

SPATE IRRIGATION IN YEMEN

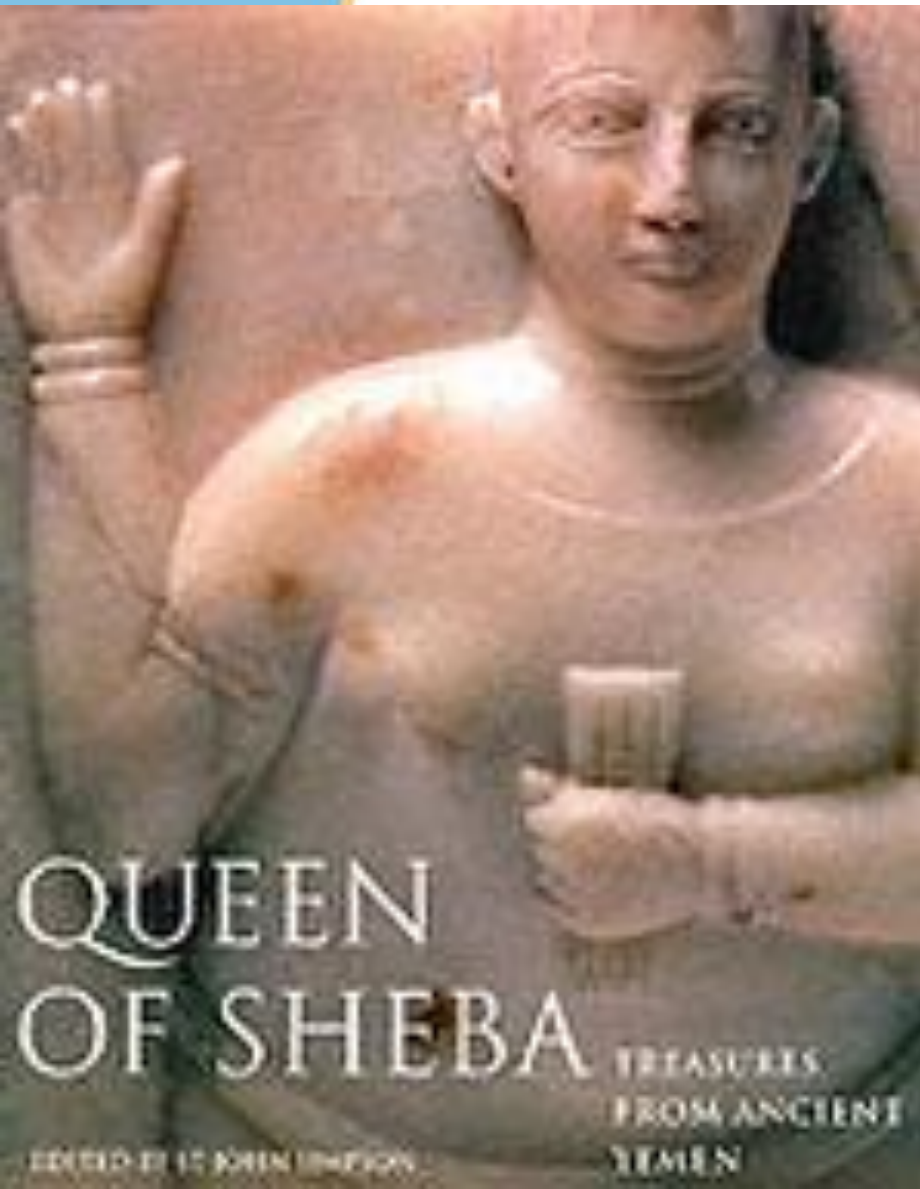
By
Dr. Sharafaddin A. Saleh



SPATE IRRIGATION IN YEMEN



Was spate irrigation invented in Yemen?



Mar'ib Dam

سد مأرب

- Construction is started 5000 years ago
- Barrage 18 meter high and 700 meter long
- Irrigation off-takes on both sides (60 cubic meter/s)
- Command area of 9600 hectares
- Supported population of 30-50,000 people
- Final catastrophic breach 2400 years ago





Box 1.1 Mar'ib Dam (continued)



Figure 1.2 Remains of the Mar'ib dam left bank abutments and irrigation off take, Yemen



