

Watershed management under conditions of water scarcity

● Water scarcity, growing population demands and the spectre of climate change are creating a renewed interest in sustainable management of water resources. This is especially true of countries in the Mediterranean region. **DAVID PARGAMENT** and **SCOTT WALLACE** discuss the rise, fall, and rebirth of the Yarqon river in Israel, which provides a useful case history for integrated watershed management.

The Yarqon river is one of the most important rivers in Israel (28 km long with a drainage area of 1800 km²). The perennial part of the watershed, the Yarqon, flows from its springs by the foothills of the Judean Hills and discharges into the Mediterranean Sea (Figure 1).

One unique feature of the Yarqon is its source of water – springs fed from the ‘Mountain Aquifer’. The presence of a continuous, year-round supply of water (25,000 m³/hr) created a unique ecosystem with many species of plants, fish, and aquatic invertebrates endemic to the watershed. The strategic position of the Yarqon river along the north side of Tel Aviv allowed the city to grow with a readily available water supply.

By the 1950s Israel had developed to the point where water allocations were a national priority. A water policy of managing the Mountain Aquifer was implemented such that spring discharges essentially ceased. Cut off

from its base flow of water, the Yarqon river ecosystem collapsed. The Yarqon river watershed became one of the most heavily populated areas in Israel and pollutant loads to the river from sewage, low quality effluent, and urban and agricultural non-point sources dramatically increased. The natural flora and fauna were displaced by species tolerant of low or no flow and to pollution; the river lost its natural services and became a health hazard and an aesthetic nuisance. These conditions, which prevailed for over 40 years, influenced urban planning among the seven municipalities in the watershed, resulting in inferior land uses along substantial parts of the river.

The Integrated Watershed Management approach

The Yarqon River Authority (YRA) was established in 1988 to rehabilitate the river, to mitigate floods, and to prepare the river corridor for recreational uses. The Authority,



Figure 2: Reconstruction of eroded riverbed before replanting vegetation

though not in charge of the whole watershed, operates on a watershed basis in many issues, encouraging participation of its members and stakeholders in planning and policy making. YRA’s main activities include regional infrastructure planning and implementing projects that directly benefit water quality, the environmental health of the river, and the communities along the Yarqon.

Ecological restoration

To date, YRA has restored over 20 km of riparian habitat (Figure 2) including the reconstruction of eroding river banks, the removal of invasive species, and the reconstruction of runs, riffles, and pools within the river channel. A main reason for the poor state of the riparian habitat was the practice employed for mosquito larva eradication. Effective spraying of the water necessitated total removal of riparian vegetation on one bank. Rehabilitation could proceed only

Figure 1: Yarqon River watershed





Figure 3:
Recreational use
of the Yarqon
River

after changing spraying materials and methods as part of adopting environmentally suitable practices.

Drainage and flood control

Drainage and flood control planning requires accurate mapping and flow modelling on a sub-watershed basis, including the definition and protection of floodplains and the use of abandoned quarries for floodwater storage. The goal to reduce peak discharges and to lower flood water elevations is especially important as high flood stages on the Yarqon affect the storm drainage network within the Tel Aviv metropolitan area.

Recreation

Another major goal of YRA has been to develop and promote the use of the Yarqon river as a recreational resource by developing green space and recreational amenities along the river. The Hayarkon Park is one of the major green spaces on the north side of Tel Aviv. Recreational use of the river comprises fishing, Olympic rowing, and kayaking, including teams from Europe who come to enjoy favourable winter conditions.

Water quality

None of these watershed management goals are achievable without suitable water quality and a sustainable base flow to the river. A Governmental Directive issued in 2003 allowed YRA to define the required water quantity and water quality necessary to sustain a healthy ecosystem in the Yarqon river. This led to some re-allocation of water from the Mountain Aquifer, resulting in a net discharge from the springs at the headwaters of the Yarqon. Most of the water used to sustain base flow in the river is reuse water from municipal wastewater treatment plants (Israel is the world leader in water reuse, with 75% of wastewater being reused).

To date, YRA has been involved in the upgrading of the wastewater treatment plant at Hod Hasharon to tertiary levels (BOD (biological oxygen demand) 10 mg/l, ammonia-N 5 mg/L, TP (total phosphorus) (total 0.2 mg/l). Even with this level of treatment there are still potential concerns regarding chronic toxicity and stresses to the aquatic ecosystem.

The constructed wetland alternative

In its most ambitious project to date,

YRA has commissioned the design and construction of a large-scale constructed wetland system at Hod Hasharon. The purpose is to cancel out expected fluctuations in the quality of municipal effluents and to remove pesticides, insecticides, and compounds from medicinal sources and hormones. The decision to construct the wetland system followed an evaluation of how effluent toxicity impacts the river, and the observed benefits of other small-scale wetland treatment systems operating in Israel. The constructed wetland, due to begin operation at the beginning of 2010, is expected to be the linchpin of YRA's goal of creating a sustainable base for the river.

With a design flow rate of 30,000 m³/d, the Yarqon wetland is far larger than any other treatment wetland operating in the country. North American Wetland Engineering of White Bear Lake, Minnesota (now part of Stantec) was retained as the process engineer, while detailed civil design was completed by Lavi-Natif Consulting Engineers Ltd in Tel Aviv.

To deal with the constraints of a limited site area and high flow rates, the engineering team designed an innovative tidal flow wetland process in which three wetland basins (filled with a gravel media and planted with emergent wetland vegetation) are alternately filled with pumped municipal effluent and drained using paired 40cm discharge siphons to improve oxygen transfer. The wetland basins have a combined area about 12,500 m². Although the primary goal of the project is water quality, the constructed wetland alternative provides the additional benefits of open space, wildlife habitat, and recreational use (Figure 3).

Moving forward

The long-term goal of YRA is to utilize the wetland system as a leading example of 'green infrastructure' in the Mediterranean region. For the Yarqon river constructed wetland technology becomes the link between mechanical human infrastructure and the aquatic ecosystem. This approach allows a man-made input (reused municipal wastewater) to substitute for a natural water input (the spring discharge) to create a sustainable base flow for the Yarqon and essentially return the hydrology of the river back as closely as possible to pre-development times. ●

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Figure 4:
Impressions of the
completed
constructed
wetland system at
Hod Hasharon,
Israel