Spate Irrigation Network

Water and Environment Centre

# Newsletter

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## Introduction the First Spate Irrigation Newsletter

**Prof. Dr. Abdulla S. Babaqi**

***Director of***
***Water and Environment Centre (WEC)***

In front of you is the spate irrigation newsletter, hopefully the first one of a long regular series, information and communication, experiences and knowledge exchange, knowing of each others activities, and being informed of the current and planned activities oft spate irrigation technology and practices. This newsletter is one of the Spate Irrigation Network activities in Yemen branch. The spate irrigation network is an international network coordinated in the Netherlands by MetaMeta company. The network has several branches in different countries such as Yemen, Pakistan, Sudan, Irteria, and in the way of establish in Ethiopia. The newsletter will play an essential role in forming and strengthening our partnership. Also the newsletter is meanly meant for internal communication between members of spate irrigation network form different countries, and intends to from part of our publicity to outside word. Moreover, the newsletter looks at the future of more spate irrigation training and communications skills between spate engineers and farmers.

This newsletter will published in two languages Arabic and English, in order to be one facility for communication between advisor engineers in different departments and farmers in different areas of spate irrigation, in addition it share in explaining problems faces the farmers in this areas and supply the proper solution.

This Newsletter is published as one activity of spate irrigation network Yemen branch which is operated by Water Environmental Centre (WEC), Sana'a University, Republic of Yemen with partnership with metameta in the Netherlands.

## Dr. Frank Van Steenbergen

***MetaMeta Director***

It is with great pleasure that the first newsletter of the Yemen Spate Network can be presented. Many trace the origins of spate irrigation back to the rich history of Yemen and up to this day spate irrigation in Yemen is very important with more than 100,000 ha under spate irrigation. Spate irrigation also holds the key to sustainable water management in the country as well as to poverty alleviation. Over the years the spate irrigated areas, especially in Hadramawt, Tihama and southern coastal region, have developed into highly productive systems, with a combination of spate and groundwater irrigation. Yet there is much more that can be done.

In several countries for instance it is now clear that the combination of spate irrigation and groundwater use is superior to almost all other forms of water management - including the development of reservoirs. In Saudi-Arabia recent research indicated that water use efficiency is highest is such systems that combine spate and groundwater irrigation. No water is wasted, as all water is stored as shallow groundwater and used at the right time for high value agriculture. We can further optimize the groundwater recharge impact of spate irrigation. This is now often not well understood, but ensuring the tail areas are also served by floods will recharge wells in addition to bringing the direct benefits of the spate flows. But there are many other important fields of improvement: better field level water management, learning from improved crop varieties in different parts of the world, better grain storage and seriously working on combing traditional and modern engineering.

We hope that the Yemen Spate Irrigation Network will play a large role in this and can be the platform of good experiences within the country and internationally. I want to very much thank the WEC team for leading in this and hope this is the start of the exchange of many good ideas. I also encourage the readers and members of the Yemen Spate Network to contribute their own contributions - either to this newsletter or to the website of the global network - and promote the large potential that spate irrigation has.

## The Network NEWS

- **Community of Spate Irrigation Training in 4th -13th September 2006.**
- **Spate Irrigation Engineering Training well be in July 2007.**
- **Yemen Spate Irrigation Network Web Site July 2007.**
- **There are about 100 member in Global Spate Irrigation Network.**

## *Newsletter Team:*

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WEC Director

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# SPATE IRRIGATION IN YEMEN

**Dr. Sharafaddin A. Saleh**

***Water and Environment Center***
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The Republic of Yemen (R.Y) located at south west of Asia in the South East of Arabian Peninsula. The area of (R.Y) is (550 thousand $Km^2$), about (55 M ha) is the agricultural land. Only about (2.9 M ha) from the agricultural land are cultivable depending on the availability water.
Yemen is a semi arid country. It is one of the oldest irrigation civilizations in the world, where spate irrigation and rain water harvesting techniques were developed more than two thousand year ago. The country sits a stride the major mountain range of the Southern Arabian Peninsula. The mountains benefit from regular monsoon rains, and the numerous ridges and valleys of this range make it possible to raise a range of tropical and temperate zone crops. The warm coastal strips along the Red Sea and the Gulf of Aden are cut by a number of wadis where irrigated farming is possible on the alluvial fans deposited by the stream.