and satellite image for recent Marib dam
and old Marib dam

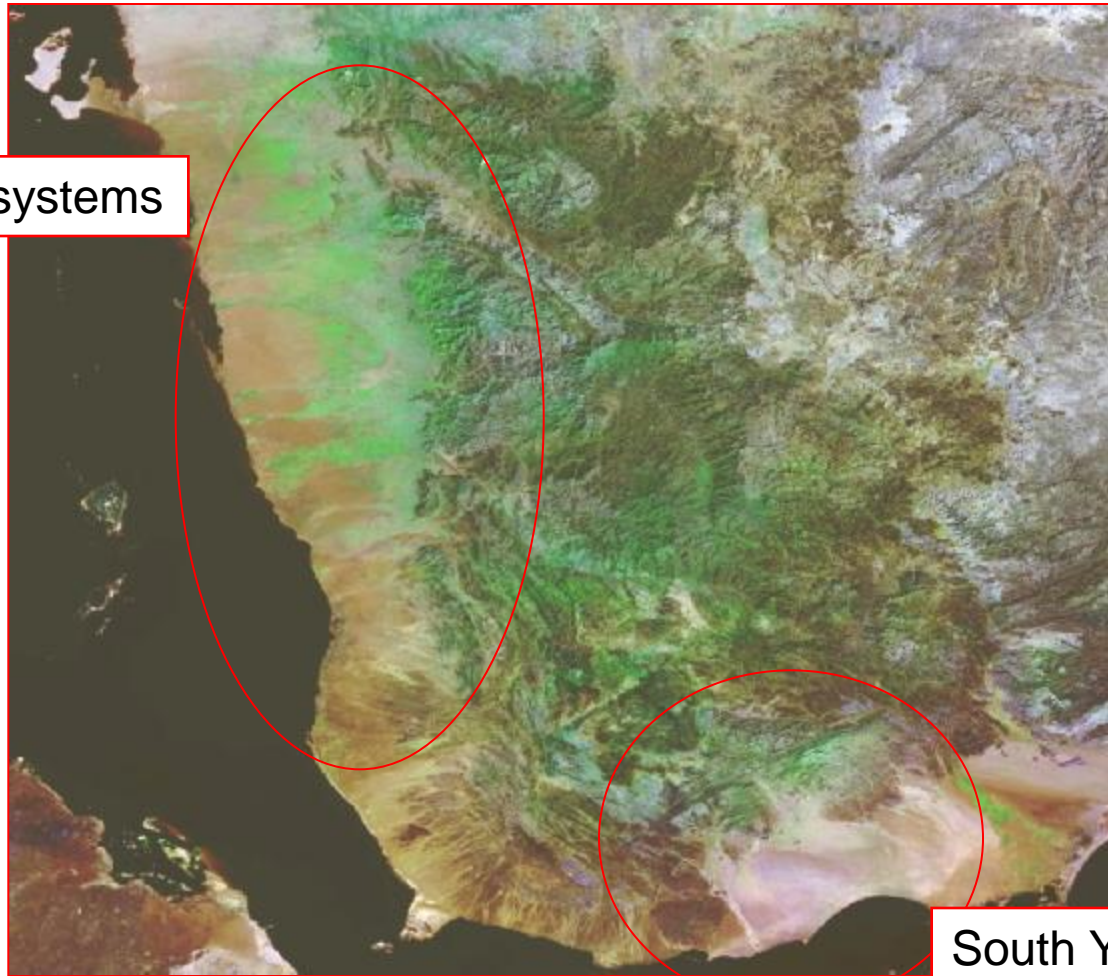
Yemen satellite image map



Type of spate systems in Yemen:

(1) large coastal systems

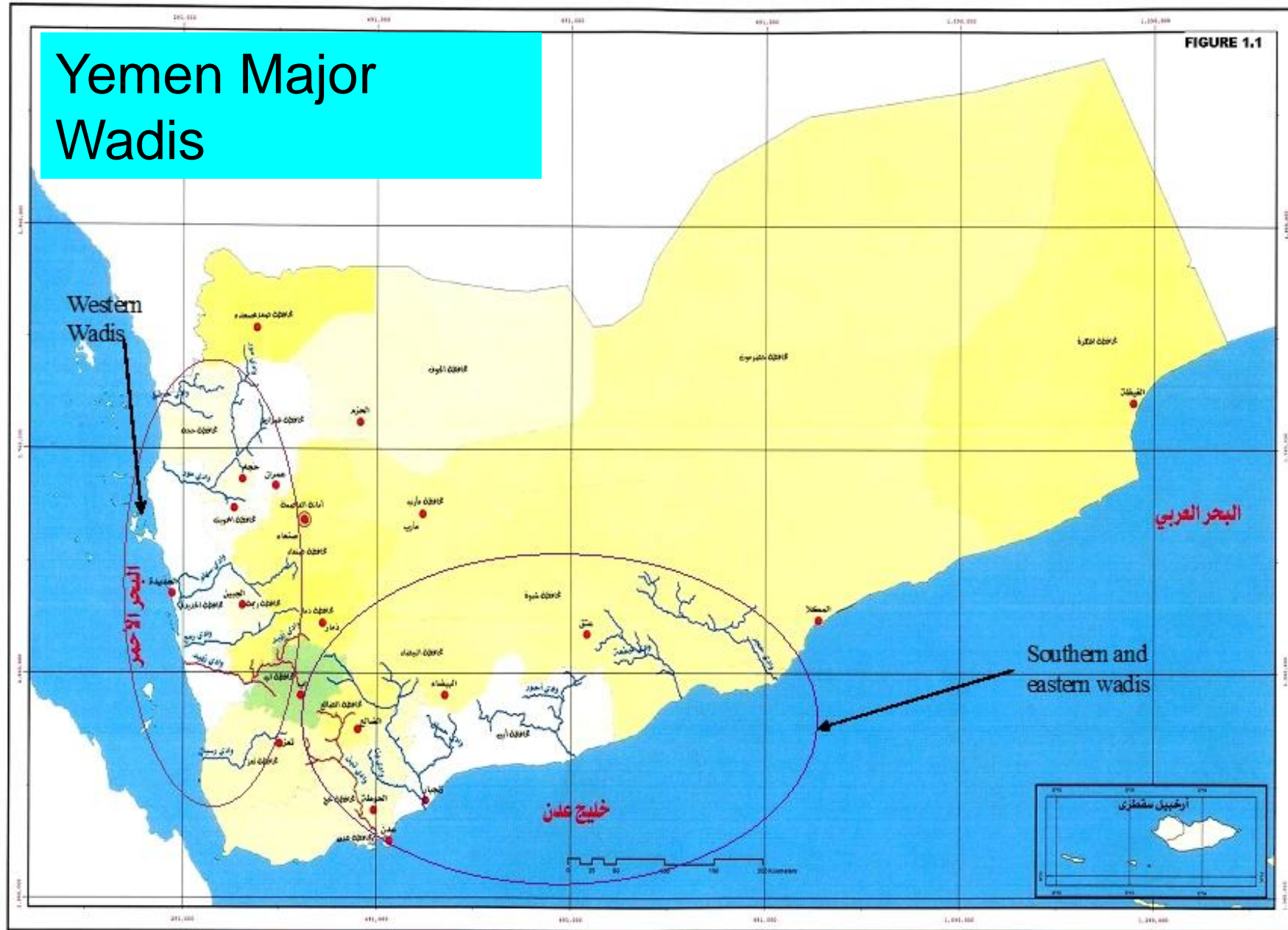
Tihama systems



South Yemen
Systems



Yemen Major Wadis



Rainfall in Yemen is characterized as:

- The Red Sea Convergence Zone from March to May (the summer season (Sief Season))
- A monsoonal Intertropical Convergence Zone from July to mid October (the autumn season (Kharif season)).
- The Mediterranean Zone that causes occasional light rainfall events in the dry season from December to January.



