diminished flow of spring discharge. Of the 75 springs sampled, ten were dry by the beginning of the winter and a further five by the end. The effect was obvious in massively reduced cultivation and poor yields of those crops which had been cultivated. Many of the springs discharge into rock pools, some at depths of ten metres below the surface. As water levels dropped, DO diminished and bacteria increased. Some of the springs had been sampled by WSERU in 1995, but there were no significant differences in the chemistry. Bacterial contamination was present in all samples.

The results of the analyses of the samples collected were run through a series of computer programs to assist interpretation (Langguth, 1966; Sawyer and McCarty, 1967; Todd, 1980; Lloyd and Heathcoat, 1985; Rollins, 1988; United Nations Organization, 1996; American Public Health Association, 1995).

The springs sampled may be placed in three groups according to their water chemistry. The discharge from most of the springs is of calcium carbonate water with prevailing bicarbonate, indicating recharge water reacting with the limestone rocks during the relatively brief residence time within the aquifer. Characteristic of this type are the springs of Firah in the Wadi Deir Iqtah near Idna, the municipal spring (Balad) and Umm el Deek in Wadi Fukin, Namous in Husan, Jami in Battir and two of the springs to the north of Dura; Kanar West and Kanar East.

A smaller group of springs discharges earth alkaline water with increased portions of alkalies and prevailing bicarbonate. These include three to the west of the village of Beit Ula: Al Masna, Ahmad Abdullah, and Issaq al Adam. Hawooz in Tafu, Musallam, a shallow well to the south-west of Tarqumiya, the municipal spring (Balad) in the grounds of the clinic at Idna, and Qais in Abda. One of the three springs sampled from Wadi Fukin, Al Fawwar, is also included in this group.

A third group is classified as earth alkaline water with increased portions of alkalies and prevailing chloride and sulphate. This group includes two springs from Beit Ula: Jamil al Amlah, and Fawzi al Adam, two from Dura; Nabil Sharif and Saqiya as well as Al Bus from Idna and Ali Taha from Tarqumiya. Their location, close to arable farming, accounts for the sulphates, derived from agricultural applications.

The Durov pollution indicator, revealed that mixing with wastewater or fertilizer was responsible for the pollution detected in two of the Dura springs Saqiah (Abdal Khader Ynis), and Nabile Sharif. This was also the case at El Bas in Idna, while the Gharbi spring in Dura shows reverse ion exchange. At Jamil al Amlah in Beit Ula pollution from agricultural applications is clear. The pollution at the Ali Taha spring in Tarqumiya, which discharges high above the arable farm land in the wadi floor, revealed that NaCl had been brought into the system, suggesting pollution from animal watering. Sheep and goats are frequently brought to this spring. The water is also used for irrigation.
The majority of the springs have very hard water, notably Gharabi, with 852 mg/L, Nabil Sharif 750 mg/L, and Saqiah 710 mg/L, all from Dura.

None of the springs is free of fecal coliform bacterial contamination. Nitrate values were particularly high in samples taken from the agricultural springs of Dura including Gharbi, with a maximum value of 300 mg/L, Nabil al Sharif with 290 mg/L and Sharqui, with 226 mg/L. Clearly, an overapplication of fertilizer is responsible for this contamination. High chloride readings were noted in the springs of Nabil Sharif, 386 mg/L, Gharbi in Dura, 322 mg/L and Ali Taha in Tarqumiya 307 mg/L. Although the sulphate content does not exceed the WHO guidelines, with readings between 100 mg/L and 120 mg/L, it is much higher than the other springs in the area. This is also the case with the sodium content, ranging between 150 and 200 mg/L. High EC readings were noted in Saqiah, 2600 µs/cm, Gharbi, 2700 µs/cm, Nabil Sharif, 2400 µs/cm in Dura and Naqiah, in Idna with 2500 µs/cm.

About 5% of the samples are of doubtful water type according to their soluble sodium percentage (SSP). This group includes Saqiah and Naqiah. 55% of the springs sampled are classified as having good water, including most of the springs in Beit Ula, Qais in Abda and El Bsas in Idna. The remaining 40% are classified as excellent. These include Jami in Battir, Mansour in Beit Jala, Jinan and Majnouna in Dura Tina in Halhul and the springs of Wadi Fukin. The springs of Naqiah in Idna and Nabil Sharif in Dura are classified as having very high salinity. The remainder are from medium to high salinity.

Discussion
In this record dry season, the basic economy of these villages and towns, dependent mainly on the sale of market garden produce, has been massively reduced. Less fruit and vegetables have been available to the villagers and townspeople themselves. The quantity of drinking water available from all sources; springs, rain-fed cisterns and the network, has been reduced to levels that represent a danger to health. Lack of water from springs in villages dependent on them for drinking water also reduces the quality of water. This presents a serious health hazard, especially for the children. Significant increases in amoebic dysentery among both children and adults were reported in most of the villages of this study.

Should a single rainy season, one which is the lowest on record, be used as a valid measure of the sustainability of the towns and villages in this study? If the populations of these villages continues to increase at the present rate and if demand for both domestic and agricultural water remains the same or, more likely, increases, the answer must be no. The larger towns, in particular, the city of Hebron has a significant industrial base with huge demands on this diminishing resource. Wells drilled in the eastern basin of the Mountain Aquifer following the requirements of Article 40 of the Oslo Accords have promised increases of so-called new water.

Study of the data available from the Israeli Hydrologic Service over these past 15–20 years, during which time, the Herodion Beit Fajjar water well field has been developed, reveals an average annual drop of three metres in the water table (Abed Rabbo et al., 1998). The additional six wells, drilled these last few years, but not yet on tap, will lower the water table at a greater rate as demand increases. If this kind of irresponsible water management continues, the geohydrological dynamics of this aquifer basin will change and this valuable resource could be lost.

Conclusions
Prioritization of water use is a difficult political judgment to make. This is particularly the case for the Palestinian Water Authority which has very limited control over supply and distribution from the deep wells. Network supply to these Arab villages from deep wells is
extremely limited and unreliable and does not satisfy the need for the sustained good health of the Palestinian population. Equitable distribution, although integral to the Peace Process, seems unlikely in the foreseeable future. Diversification of the Palestinian economy, so that dependence on water for irrigation and industry is massively reduced, is essential if the required amounts of drinking water are to be made available from sources under Palestinian control.

The meagre and precious resources available that are under Palestinian control, namely the springs and rain-fed cisterns, must be upgraded and properly maintained. Recent studies (Mizyed and Haddad, 1996 and Mizyed, 1997) have suggested ways of upgrading Palestinian springs. It is common to see sheep and goats drinking directly from spring outlets. Fecal waste pollutes the springs’ surrounding area and there is a danger of animal diseases being transferred to humans. Some springs have been rehabilitated, either by the Palestinian Hydrology Group, as at Alaqa Foqua, or by commercial interest, as at Sabieh in the Wadi Deir Iqtah. Here a tunnel was dug 5 m into the rock face this winter to reach the ever receding water table.

Acknowledgements
This study would not have been possible without the generous grant received from Irish Development Aid. I am grateful for the assistance and encouragement of my colleagues at WSERU and the Administration at Bethlehem University.

References