In this semi arid and mountainous country of 55 M ha, only 2.9 M ha are cultivated lands depending on the availability of water. In reality less than 40% (1.1 M.ha) of the potentiality cultivable area is at present cultivated. Rain fed agriculture makes up 61% of cultivated area (671,000 ha). The remaining 39% (429,000 ha) is irrigated agriculture of which (117,000 ha) is under spate irrigation and the rest being irrigated with groundwater. Moreover, spate irrigation contributes heavily to ground water recharge.

Spate irrigation has benefited from considerable investments since 1950s in the Southern coastal region and the 1970s in the Tihama plain, resulting in increased agricultural production. But also increased the dependencies on government institutions to operated and maintain the modernized irrigation systems.

Spate irrigation structures in Yemen's wadis are divided to three types the first is the traditional structures, the second is the modernized structures, and the third is the improved traditional structures.

The traditional spate irrigation systems are based on the Obars, Athoms and Ogmas that are manual built by the local farmers. The Athom is earthern bunds surrounded the field/ or basin , which is 1 – 1.5 m hight with 5 -6 m base width , it is impounding 50 to 60 cm water depth in field or basin. The Obar is a small earthen banks, that form of temporary supurs projecting into wadi flood water over the adjacent fields. The Ogma is low earthen or stone spreader dyke, constructed across the stream of the wadi to divert the entire low stage flow of the flood into the fields.

The modernized spate irrigation is the permanents diversion structure with all its component (weir, sluice way, fuse blug, head regulators with gated intakes, and sediment ejector or still basin). Several of these structures were constructed in most of the major wadis in Yemen.. some of them constructed with two intake structures in both sides of the wadi, and other constructed with one intake to transition canal and then divert the water to the other wadi side by constructing a siphon under the wadi bed.

The improved traditional spate irrigation structures are the traditional structures strengthen by gabion, masonry, or wooden materials. This kind of structure is combined structure from embankment materials with Gabions or Masonry spillway and intakes. Some times the Gabions is used for free intake or weir.

In recent in the 1970 s the country has fallen into a water crisis from mining of ground water, and extreme water supply. The main causes are the rising demand from the population development of market led agriculture, uncontrolled ground water exploitation and promotion of expansion rather than efficient use and sustainable management.

# RAINWATER HARVESTING SYSTEMS

**Dr. Taha Mohammed Taher**

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***Rooftop water harvesting systems***
The roof water harvesting in Yemen has the advantage of being low cost, relatively simple in design (household technology), less laborious and it saves time. It provides adequate water during the rainy season, a period when the rural people are busy with farming activities. They are more appropriate in mountainous areas where there are no ground water sources, and where rainwater is the only feasible means of providing a water supply. In such areas it is difficult to think that communities can be served by a centralized water supply schemes which proved to be very expensive in terms of implementation, operation and maintenance. Other sources require long walk and time for women and children to fetch water. The quality of water is also reported as good compared to other water sources in the rural areas.

In Taiz Region, during the rainy season, roof water is collected in a dug-out structure, known as Seqaya. These structures are excavated into the hard rocks. In addition to roof water surface runoff is also collected into the hard rocks. Surface run-off is also collected into the dug-out structures for multifarious uses. In hilly areas of Al-Hujaria District, roof with provision of border-line lead pipe and outlet is common. The harvested rainwater, in turn, is guided to an underground storage tank through a settling tank for domestic use.