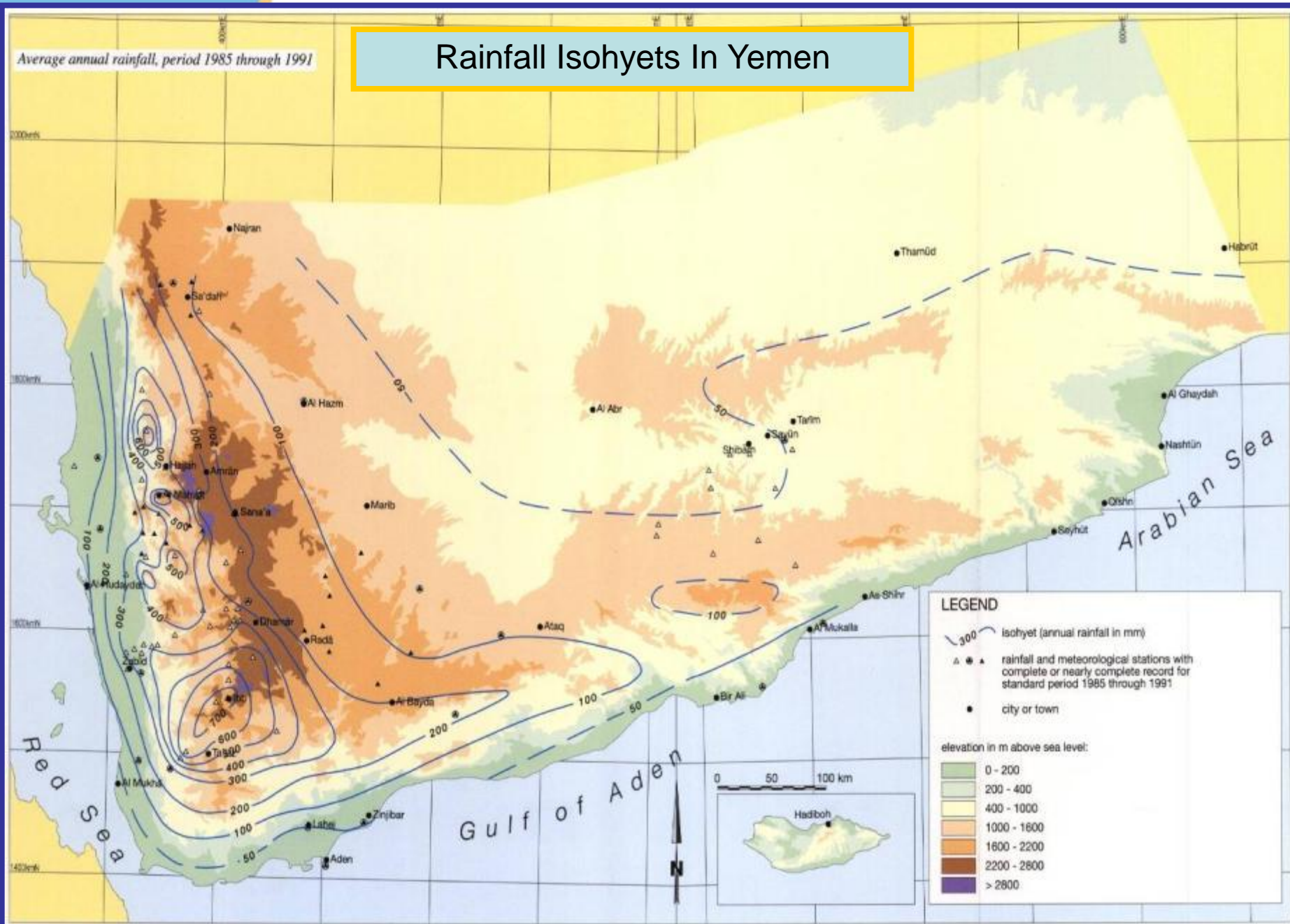
➤ The average rainfall fluctuates from 50 mm /year in the castle plain and Eastern regions To 300 mm/year in the middle altitude areas and Southern provinces.

➤ The rainfall exceeds to 800 mm/year at the wadis catchments areas in the central and Southern highlands of Yemen



