Aammiq conceptual hydrogeology

Chris Leake
Hydrogeologist
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1 Background

The hydrogeology of Aamiq has previously been investigated however earlier work is understood to have concentrated essentially on the irrigation requirements of the Skaff estate. The preliminary conclusions of the site visit made by myself (October 2003) suggest that the deposits within the main body of the Bekaa Valley contribute a larger volume of water to the local water environment than had previously been envisaged. An attempt has therefore been made to develop a conceptual model of the hydrogeology in the vicinity of the marsh as an aid to future site management.

The conceptual hydrogeology should be regarded as provisional at this stage, it is anticipated that as data is collated from the on-going and proposed expanded monitoring programme that the model can be refined. The model is therefore necessarily qualitative at this stage and should be regarded as provisional.

2 The geological setting

The geology in the vicinity of the site can be broadly sub-divided in two: Vertically extensive limestone deposits on the flanks of the Bekaa Valley and sedimentary deposits beneath its valley floor. Less extensive sandstone deposits are known to occur on the margins of the valley floor however within the context of the whole hydrogeological regime they are not considered to be greatly influential.

A series of sub-parallel geological faults occur on the margins of the valley side and are thus orientated predominantly southwest – northeast. They are of regional scale and have substantial vertical throws.

The lithology of the sediments in the valley floor is poorly understood and its characteristics have had to be inferred on the basis of sparse data. Cuttings recovered from two waterwells drilled to the north of the marsh indicate a wide range of sediment size, grading from 'clays' and silts to horizons of medium – coarse, angular –sub angular sand.

3 Hydrogeological properties of the lithologies

It can be assumed that the two principal lithologies in the region have disparate hydrogeological properties: The limestone having negligible primary porosity with groundwater storage potential being almost entirely within fissures and fractures. The control on groundwater distribution exerted by marl bands within the limestone is recognized and may be a principal reason for the abundant water supply provided by the Ains which occur on the flanks of the valley.

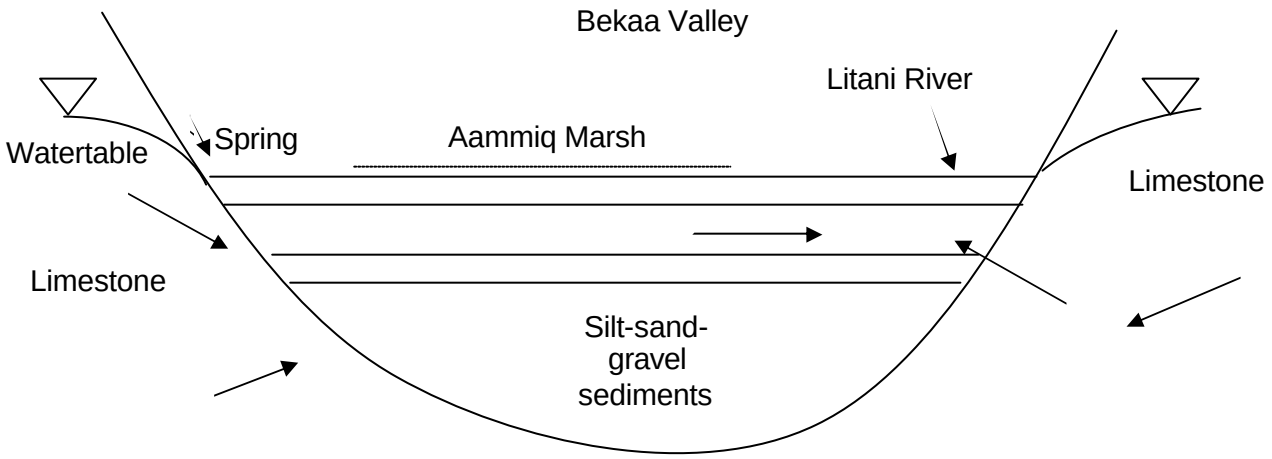
The sediments within the valley floor are assumed to comprise a sequence of fluvial and lacustrine deposits varying between silts and sands with occasional coarser material, primarily associated with fan deposits. Layers of organic debris are also likely to occur in the sequence. The reference to gas being encountered in a waterwell drilled close to the central axis of the valley probably relates to the release of a build-up of gas generated from organic matter.