***Terracing***
The objective of terracing in these regions is to collect rainfall for farming and slow down the runoff process. Rain water collects in the terraces and soaks into the shallow soil. Walls at the edge of the terraces prevent runoff form flowing down to the next terrace except during intense rainfall events. The walls of the terraces are built of stones, while voids between the stones allow water to move down to successive terraces without eroding the soil. Water can also move from level to level near the sloping bedrock. Subsurface drainage is required in these areas to channel flow from one terrace to the next trap fine sediment. They are designed and constructed in a manner to allow the passage of runoff through sheet flow, which prevents damage to the terraces from runoff concentrating at certain points. This method is effective if terraces are constructed in the upper parts of the wadi.

Plate 1Terraces on mountain slopes in the Yemen Highlands

***Ponds***
Farm ponds are small storage structures used for collecting and storing run-off water. As per the method of construction and their suitability for different topographic conditions farm ponds are classified into 3 categories, viz. Excavated farm ponds suited for flat topography, embankment ponds for hilly and rugged terrains with frequent wide and deep water courses; and excavated-cum-embankment type ponds. Selection of the location of the farm pond is dependent on several factors such as potentiality for yielding sizeable quantity of run-off, rainfall, land topography, soil type and structure, permeability/water-holding capacity, land-use pattern etc. Structurally, the excavated farm ponds could be of 3 types: square, rectangular and circular. All farm ponds must have the provision of removal of excess run-off water by providing 'drop inlet spill-way under normal condition' and 'emergency spill-way' to dispose off overflow of water after heavy rains. Such spill-way should ideally discharge into a grass waterway to avoid excessive erosion.

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# FLOOD WATER HARVESTING

**Dr. Abdulla Noaman**

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Flood water harvesting, known as 'large catchment water harvesting' or 'Spate Irrigation', is the simplest type of water harvesting, where cultivated areas lie within and immediately adjacent to an ephemeral stream or wadi. It is rations the occasional floodwaters form storms in the mountainous catchment areas to the coastal and foothill areas.

Traditionally, agriculture in Yemen has depended on dry farming using either rainfall or spate irrigation. Rained agriculture is practiced on terraces in most of the highlands, while spate irrigation is practiced along the wadi courses and coastal plains of Tihama and south and eastern parts of Yemen. More than 1.6 million hectares are regularly cultivated. Of the cultivated area, 50% is rain fed, 32% under well irrigation, and 18% under spate irrigation and base flow. Spate irrigation is widely used in Yemen for the production of major crops; A large portion of the cultivated area relies on spate irrigation. Figure 1 shows the irrigated area under floodwater harvesting in Yemen and other countries in North Africa and the Middle East, according to FAO (1997).

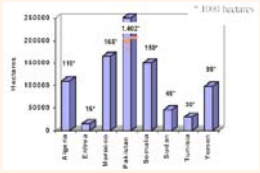

Figure 1 Area under spate irrigation in selected countries (FAO, 1997)

The country's particular topographic structure affects and modifies the climate on a regional basis, especially rainfall distribution, and influences the availability of water for agriculture. The majority of Yemen consists of rugged terrain of igneous and metamorphic rock. Some areas receive rainfall in excess of 500 mm/yr. Extensive terracing is being practiced in the mountainous areas.

The hydrographic system of Yemen consists of rain fed watercourses (wadis) occasionally flooding but usually dry, draining from the main watershed along the three major escarpments. In the rugged slopes of the Western escarpment seven major wadis run toward the Red Sea, which they sometimes reach during periods of heavy rain. In the southern slopes the wadis of Tuban and Bana run, through a similar but less precipitous course, to the Gulf of Aden. Table 4 presents average of total annual flow at some selected wadi in Yemen.