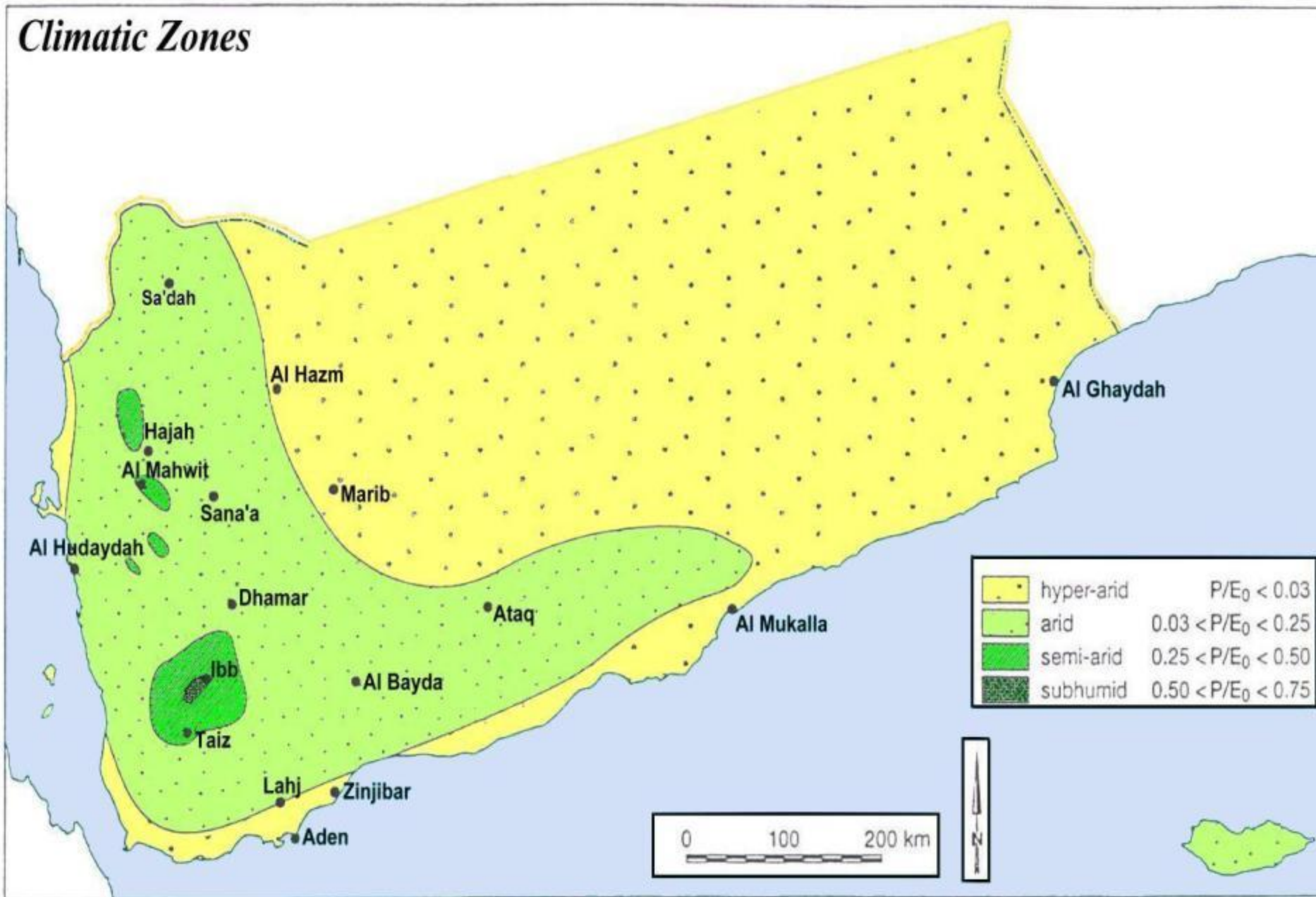
Average annual rainfall, period 1985 through 1991

Rainfall Isohyets In Yemen



Yemen map with different climatic Zones

Climatic Zones



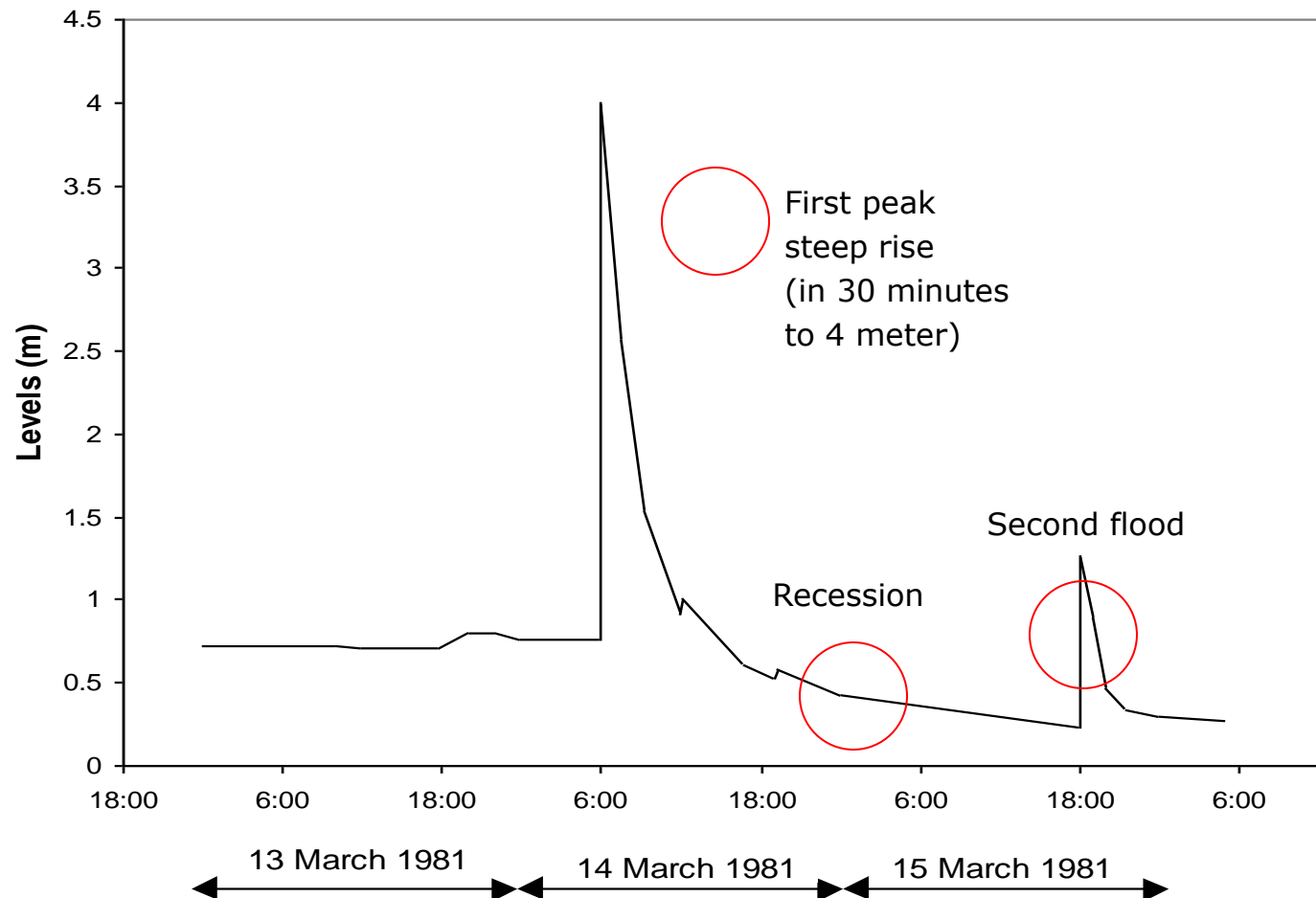
The Mean Annual flows and Catchments Areas for Major Wadis in Yemen