The presence of confining layers within the valley floor sediments and the hydraulic continuity between the two elements of the aquifer system is demonstrated by the reported occurrence of strongly artesian flows from several boreholes installed on the valley floor.

4 The aquifer system

Hydraulic connectivity between the two elements of the system, as defined above, is likely to be good - very good, therefore it is assumed that groundwater can be readily conveyed between the two rock types. Ground elevations are such that the predominant groundwater flow direction will be from the limestone into the valley floor sediments.

Groundwater movement within the limestone is controlled by the presence of fissures and fractures which can readily convey groundwater over large distances. The presence of significant volumes of groundwater within the limestone is evidenced by the high and sustainable flow rates from both the Aammiq spring and also the Ains which occur in the locality of the marsh.



Schematic cross section to show relationship between geology and hydrogeology

3 Recharge

3.1 Limestone

Recharge to the limestone aquifer system is sourced from direct rainfall and snowmelt. The total volume of recharge is high (averaging some 1100 mm/annum ?) however it has marked seasonal variation: the great majority occurring in the winter months.

3.2 Sediments of the floor of the Bekaa Valley

Recharge to the aquifer in the floor of the valley is (at this stage) considered to be derived from both direct rainfall recharge and lateral inflow from the limestone. The assumed arenaceous nature of much of the deposits is such that the degree of hydraulic continuity between the limestone and valley fill sediments is likely to be high.

Hydraulic continuity between the limestone and younger sediments will allow groundwater flow to recharge the sediments from the mass of the limestone on the flanks of the valley.

4 Egress of groundwater

The comments on recharge suggest that potentially significant volumes of groundwater are present in the area. Lrge volumes of water are likely to be lost via evaporation and flow to the Litani River however there appears to be a mismatch between the recharge and the observed outflows from the system. It would appear that the dominant mode of egress of water from the system has not yet been identified. (A difficulty with this argument is that the southern end of the Bekaa Valley appears to be floored by 'hard rock' which would not provide an obvious egress route for southeasterly flowing groundwater in the valley sediments.) The investigation of the southwestern section of the Bekaa Valley may reveal the presence of large springs or outflows which represent the egress from the valley deposits. (Very conjectural at this stage!)

5 Origin of the marsh

It is understood that the area of marshland in the floor of the Bekaa Valley was historically significantly greater than today. This correlates with the nature of the deposits and comparison with similar sites in other areas. However the maps which are available, and which date from the 1950s, show that the extent of the marshland has not change greatly for 50 years. This suggests that approximate equilibrium exists between the inputs and outputs to the local water environment. It can be further tentatively inferred from this observation that the effect of abstraction from boreholes in the vicinity of the spring is not having a great impact on the integrity of the marsh.

The areas of open water and marsh are situated at lower elevations than the surrounding floor of the Bekaa Valley. The proposed levelling survey will provide data which can be used to correlate ground elevations with groundwater elevations. It is considered that the presence of the marsh can be attributed to the observed ground level variations. The lower elevations are not likely to be artificial and are possibly due to erosion caused by the flow of water from the springs at the western site boundary: the springflows are significant with significant potential to erode and mobilise the soft, surface deposits, thereafter transporting them out of the area.

It had been assumed, and it seems logical, that the presence of the marsh is principally due to the source of water provided by the springs adjacent to the road. However it has been noted (C Naylor pers comm) that the marsh starts to become wet in the lowest sections of the site and not from the west. This suggests that a significant amount of water within the site is not derived from the springs but is sourced from the aquifer within the valley floor. The seasonal variation in water levels in the marsh is therefore likely to be largely attributable to recharge variations and corresponding fluctuations in the watertable within the aquifer within the sedimentary deposits.