Table 1 Mean catchment yield for gauged wadis in Yemen(Van der Gu, and Ahmed, 1995)

| W. Name | Bana | Zabid | Surdud | Mawr | Adhana | Masila | Tuban | Jaza'a |
|---|---|---|---|---|---|---|---|---|
| Catchment Area ($km^2$) | **6200** | **4632** | **2370** | **7912** | **8300** | **22500** | **5060** | **15000** |
| Average Annual flow ($Mm^3$) | **169.9** | **125** | **69.3** | **162.3** | **87.5** | **51** | **109.4** | **60** |

The floods of the wadis in Yemen are generally characterized by abruptly rising peaks that rapidly recede. In between the irregular floods the wadis are either dry or carry only minor base flows. Surface water is considered to be an important source for irrigation in Yemen; it is estimated to be about 1,500 $Mm^3$/year. Several dams and dikes were built on many main wadis for the purpose of directing spate waters into man made spate irrigation systems. Cultivation of flood is carried out through the sources of water include either direct rainfall or flood water spate. The flash flood, as it appears along the wadi banks, is diverted using temporary structures to small individual farmlands located along the wadi banks, and the diverted water is spread into the field as to irrigate crops.

Cont'd **(RAINWATER HARVESTING SYSTEMS)**

**Cistern system**

*Karif* or *Majel* is a local name for cistern in the mountainous area of Yemen. It is generally underground tank, constructed from masonry or concretes and usually covered and used for the collection and storage of surface run-off. This system of rainwater harvesting is also common in the rural areas of Botswana, Ghana, Kenya, India, Sri Lanka, Thailand and Indonesia. Water thus collected in is generally used for drinking and other domestic uses.

***Medium-size catchment water harvesting systems***

Medium-size catchment runoff farming refers to large-scale rainwater harvesting. This may be the diversion of a natural wadi, or a wadi flowing from a natural catchment. The collected flow is immediately diverted by a diversion structure to flood irrigate an adjacent agricultural field. The catchment should be big enough to provide the needed irrigation water. The diversion structure may consist of a stone barrier across the wadi or the intermittent stream. When the rainwater flows into the wadi, it will be slowed down and diverted from its course in the stream channel to flow over the rather broad flat floodplain bordering the wadi. Strategic placement of rock barriers and crops will allow the maximum use to be made of the floodwaters with the minimum damage to land and crops. Careful design and layout are necessary to withstand floods and prevent erosion.

The open ponds are mainly used for watering animals. In Tunesia, the "Meskat" and the "Jessour" (see Figure 1) systems have a long tradition and are also still practiced. The "Jessour" system is a terraced wadi system with earth dikes ("tabia"), which are often reinforced by dry stone walls ("sirra"). The sediments accumulating behind the dikes are used for cropping. Most Jessours have a lateral or central spillway (Prinz, 1996).

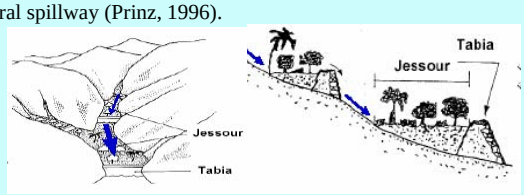


Figure 1. A row of "Jessour" in the South of Tunesia. (Prinz 1996).

# TRADITIONAL SPATE IRRIGATION STRUCTURES IN YEMEN

**Eng. Osama Hamdan**

***Tihama Development Authority***
***Ministry of Agriculture***

The fundamental feature of traditional spate irrigation systems in Yemen is the well-established principle which gives upstream irrigators priority rights to water abstraction over the downstream users. With traditional systems, modest and often temporary deflectors allow water to pass to lower off-takes, thus creating a perception amongst farmers, of a large degree of fairness in water utilization

Spate systems are made in such a way that ideally the largest floods are kept away from the command area. Very large floods would create considerable damage to the command area. They would destroy flood diversion channels and cause streams to shift. This is where the ingenuity of many of the traditional systems comes in. Spurs and bunds are generally made in such a way that the main diversion structures in the river break when floods are too big.

**Free Wadi Intake works:**

Free wadi intake works divided into two types:

A) *Earthen dyke across the wadi (Ogma)*: Local farmers build an earthen dyke or (Ogma) of wadi bed material across the low flow channel of the wadi, with the object of diverting the entire low stage of the spate flow to their fields. Usually this type used to irrigate large area, it is costly work, many farmer benefits and they share construction cost.. See (Figure 1 and photo 1and 2)

## SOCIO-ECONOMIC FACTORS

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***Participation***

Rainwater harvesting projects are to assist farmers to improve their production systems; therefore, it is important that the farmer's priorities are being considered. If the priority is irrigation water, the response will be then for water harvesting systems for crop production. Once the priority is defined, it is becoming more widely accepted that people should actively involved in the projects development. It is important that the beneficiaries participate in every stage of the project; planning, construction and operation and maintenance stages.