Escarpment	Name of Wadi	Catchment area (km ²)	Mean Annual rainfall (mm)	Mean Annual flow (Mm ³)
Western	Mwar	8,000	480	210
	Surdud	2,700	650	121
	Siham	4,900	500	130
	Rima	2,700	570	103
	Zabid	4,700	560	164
	Rasyan	2,000	500	54
Southren	Bana	7,200	349	160
	Tuban	5,090	224	125
	Hassan	3,300	300	30
Middle	Al-Jawf	14,000	140	35
	Adhanah	12,600	Not available	Not available
	Ahwar	7,250	100	40
	Maifaa	6,000	200	30
	Baihan	3,600	150	54
	Hajr	9,324	80	228
Eastern	Hadramaut	113,900	63	230
	Masila	Not available	200	27

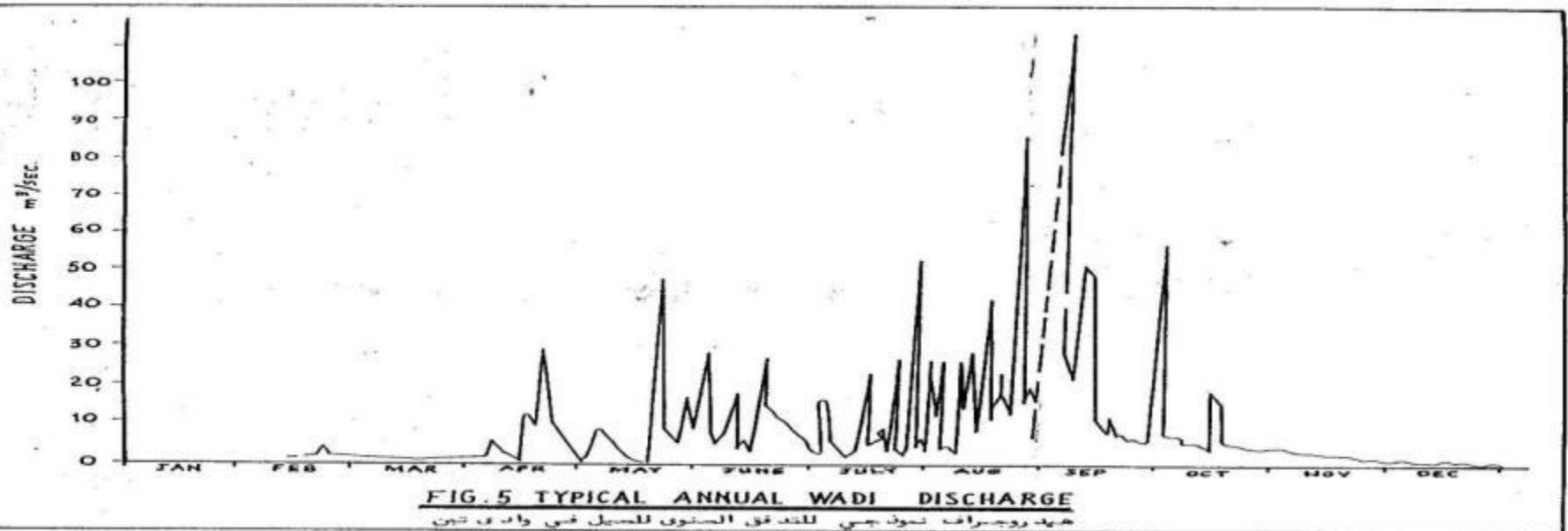
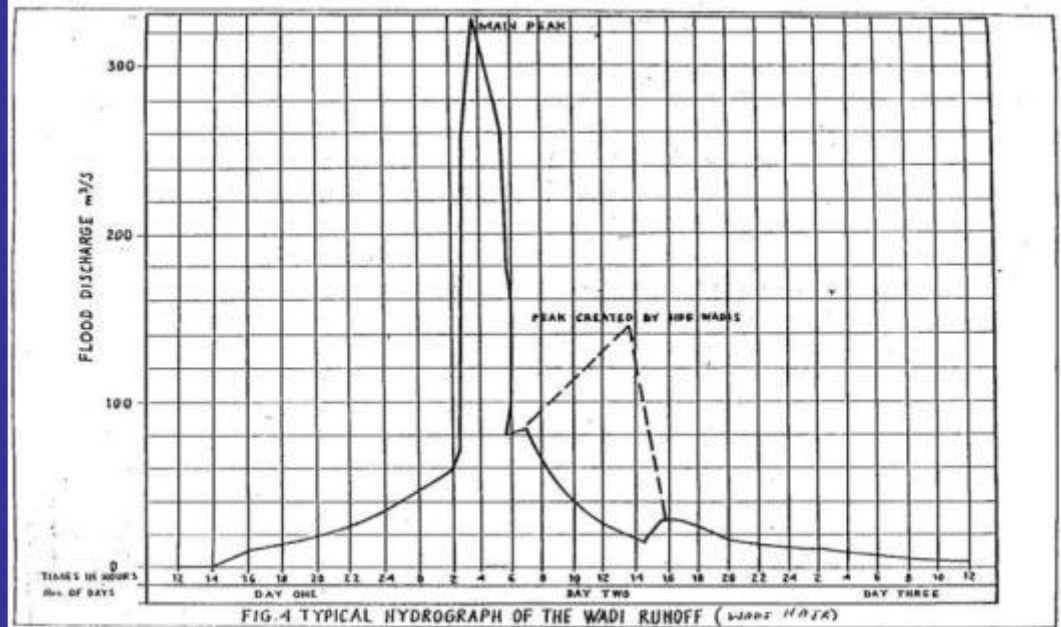
Source: Participatory Spate Irrigation Management Study

