

## **Does climate influence population and settlement? A case study of Wadi Faynan Andrew Wade, Hydrology sub-project**

One of the key hypothesis being tested in the *Water, Life & Civilisation* Project is that 'Changes in precipitation or temperature caused the abandonment of settlements during the Holocene'. To test this hypothesis, predictions of the precipitation and temperature of the past are being generated by using General Circulation Models and from direct evidence of the palaeoenvironment, which are then linked with water-balance models. By estimating past water consumption, such as for drinking, farming, industry, bathing, it will be possible to compare water supply and demand, and then to estimate sustainable population levels that for the given climate conditions and socio-economic organisation. These estimates can then be compared with evidence from the archaeological record to evaluate whether climate may have influenced the abandonment of settlements.

Wadi Faynan is an important archaeological locality in Jordan. It has a long sequence of occupation, stretching from the early Palaeolithic to the present day, and its archaeological evidence shows a sequence of developments regarding water management. As such, Wadi Faynan has been chosen as a case study to test the hypothesis and to more general explore the relationship between climate, society and technology.

As part of the ongoing work in the WLC Hydrology sub-project, an annual water-balance model is being developed for Wadi Faynan, with specific reference to the irrigation of the Roman, Byzantine field system (WF4). The model accounts for possible irrigation by water from four potential sources:

- rainfall harvesting using the field walls
- inundation by wadi floods
- water stored in reservoirs
- and by offtake from the perennial base-flow.

To develop the model, estimates are currently being made regarding levels of water consumption, cultivation methods and the hydrology of the wadis. To help address the latter, recent fieldwork included measurement of the perennial baseflow in the Ghuwayr and estimation of the discharge of the last flood and bank-full discharge in the Ghuwayr and Dana. This was done to estimate the amount of available water under contemporary climate conditions to help constrain the model. The model will be run within a Monte-Carlo framework so that uncertainty in the hydrological inputs and model assumptions can be included in the

analysis of the results. A sensitivity analysis has also been done on preliminary model runs to identify the components of the model which control the behaviour and therefore might be thought of as the key factors sustaining the population in terms of water supply. In addition to the development of the annual model, data describing the physical setting and the hydrology of the region around Wadi Faynan have been reviewed to help understand why Faynan was such a locus for settlement throughout the human past. Fieldwork at the end of April 2006 included a visit to The Ministry of Water and Irrigation to obtain the most recent flow data for wadis throughout Jordan.

The response of the seasonal patterns in flow to shifts in precipitation and temperature is important since it effects the period of crop cultivation: the timing of water availability may be as important as the volume of water available in determining settlement and population. Given this, and the need to understand how flow volumes might change in Wadi Faynan in response to climate variability, a seasonal hydrological model of Faynan is also being developed, using the Hydrological Simulation Model (HYSIM). As no hydrological data are readily available for Faynan HYSIM is being applied to other wadis in southern Jordan which drain the eastern scarp slope of the rift valley, and HYSIM has been successfully applied to the Hisbani, a tributary of the Jordan River, in previous projects. These other wadis will act as surrogates for Faynan and potential wadi for this purpose were identified as part of the physical setting and hydrological review during the first year of the WLC project.

The latest results were presented at the six month WLC review in Reading in June 2006. The development of the seasonal and annual models and the results from these and the data review are now being finalised, and will soon be prepared for publication in collaboration with the other project members.

**Figure 1:** Drs. Andrew Wade and Sam Smith from the University of Reading visited Wadi Faynan in April 2006 to measure the baseflow in Wadi Ghuwayr and estimate the flood flows in Ghuwayr and Dana to provide data with which to constrain the model of the annual water balance.

