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Chemical and Biological Monitoring in Ephemeral Transboundary Palestinian-Israeli Streams

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Chemical and Biological M Ephemeral Transboundary

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Because they lack the recreational appeal of perennial rivers and offer a different aesthetic, ephemeral streams, with their seasonal flow are often neglected water resources. Environmental conditions in ephemeral streams in general are more difficult to characterize than perennial streams.

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There are two reasons for this:

- the difficulty of representing spatially variable inputs (especially rainfall) in arid areas that are notorious for variability and lack of observations and
- the dominance of in-channel processes that are either difficult to quantify or simply not understood sufficiently to incorporate into models.

In their natural state, ephemeral streams lie in watersheds in which channels are hydrologically active for less than 2% of the time or about seven days /year. These watersheds are also characterized by flash floods, making them difficult to monitor and stream behavior, the ecological systems it supports, high sediment content and pollutants.

Effluent concentrations produced by municipal wastewater treatment are typically set based on the full dilution associated with perennial streams, while flow conditions in ephemeral streams present different hydrological and ecological requirements. In addition effluent discharge introduces continuous inputs of water into a desiccated ecosystem. This shift affects vegetation cover, bank and bed stability, sediment transport and storage. The associated hazards of mosquitoes, odors and groundwater contamination can be substantial. Natural vegetation and fauna are often replaced by invasive species, better adapted to contaminated wet environments.

We conducted a three year study that for the first time characterized environmental conditions in transboundary watersheds that cross the Palestinian Authority into Israel: the Hebron / Besor and the Zomar / Alexander. These two stream systems are representative of over ten ephemeral streams that originate in-land under the jurisdiction of the PA in the West Bank and that flow into Israel. In the Zomar/ Alexander the current flows from the West Bank into Israel and to the Mediterranean. The Hebron / Besor watershed begins in the West Bank, where water flows south in the Hebron to Beer Sheva – and from there returns to the Palestinian Gaza Strip. Restoration strategies require cooperation and coordinated management by the two sides, making the study of particular importance.

Methods

A network of automatic hydrometric monitoring stations was established for sampling of storm events in the basins. Four stations were set up in the PA territory, and ten in Israel. Monitoring the base flow was an important preliminary step for quantifying dominant wastewater "point source" inputs in both streams. Samplers in the stations were programmed to sample every fifteen minutes during the first hour of a rain event and every two hours subsequently, to better characterize “first flush effects” where higher concentrations of pollutants are typically found. Extensive chemical analysis was carried out with major ions measured as well as metals and trace elements. Nutrient fluxes were calculated during storms. The study also included monitoring of in-stream macroinvertebrate communities which served as a proxy for stream health. This requires comparing the community structure of the studied stream/site with that of an undisturbed situation (reference stream/site).

Findings

In the Hebron/Besor watershed, the predominant initial source of pollution in the watershed is effluent and raw sewage leaving the Palestinian city of Hebron and Jewish settlements, especially Qiryat Arba. Measurements

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suggest that 15,000 cubic meters of sewage per day, mostly untreated, flow over approximately 120 kilometers downstream until reaching Israel's Besor Reserve in the Negev region. This steady baseflow fundamentally alters the character of the stream, transforming it from a seasonal stream where historically high quality storm water flowed for only a few days a year throughout a largely semi-arid watershed, to one with a constant flow of sewage throughout the year.

A significant portion of the water in the Hebron/Besor does not reach the Israeli border. Measurements of flow from the different monitoring stations in various seasons indicate that along the stream's first 60 km, between 40% and 90% of discharged wastewater percolates into groundwater before reaching the border and the Beer Sheva stream. This is consistent with previous hydrological research in Israel and in other regions.

These values represent high transmission channel losses in during the flow, and infiltration into the groundwater, far beyond the potential water lost by evaporation and transpiration by plants and vegetation cover from the streambed. The rate of percolation appears to be seasonal. The quality of the water which infiltrates the surrounding aquifer in the upper stretch is extremely poor – made up of raw sewage.

Water quality in the stream varies dramatically along its flow as a process of biological purification. There is a substantial drop in nutrient concentrations for Total phosphorus and NO3, reflecting general reductions in concentrations of organic material flowing in the stream. The declining gradient in pollution levels along the sampling route between the top and the bottom segments of the stream is further reflected in a drop of 91.7% in biological oxygen consumption (BOD), 87.7% in chemical oxygen consumption (COD), 73.9% in overall nitrate levels, and 72.8% in overall ammonia levels (yearly average). Results suggest that water quality improvement is not as predictable and linear as anticipated.

Similar to the Hebron/Besor watershed, discharge measurements revealed that in all of the Palestinian and Israeli sections of the Zomar/Alexander watershed, the predominant source of water and pollution in base-flow were sewage effluents. The trend in the data reflects a steady increase in base flow due to increased discharges of waste water from the area's growing population.

Pollution loads during storm events are much higher than pollution loads in base flow. Furthermore, the data show that the larger the discharge of the storm, the larger the pollution loads. Accordingly, the highest quantities of nutrients discharged into the stream correspond to winter storms. These results can be explained the water flowing in the stream that already contains nutrients. Nutrient levels differ duringe storm events. At the same time, results consistently indicate that the greater the amount of water flowing in the stream, the higher the nutrient loads.

Conclusions

Although the geomorphology of the two streams differs greatly as does their climatic setting and conditions, the ecological state of both upper tributaries is "very poor". Man-made alteration is so extreme (perennial flow and heavy pollution) that none of the site specific attributes is being expressed biologically.

As both watersheds receive no rain during the summer and have trivial spring flow, their water quality is dominated by sewage discharges. The greater precipitation during the rainy season and associated dilution in the Zomar/Alexander basin do not affect this dynamic. Nor does a decade of efforts to reduce point sources and partially treat sewage from the West Bank. Both streams are heavily polluted as reflected in water quality variables and by biological health categories. This is noteworthy given the steady growth in the number of residents living in the watershed, particularly on the Palestinian side.

Regardless of reductions in point source discharges as well as self -purification processes, reducing pollution loads, water quality did not attain the required level even at the stream's distant downstream reach. Water quality during storm events, in terms of pollutant concentration, is of better quality than that found in base flow. However, during storm events, significant amounts of nutrients (total nitrogen and total phosphorous) flow through the stream. Thus, nonpoint source discharges from the agricultural fields surrounding the stream, and urban runoff from adjacent towns, are the most plausible nutrient sources. Even before formal common water quality standards are set and a coordinated management strategy for restoring transboundary streams crafted, controlling non-point source pollution can and should be integrated into present management programs.