Example Flood Hydrograph (Wadi Rima)

Water level record - Mishrafah March 1981



Flash flood in wadis in Yemen



As a result every wadi has different strategy for diverting water, that relates to flood patterns, shape and level of command area and groundwater conditions

- Capture the base flow?
- Divert the small and medium sized floods only or also capturing the peak floods?
- Improve groundwater recharge?



Spate Irrigation Potential

➤ Spate areas increase from (117,000 ha) in dry years to (165,000 ha) in wet years.

➤ The spate irrigation systems is defined as:

❖ Small scale Irrigation systems (SSI)

- range from a few hectares to 300 ha most
- Wadis upper catchment's
- traditional systems made by farmers.

❖ Medium Scale Irrigation systems (MSI)

- ranges from 300 ha to 2000 ha
- the Wadis middle catchment's and upstream lower part.
- mostly made by farmers and some times local authority.
- most of them are tradition or improved.

❖ Large Scale Irrigation systems (LSI)

- More than 2000 ha
- exist in the western and southern coastal plains
- modern systems or improved traditional systems
- most of them constructed by Government Authority and Ministry departments.



The common Spate Irrigation Systems in Yemen & responsibility of Operation and Maintenance (O&M)

Infrastructure O&M	Traditional Systems (TS)	Improved Infrastructure (II)	Modernized/ and New Systems
Farmers (F)	F (S)		
F + Local Gov (LG)		F + LG (M)	
F+ Agency (A)		F + A (L)	
F + LG + A			F + A (M and L)
Special Agency			(L)

(S) Small System (M) Medium systems (L) Large system

Spate Irrigation Water Resource

- Surface Water (flood water or spate water, springs, and Wadis Base Flow).
- Ground water.
- **The flood occurs in two seasons (Seif and khsrif)**

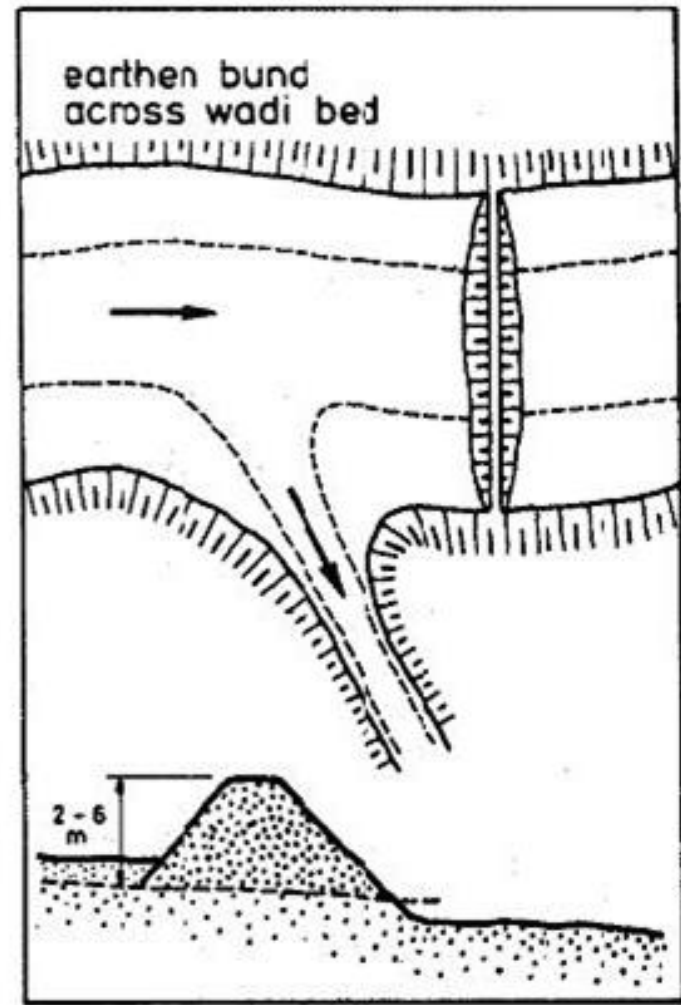
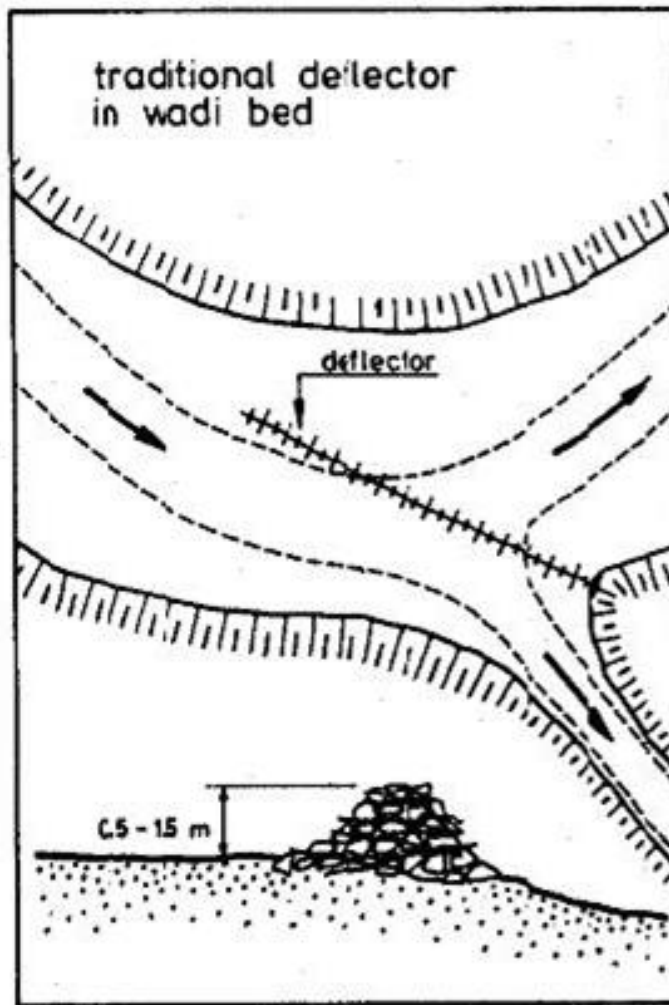


