Hydrological studies at Aammiq Marsh 2002-2003

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"Hydrology is probably the single most important determinant of the establishment and maintenance of specific types of wetlands and wetland processes."
Mitsch and Gosselink (2000)

Summary

Aammiq Marsh, in the Bekaa Valley, Lebanon, is a remnant of a much larger system that use to cover much of the valley. In the last 40 years the valley has been subject to massive efforts to drain water and convert the valley floor to arable lands. Thus the hydrology of Aammiq is strongly influenced by the demands of the surrounding farmland: drainage of surface water during the wet winter months, and abstraction of ground water for irrigation during the dry summer months. A Rocha Lebanon has an aim to "maintain the wetland at its current size, and if possible, increase the area covered by wetland habitats." As pressure on water resources in the Bekaa is likely to increase in future years, it is imperative that we understand the hydrological needs of Aammiq marsh, in order to achieve this aim. We need to answer such questions as whether ground water abstraction on adjacent lands is removing water from the marsh, can we significantly increase the flooded area or the flood duration by adding a new source of water to the marsh? To provide baseline knowledge of the marsh hydrology and to answer these immediate questions, we have begun studies of various parameters that determine the behaviour of water within the marsh area. In particular, we are measuring the volumes of water that enter and leave the marsh via various pathways. This involves measuring surface water flows, estimating ground water gains and losses, and measuring exchanges of water with the atmosphere. To help determine the effects of these inflows and outflows on marsh water levels, we are also estimating the volume of water that occurring in the marsh at different water levels. Data collection during 2002-2003 has been hampered by heavy rains, but some results have been obtained, and studies will continue into 2004.

Introduction

Hydrology, the amount and timing of water that enters a wetland, is what creates the wetland environment. Simply put, without water there would be no wetland; and the behaviour of the water – how much there is, when it comes, and how long it stays – determine the type of habitat available for wildlife – the plants, invertebrates, amphibians, reptiles, birds and mammals that use the marsh. Land that gets flooded for more than a few days each year is not a suitable habitat for terrestrial plants, so specialised wetland plants grow there instead, and these create habitat for wetland animals. Wetland animals arrive at different rates, and therefore land that is flooded for a long time develops a different community of animals to land that is flooded for a short time.

At Aammiq, water is a precious resource, and part of it is controlled by the farmers who grow crops around the conservation area. During the wet months of the year, farmers drain water away from the plain so that their fields are not flooded, whereas during the dry growing season they take water from underground and from nearby springs to irrigate their crops. Both of these activities alter the natural pattern of water supply to the marsh, and could reduce the ability of the marsh to support wildlife. However, farming is an important source of income to local people around Aammiq, and cannot simply be stopped for the sake of conservation.

How then can we find a solution that balances the needs of the marsh and those of local farmers? One of the aims of A Rocha Lebanon is to "maintain the wetland at its current size, and if possible, increase the area covered by wetland habitats." Can we increase water supply to the marsh without hurting the needs of farmers? If we add a certain amount of water to the marsh, will it make a difference to the area of the marsh or the length of time the marsh stays flooded? Is groundwater pumping on adjacent lands removing water from the marsh ? In order to answer these questions, we first need to understand the hydrology of the marsh. In particular we need to know:

- how much water enters the marsh from different sources?
- how much water is lost from the marsh through different pathways?
- what are the physical properties of the marsh and the surrounding lands that determine the way that water enters and leaves the marsh area?

As part of the A Rocha project, I am proposing field studies in the conservation area that would begin to answer these questions.

Methods

1. Volume of the marsh

The volume of water in the marsh is an important parameter, as it will help us to determine the likely contribution of various water sources (present and future) to the water level in the marsh. The water volume will be estimated by mapping the outline of the flooded area, using a global positioning system (GPS) on a series of dates as the water level decreases during the summer months. From these data we can produce a contour map of the marsh volume.

2. Rainfall and evapotranspiration

Rainfall, and evapotranspiration represent gains and losses of water via the atmosphere. Clearly, as well as direct rainfall on the marsh, rain also represents the origin of surface water and ground water inflows. In order to make surface and ground water inflow measurements in one year relevant to future years, we must make these measurements in conjunction with rainfall measurements. Therefore, rainfall will be measured using a rain gauge at Aana village. Measurements of temperature and wind speed will be used in the future to calculate the rate of evapotranspiration loss from the marsh, and estimate its importance.