Yemeni farmers in wadis have been practicing participation for centuries. During flood seasons, they involved intensively in the preparation of traditional deflectors or earth bonds where they the farmers in the area participate in the construction either by providing labor, tools or money. Each farmer has to pay his share in these activities according to his commitment and property (Tahir, et al, 1996).

Widespread adoption of water harvesting techniques by the farmers is the only way that significant areas of land can be treated at a reasonable cost on a sustainable basis. It is therefore important that the systems proposed are simple enough for the people to implement and to maintain. To encourage adoption, apart from incentives in the form of tools for example, there is a need for motivational campaigns, demonstrations, training and extension work (Critchley, et al. 1991). Throughout the course of the season it is helpful to involve people in monitoring, such as rainfall and runoff and recording tree mortality.

After the first season it is the farmers themselves who will often have the best ideas of modifications that could be made to the systems. In this way they are involved in evaluation of the water harvesting systems.

***Gender and equity***

If water harvesting is intended to improve the lot of farmers in the poorer, drier areas, it is important to consider the possible effects on gender and equity. In other words, will the introduction of water harvesting be particularly advantageous to one group of people, and exclude others. Perhaps water harvesting will give undue help to one sex, or to the relatively richer landowners in some situations. These are points a project should bear in mind during the design stage. It is apparent from farming experience in several of the Arab countries such as Egypt, Syria, Yemen, etc. that women are involved extensively in helping the man in the fields and that she is a complete partner with the man.

***Land ownership and management***

Land ownership issues can have a variety of influences on water harvesting projects. On one hand it may be that lack of ownership means that people are reluctant to invest in water harvesting structures on land, which they do not formally own. Where land ownership and rights of use are complex it may be difficult to persuade the cultivator to improve land that someone else may use later. On the other hand there are examples of situations where the opposite is the case - in some areas farmers like to construct bunds because it implies a more definite right of ownership.

The most difficult situation is that of common land, particularly where no well-defined management tradition exists. Villagers are understandably reluctant to rehabilitate areas, which are communally grazed. Land management by communities has recently been acknowledged to be extremely important. Degraded land can only be improved if the communities themselves face land management issues. Water harvesting is one of the techniques- amongst several others- that can assist in rehabilitation of degraded land.

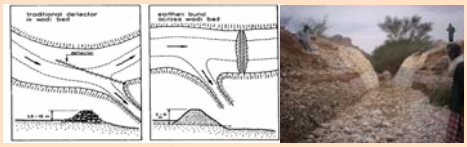

Figure 1 Schematic layouts of the traditional spate irrigation in Yemeni wadis and canal free intake in Wadi Hadramout

*Earthen deflector dyke*: this dyke is used to diver part of wadi flow to wadi side. It is constructed parallel to wadi direction. Usually this work is done to irrigate small area. This dyke is also washed out by high floods.

**Field structures**:

***a) Drop structure*:**
is used to divert water from field to field when there is different in elevation between them. It constructed to protect lands from erosion.

***b) Breaching Structure*:**
is used to divert water from field to field when there is no different in elevation between them. It constructed to maintain water flow within the structure.

***c) Spilways (Al Masakhil):***
The purpose of this structures is to control the quantities of water which enter the main spate canal. Al Masakhil is usually built on the earth embankment of the canals from medium size stone. The frame of the structure on both sides of the embankments goes down deep in to the undation, so the supporting soil has no direct contact with the water

## *Announcement*

Who would like to be member in Spate Irrigation Network can fill the APLLICATION form and send it with the CV to Dr. Sharafaddin A. Saleh at this address:

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