Spate Irrigation Diversion Structures Systems

- Traditional Spate Irrigation Systems
- Improved Spate Irrigation systems
- Modern Spate Irrigation Systems



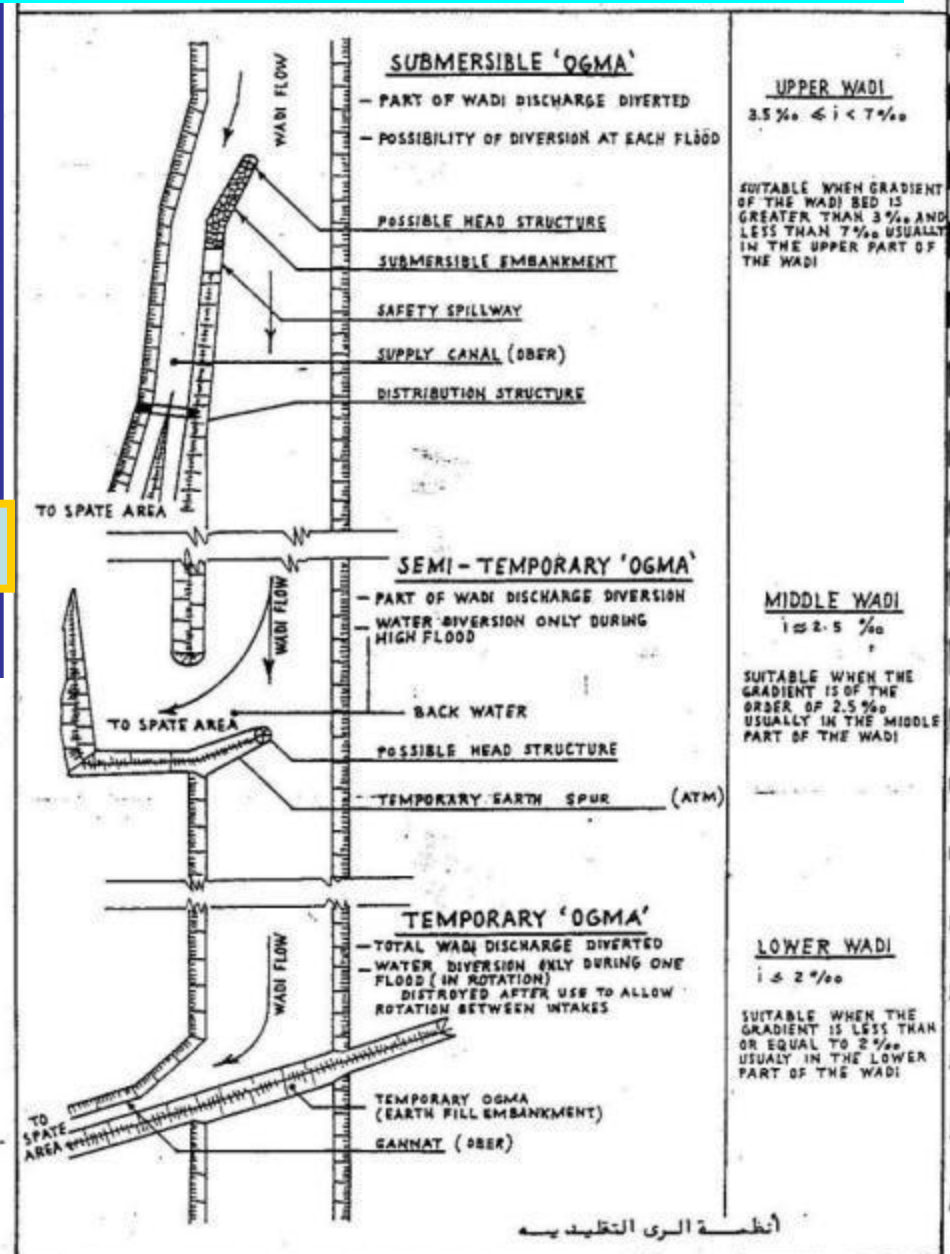
Traditional Spate Irrigation Systems



Traditional Spate Irrigation Systems



Traditional diversion structure in Yemen





Traditional Spate Irrigation Systems





Improved Spate Irrigation systems



Wadi Siham Dabashia diversion downstream1



Improved flood channel open intake



Improved Spate Irrigation systems





Modern Spate Irrigation systems



Modern Spate Irrigation systems



Modern Spate Irrigation systems

The irrigated areas in Major Wadis in Yemen

Escarpment	Name of Wadi	Irrigated areas (ha)	Notice
Western Wadis	Mwar	17,000	Traditional systems (9,000ha)
	Siham	10,929	
	Rima	7,100	
	Zabid	15,215	Sometimes extended to (21,000ha)
	Rasyan	Not available	
South and Eastern Wadis	Bana	25,722	
	Tuban	11,000	
	Hassan	6,300	
	Ahwar	7,000	
	Hadramaut	8000	The flood occur every 1.5- 2 years

