Traditional irrigation structures in Wadi Beihan

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1. Introduction

Traditional irrigation structures are those structures which depend on raw local materials for their construction and are built by the farmers themselves who rely on experience gained through everyday observation, or knowledge descended from their forefathers. The traditional structures have proved their effectiveness and resistance to high floods for a long time now as seen during the catastrophic flood of 1982, which was the largest flood ever experienced in Wadi Beihan. The majority of the old traditional structures withstood the flood despite the absence of maintenance in the period before its occurrence for ten—and in some cases for hundreds—of years.

In Wadi Beihan the number of traditional structures has been decreasing since the establishments of Wadi Beihan Agricultural Development Project in 1983, as a result of introducing gabions in the area. The farmers became totally reliant on gabions and ignored the traditional structures, although they are much more effective than the gabions in many ways. In addition, costs of traditional structures are estimated at about ninety per cent of the costs of gabions.

2. Types of traditional structures

The structures can be classified according to their shapes and the way they are built as follows:

2.1 The conical structure (aglama)

The aglama is conical in shape, with a circular base of 3m to 4m in diameter and a sharp conical point. The height is usually between 2 and 3m and the inclination ranges between 35° to 40°. The outside surface of the structure contains no holes or cavities, as it is completely filled with small stones and cobbles.

The aglama are usually constructed alongside the Wadi, perpendicular to the flood current. In this way they protect a long stretch of agricultural land. When these structures are constructed in a band, their foundation will be made deeper than usual. The function of the aglama is similar to that of the gabion groynes, which control the direction and velocity of the flood in the wadi. The aglama is constructed by firstly examining the wadi bank and selecting proper construction places; and secondly, by digging a circular foundation of two metres deep and lining it with large stones, and filling in the gaps with smaller stones. The whole structure is constructed the same way. This structure has proved that it can successfully replace gabions, and as the wadi flood is intermittent, maintenance work can be carried out without any difficulty. If machinery is introduced for construction, to speed up the building process, the farmers may be encouraged to continue building this traditional structure and rely less on gabions.

2.2 Drop structures (Al Masaqit)

These are built in spate canals when:

(i) a canal has a steep longitudinal gradient
(ii) the water is transferred from a higher canal to a lower one; or
(iii) when the water is diverted from one field to another. The purpose is to dissipate flow energy so that scouring is minimised.

The structure is built on a foundation of dry stone, occasionally mixed with a little concrete. The remaining part of the structure is constructed with stones interlocked properly, the gaps filled in with smaller stones.

2.3 Al-Qaid

This is a structure built to divert water from the main wadi to agricultural lands in quantities proportional to the irrigated area and the size of the flood in the wadi.

The structure branches off from the main spate canal feeding the land and forms an acute angle with the flow direction and it stretches to the centre of the wadi. The height of Al Qaid varies gradually from zero in the centre of the wadi to the height of the spate canal by agricultural land.

The foundation—usually deep and made of interlocking stones—rises gradually to form a triangular prism to that the drag force on the structure is minimal. The qaid structure is commonly used in Wadi Nahr.

2.4 Al-Masih

This structure is constructed on the edge of the wadi to protect the agricultural lands adjacent to it which are vulnerable to floods. The function of this structure is similar to the function of retaining walls. Al Masih is usually built on the inclined embankments which form the land boundaries. The structure is usually built from round stones and the gaps are filled with stones of smaller sizes to prevent direct contact of the earth embankment with the water. The

common inclination of the structure with the vertical ranges between 30° to 45°, but this depends on the angle of the supporting embankment. Stones used in construction are usually laid in one plane as a smooth surface, to minimize the tangential flood force on the structure.

2.5 Spill ways (Al-Masakhil)

The purpose of this structure is to control the quantities of water which enter the main spate conals. The structure is therefore, constructed on the side embankments of the feeder canals, not far away from the intake. Any discharge exceeding the capacity of the canal will return through this structure back to the wadi. The structure can therefore be considered as a safety valve to the main spate canals. Occasionally this type of structure is built to transfer spate water from one agricultural land to another when the difference between the ground levels is relatively high.

Al Masakhil is usually built on the earth embankments of the canals from medium size stones. The frame of the structure on both sides of the embankment goes down deep into the foundation, so the supporting soil has no direct contact with the water. In construction, no cement is used or only on very rare occasions. Occasionally steps are built on both sides of the structure.

2.6 Comparison between the traditional and gabion structures

Here the comparison is made under the working conditions and general circumstances of the Beihan sub-governorate. What is valid in Beihan may not be valid elsewhere, and what is applicable now may change in the next twenty or so years. However, at present the following points are observed:

- continuation of gabion works depends on the availability of gabion boxes, wires, transport and machinery which can not be granted after the completion of Beihan Agricultural Development Project;
- the farmers are now fully reliant on the project for these materials. In contrast, the traditional structures do not need more than local materials, skills and machinery to construct them;
- it is unquestionable that the traditional structures last much longer, and their maintenance costs are lower, than equivalent gabions;
- traditional structures have proved that they resist the flood force much better than the best constructed gabion structure in the wadi; and
- the traditional structures are more economical than the gabions.

In an effort to encourage the construction of traditional spate structures, the Wadi Beihan project supported the construction of two structures by making available equipment for transport of stones and excavation and financing part of the labour costs. The farmers provided all labour for stone collection and work on site. A comparison of cost between a traditional and comparable gabion structure showed a slightly lower cost price in m^3 (YD 20.-) for the traditional structure, of which approximately 50 percent was provided by the farmers themselves.

2.7 Conclusion

Traditional structures should be encouraged in Wadi Beihan and, maybe, in other parts of the country to avoid extensive use of imported gabions. This can be achieved by spreading the diminishing skills of building such constructions, and inviting the old masters to teach the younger generation the building techniques.