However the water derived from the springs will have a direct and possibly significant influence upon the physical and chemical characteristics of the water within the marsh and hence its ecology. The significance of specific water characteristics has not, I understand, been investigated in detail. For example, is any of the ecosystem

dependant upon characteristics of the water which is derived directly from the limestone? The proposed monitoring of surface and groundwater quality would provide information which could be used to determine the sensitivity of the local ecology to change. A useful comparison could be made between the water chemistry of the marsh and isolated bodies which do not receive spring water directly, (such as the excavated pond to the south east or the 'Bedouin' pond), to determine whether significant differences exist.

6 Threats to Aammiq Marsh

The possible threat to the future wellbeing of the marsh have previously been discussed by myself. However they are discussed below for the sake of completeness. It is considered that the current system could be compromised by either a degradation of water quality or a decrease in the availability of water.

6.1 Water quality

Pesticides and other chemical are understood to be used widely in agricultural areas surrounding the marsh. Reports of bird deaths and the presence of empty chemical containers close to the site suggest that chemical use is not always well controlled. Contaminated water may enter the site either directly, by surface flow/runoff or from the inflow of contaminated water via the shallow aquifer.

The most pragmatic means of mitigation against this potential threat is considered to be education of the local landowners in the possibly great adverse effects of chemical misuse.

6.2 Water volumes

The irrigation boreholes to the northeast of the springs, are known to have a direct influence upon springflows which supply water to the marsh. (Direct observation by R Storey) However, as discussed above, the flow reductions do not appear to have had a marked effect upon the overall viability or health of the marsh. This situation requires monitoring however it is considered that it would be premature, and possibly counterproductive, to involve landowners at this stage as a causal link between borehole abstraction and derogation of the marsh has not been established.

The greatest threat to water supply is considered to be the installation of boreholes in the valley floor sediments. Abstraction from the 2 Howsh Aamiq boreholes appears to show that surface water can be readily affected by pumping from depth.

The two newly installed boreholes to the north of the site are of particular concern in this regard and observation of their performance and effects will be extremely useful.

There is not considered to be a practical means of mitigating these effects without substantial intervention, which is likely to be beyond the means of the project. The best means of countering this threat is therefore possibly to increase the 'value' of the current site, possibly by lateral expansion and further enhancement of its interest. These issues are discussed below.

7 Potential means of future development

The comments below are intended for discussion and would require detailed planning with ecologists to ensure that they preserved the existing interest of the site

The presence of several manmade pools to the east and southeast of the main marshland area, and their rapid colonisation by flora and fauna, has demonstrated that it would be feasible to expand the area of wetland interest relatively easily. Although it is noted that the physical and chemical characteristics of the water in these isolated ponds will differ from those of the main body of the marsh it is understood that the presence of water itself is the single main factor which provides interest to the site.

Excavation of additional, 'satellite' ponds around the main marsh area would greatly increase the overall interest of the area. This could in turn raise the profile of the region which would, or should, provide some security against threats to the sites in the future. The integration of the wetland site (to the east of Chtoura?) into a mosaic of wetlands within this section of the Bekaa Valley, which has been previously been discussed, would also be highly beneficial in this regard.

A further increase in the interest of the area could possibly be created by enlarging the area of open water within the site. Natural succession appears to be returning large areas to dryer reedbeds. Advice would have to be sought from ecologists as to whether the overall interest of the site would be increased by a more aggressive programme of management. (I am frequently surprised by the amount of 'heavy duty' management undertaken on reserves within the UK. This is undertaken to maintain the sites at the most diverse stage of their natural succession.) Large areas could be cleared of reeds with relative ease using either bulldozers or long reach excavators. Placement of the dug material in newly excavated ponds would lead to their rapid colonisation and is widely adopted method of habitat creation.

8 In conclusion

A summary of the conceptual hydrogeology as it is understood to date has been provided. This is necessarily qualitative due to the absence of long runs of data. The on-going and proposed monitoring programmes will generate data which can be used to substantiate or modify the stated conceptual model.

Despite the absence of 'numbers' it is considered that the two important conclusions which can be drawn at this stage (re water quality and quantity) are valid and can inform actions at this stage. The ability to expand the site, both in the vicinity of the marsh and regionally, is considered to be of importance for the long-term safeguarding of the marsh and could be progressed without the need for additional data.