# THE QUALITY AND SUSTAINABILITY OF THE WATER RESOURCES AVAILABLE TO ARAB VILLAGES TO THE WEST OF THE DIVIDE IN THE SOUTHERN WEST BANK

**David J. Scarpa**
Bethlehem University
and
SOAS University of London

**SOAS Water Issues Group**
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**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. This is an introductory paper, mainly concerned with the quality of the spring water, in a study designed to assess the sustainability of these villages. Analysis of the water sampled from 75 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 the springs, 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 suggest 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.

KEY WORDS

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 & Goldscshmidt, 1947; Rofe & Raffety, 1963; Jordanian Natural Resources Authority, Hydrology Division, 1965; Israeli Hydrology Service, 1978, 1990; Ron, 1984; Rosenthal, *et al*., 1986 and Nuseibeh & 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. In this present paper, emphasis is placed on water quality as an initial consideration in determining the sustainability of the villages under study.

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 rise to 1,000 m. The rain falls between September and April, averaging about 600-700 mm/yr. 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 normally carry surface water remained dry.

## 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 pop-
ulation dependent on them. The spring water was field tested for dissolved oxygen (DO), pH and temperature on a seasonal basis (September-December, 1998, January-March and April to June, 1999). Where possible, discharge rates were measured. The samples were brought to the Water and Soil Environmental Research Unit (WSERU) laboratory at Bethlehem University in ice boxes to prevent bacterial growth or chemical change. Laboratory analysis included tests for total and faecal coliform, for the major cations ($C^{++}$, $Mg^{++}$, $Na^{+}$ ,$K^{+}$) and anions $HCO_3^{--}$, $SO4^{--}$,$Cl^{-}$, $NO_3$), for hardness, $SiO_2$, $F^{-}$ and for heavy metals (Fe, Cu, Mn, Cd, Pb and Zn).

TABLE 1. The towns and villages of this study.

| TOWN/VILLAGE | DISTRICT | NUMBER OF SPRINGS SAMPLED | POPULATION+ |
|---|---|---|---|
| Battir | Bethlehem | 2 | 1,520 |
| Beit Jala | Bethlehem | 2 | 12,795 |
| Housan | Bethlehem | 3 | 3,470 |
| Nahhalin | Bethlehem | 2 | 3,634 |
| Wadi fukin | Bethlehem | 3 | 685 |
| Beit Ummar | Hebron | 5 | 8,492 |
| Halhul | Hebron | 5 | 11,330 |
| Beit Ula | Hebron | 16 | 5,297 |
| Beit Kahil | Hebron | 2 | 2,577 |

| | | | |
|---|---|---|---|
| Tarqumiya | Hebron | 2 | 7,343 |
| 'Alaqa Tahta* | Hebron | 1 | 956* |
| 'Alaqa Foqa* | Hebron | 1 | |
| Abda* | Hebron | 3 | |
| Dura | Hebron | 10 | 12,853 |
| Hebron | Hebron | 5 | 94,758 |
| Idna | Hebron | 5 | 11,190 |
| Taffuh | Hebron | 4 | 4,649 |
| Jaba'h | Hebron | 1 | 521 |
| Kurza | Hebron | 1 | 1,807 |
| Surif | Hebron | 2 | 8,071 |
| | **Totals** | **75** | **191,947** |

+ Palestinian Central Bureau of Statistics (1996)
*These three villages are taken as one in the census returns.

RESULTS

The most significant observation of the field tests was the diminishing flow of spring discharge. Of the 75 springs sampled, ten were dry at 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 chemical differences. 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 & McCarty, 1967; Todd, 1980; Lloyd & Heathcoat, 1985; American Public Health Association, 1995; United Nations Organisation, 1996).

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 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 Beit Ula; Al Masna, Ahmad Abdullah and Issaq al Adam. Howooz in Taffuh, 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 waste water or fertilizer was responsible for the pollution detected in two of the Dura springs, viz., Saqiah (Abdul Khader Ynis) and Nabil Sharif. This was also the case with Al Bus in Idna , while the Gharbi spring in Dura shows reverse ion exchange. At Jamil al Amleh in Beit Ula, pollution from agricultural applications is clear. The pollution at Ali Taha spring in Tarqumiya, high above the wadi floor where the arable land is located, 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 hard water, notably the Dura springs, Gharabi, with 852 mg/l, Nabil Sharif, 750mg/l and Saqiah, 710 mg/l.

None of the  springs is free of faecal coliform bacterial contamination. Nitrate values were particularly high in samples taken from the agricultural springs of Dura including Gharbi, with a maximum value of 300mg/l, Nabil al Sharif, with 290 mg/l and Sharqui, with 226 mg/l. Clearly, an over application 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, these are 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 the Dura springs of  Saqiah, 2600 µs/cm, Gharbi, 2700µs/cm and  Nabil Sharif, 2400µs/cm and in the Idna spring of Naqiah with 2500µs/cm.

About 5% of the samples are of *doubtful* water type according to their soluble sodium percentage (SSP). This group includes Saqiah in Dura and Naqiah in Idna. 55% of the springs sampled are classified as having *good* water, including most of the springs in Beit Ula, Qais in Abda,and  Al Bus 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 on the successful cultivation of mainly market garden produce for their food and for sale in local markets, has been massively reduced. The quantity of drinking water 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 the water. This presents a serious health hazard, especially for the children. Significant increase in amoebic dysentery among both children and adults was 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 of this study? Sustainability looks to the future. One very dry season is not going to make that much difference. The future is that the populations of these villages are going to continue to increase and there will be demands for more water. There must be a reduction in irrigated agriculture in order to meet the growing demands for the basic needs of domestic water. There must be moves towards alternative activities that will allow the economy of these villages to purchase their food from outside. The amount of water which may become available as a result of drilling new wells in the eastern basin of the Mountain Aquifer can really only provide a more healthy supply of domestic water and for activities less expensive in water use than irrigated agriculture.

Study of the data available from the Israeli Hydrology service over these past 15-20 years, during which time, the Herodion-Beit Fajjar well field has been developed, reveals an annual drop in the water table of up to three metres (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.

## CONCLUSIONS

Prioritization of water use is a difficult political judgement 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. It really does not have much control of the springs either, most of which are governed by customary law. The present situation is that network supply from the deep wells is extremely limited and unreliable and cannot supply the need for the sustained good health of the Palestinian population. In the future, water from the new wells will be able to satisfy domestic needs, but not very much more.

Recent studies (Mizyed & Haddad, 1996 and Mizyed, 1997) have suggested ways of upgrading Palestinian springs. Those that have been upgraded must be maintained. It is common to see sheep and goats drinking directly from spring outlets, even when special troughs are provided. Faecal waste pollutes the area surrounding the springs. The dangers are very often not recognized.

It is clear that the quantity and quality of water at present available to these villages, even in a good rainy season, cannot satisfy the uses to which it is put. If the lives of the population are to improve, emphasis must be on the provision of good quality drinking water and for other domestic needs. Irrigated agriculture is not sustainable, and moves towards a more diversified economy will allow the replacement of locally produced foods by those purchased from outside.

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