3. Surface water flows

To determine the amounts of water entering the marsh from different sources, we will need to estimate flow at three points: where the ditches from the fields south of the marsh enter the Riachi River (which then enters the marsh); at the inflow of the main springs area to the marsh; and at a narrow point near the lower (eastern) end of the marsh. The first measurement site is a point where all of the surface water sources south of the marsh gather to enter the marsh. The second site is a point where the largest inflow of water to the marsh (the line of springs by the road) originates, and the third site is a point within the marsh beyond which all of the inflows to the marsh have entered. Therefore, by subtracting flows at the first and second sites from that at the third, we can calculate the amounts of water entering the marsh from sources we have not been able to measure directly. These are: surface sources to the north of the marsh, and springs appearing within the marsh area itself. The third measurement site also can be considered an outflow point for the marsh, since it is beyond all points of significant inflow and is not far from the point where Aammiq Marsh joins the Litani River.

Flow measurements at the springs area have potential to answer another question: whether the groundwater pumping near the western end of the marsh is withdrawing water from the springs. The springs area is divided into northern and southern arms, and three large pumps are located near the southern arm. By measuring flows originating from the northern arm, as well as from the entire springs area, we can monitor the proportion of springs water that comes from northern and southern arms. If the pumps do indeed withdraw water from the southern arm, flows from this arm should decrease relative to flows from the northern arm when pumping begins.

At the first two sites there is a drop in water level, or “hydraulic head,” and therefore these sites are suitable for building weirs, concrete barriers over which the water flows in a well-defined way. Because there is a well-defined relationship between the water level behind the weirs and the flux (volume per unit time) of water across them, flux can be measured simply by a graduated rod in the pool upstream of the weirs.

At the third site there is little drop in head, but a well-defined channel through which the water flows. This makes the site suitable for measuring by another method. The cross-sectional area of the channel is measured with a ruler, and the flow rate of water through the channel is measured with a hand-held propeller-type flow meter. These two measurements are combined to produce an estimate of water flux as volume per unit time.

4. Groundwater
In order to further investigate the effects of groundwater pumping on marsh water levels, the groundwater itself will be monitored during the annual dry period of the marsh. "Piezometers," small PVC pipes inserted vertically into the ground, will be installed in transects, one transect along the length of the marsh, and two others that extend away from large pumps north and south of the marsh. The piezometers will show the level of the groundwater beneath the marsh soils, thus together will show the shape of the water table. If the water table show a definite dip towards the pumps, we can be confident that the pumps are withdrawing water from the marsh. Another parameter, the hydraulic conductivity of the marsh soils, determines the rate at which water travels underground, and hence the rate at which it is lost to the pumps. This parameter can also be determined using the piezometers, by performing "slug tests."

The piezometers will also tell us how far below the ground surface the water table drops in summer, and this will allow us to answer another question – whether it is feasible to create pools within the marsh area that remain wet all year.

Results to date: April 2003

1. GPS maps of the receding flooded area were completed in summer 2002.
2. Weirs were built at the springs area (north arm and main outflow) and at the Riachi River.
3. The first transect of piezometers, along the length of the marsh, was installed.
4. Measurements of water flows across the weirs and at the marsh outflow have been made during the winter of 2002-2003. Unfortunately rains this year were extremely heavy (double the average annual rainfall), and washed out the weirs by mid-winter. Measurements at the marsh outflow have continued, but have been considerably less accurate than expected because water has poured across banks, where it is difficult to measure, as well as though the main channel. Results from the early part of the winter have shown that the main springs area near the West Bekaa Road represents only 50-67% of the total inflows to the marsh. This means that unmeasured sources (probably mostly springs occurring within the marsh area) supply a much great amount of water than previously thought. These proportions may change later in the season.

Due the loss of data and damage to the weirs this year caused by the heavy rains, a full data set from the study will not be available before 2004. However, the relationship between total rainfall and total volume of water passing through the marsh area can be estimated roughly after the flood period of 2003. We also expect to complete some of the water table measurements during the dry period in 2003.