Estimated rehabilitation cost for some Spate Irrigation systems in Yemen Wadis

Project Name (related to Q18)	Type of Intervention	Rehabilitation Cost (US\$/ha)
Wadi Mawr system	PHL	3830.6(estimated)
Wadi Rima system	PHL	2312.7(estimated)
Wadi Siham systems	PHL	1756.8(estimated)
Wadi Zabid systems	PHS	231(actual)
Wadi Bana system	PHS	3544.3(estimated)
Wadi Ahwar systems	PHS	1555.71 (estimated)
Wadi Tuban systems	PHS	388 (actual)
Wadi Hadramout systems	NPH	(improved traditional structures) cost from 31\$/ha for small project to 18267\$/ha for large project
	PHS	(Moaza Shibam)

(NPH): Non permanent headwork including soil bunds, gabion structures and diversion channels
 (PHS): Permanent headwork for small systems including diversion weirs and guide bunds
 (PHL): Permanent headwork for large systems including diversion weirs, breaching bunds and siphons
 (M): Maintenance costs

Spate Irrigation Water Distribution and Water Rights

- (al a'la fal a'la) or Al-Arda'a ful Al-Arda'a
- Spate water right is based on "Aurf" and Al- Shareiah or traditional custom rights



A. Water Rights in Wadi Hadramout



First Rule is proportion of the flow going to different flood channels and fields

A. Water Rights in Wadi Hadramout



Second Rule is the flow distribution according to nearest field and fields elevations by gated or un-gated field channel with different channel bed elevation



Third Rule water depth control in field by elevated spillway or tail gates



B. Water Rights in Wadi Bana

- Specific program for spate water distribution are made for every season by the Irrigation Department with the help of local committee
- The priority is given to un-irrigated land in the last season, and for fields which have salinity problem and cereals fields.



Cropping Pattern in Spate Irrigation Areas

serl	Crop	Area (ha)	Yield (Tons/ha)
1. Wadi Tuban (improved wadi)			
1	Cotton	89	1.32 to 2.02
2	Sorghum grains	38.5	0.77to 1.85
3	Sorghum fodder	70	0.81 to 1.1
4	Sesame	48.5	0.65 to 0.88
5	Groundnut	30	0.53 to 0.78
2. Wadi bana			
1	Cotton	1890	1.28
2	Sorghum grain	1312	0.98
	Sorghum fodder	3265	11.5
3	Sesame	756	1.02
	Groundnut	677	0.71
4	Water Melon	225	8.73
5	Sweet Melon	86	5.86

Cropping Pattern in Spate Irrigation Areas-----Continued

3. Wadi Hassan			
1	Cotton	472	1.28
	Sorghum grain	328	0.98
	Sorghum fodder	816	1.02
3	Sesame	189	0.71
	Groundnut	169	8.73
	Water Melon	56	5.86
5	Sweet Melon	22	0.98
4. Wadi Siham			
1	Sorghum	458.5	0.525
2	Sesame	5.0	0.83
5. Wadi Rima			
1	Sorghum	221.5	0.63
2	Sesame	38.5	0.97

Cropping Pattern in Spate Irrigation Areas-----Continued

6. Wadi Zabid (improved)			
1	Cotton	320	1.2 to 1.9
2	Sorghum grains	96	0.8 to 1.3
3	Sorghum fodder	50	6.8 to 8.8
4	Sesame	50	0.49 to 0.71
5	Maize	30	2.78 to 3.7
7. Wadi Hadramout			
1	Sorghum grains	not available data yet)	not available data yet)
2	Sesame	not available data yet)	not available data yet)
3	Dates	not available data yet)	not available data yet)
4	Wheat	not available data yet)	not available data yet)
5			



Net annual revenues from spate irrigation in US\$ per household

Project Name	Number of Households	Net Annual Revenues (US\$/Household)	Note
Wadi Mwar systems	17174	6474	
Wadi Rima systems	68233	6394.5	
Wadi Siham systems	17470	5450	
Wadi Zabid systems	1531	-----	Not available
Wadi Rasyan systems	-----	-----	Not available
Wadi Bana systems	20941	8671	
Wadi Ahwar systems	3405	6474	
Wadi Tuban systems	13203	-----	Not available
Wadi Hassan systems	-----	-----	Not available
Wadi Hadramout systems	-----	-----	Not available

Soil Moisture Conservation in Spate Irrigation Areas

- **Farmers plough their lands before irrigation in order to make loose soil and increase the water percolation in soil depth.**
- **plough after irrigation to keep the soil moistures.**
- **Farmers do mulching for the ploughed wet soil after irrigation to keep soil moistures.**



Spate Irrigation Constrains

- The spate water fluctuations with rainfall from season to another and from year to another.
- Farmer's dependency on the government financial support for the construction of the new system, and operation and maintenance of existing systems
- High sediments concentration in floods
- The crops yield marketing is not organized and has not its opportunities for better marketing.
- The applied water is more than needed CWR
- Field to field irrigation





Recommendations

- Applying the canal water distribution method
- using adjustable or equitable water rights
- using the improved tradition diversion structures
- Sharing the farmers communities in the structures site selection and design
- Sharing the farmers communities in the O&M of canal and head-works structures



Thank you

