SPATE IRRIGATION
IN
NORTH WEST FRONTIER PROVINCE
OF
PAKISTAN

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Spate irrigation System in North West Frontier Province -
DI Khan and Tank Districts

Introduction

Dera Ismail Khan (DI Khan) is the south most district in North West Frontier Province (NWFP) of Pakistan. It is an old town established by a Baloch leader Mr. Ismail Khan of famous Mirani tribe. Three brothers established towns in 16th century on their own name, i.e. Dera Ghazi Khan, Dera Fateh Khan and Dera Ismail Khan respectively. DI Khan district is now divided into two districts, DI Khan and Tank, and are famous for spate irrigation since unknown times. It is worth mentioning that alone two districts (DI Khan and Tank) have about half share of all cultivated lands in the province.

Spate irrigation -Background

This unique irrigation system is prevailing since long time in these two districts and rules and regulation are agreed and legitimized by the users and government also. The spate irrigation system of NWFP is special in terms of established rules and procedures. It is able to provide livelihood to million of people since long time. Major hill torrents also provide possibilities of extension in the command area under this system. Actually it is the social organization behind it that supports the expansion of command areas under traditional laws and this makes it unique as compared to other spate system in DG Khan, Balochistan and else where in the country.

Free and excessive water flowing from nearby hills after rains has compelled local farmers to draw rules and procedures to cope the situation in extremely difficult circumstances. However, courageous farmers and local leaders could face the challenges of nature by controlling the spate flow and diverting required amount of water to fields in all possible manners through local resources. Before the emerging of British rule in second half of 19th century spate irrigation system was managed by local leadership and farmers. British rulers strengthen the system by providing institutional support in the form of creating revenue wing with the name of Rod-kohi.

British Period

The main work done by a British officer Mr. H.N. Bolton during his tenure as collector and deputy commissioner in 1908 is key reference for any arbitration and conflict resolution. The initial work was completed during the first settlement of 1872.

In this region (DI Khan and Tank), by realizing the importance of spate irrigation, British officers have done extra ordinary efforts to facilitate the floods in the favor of local farmers. They consulted and listened them carefully and then with the help of local population spate system was reorganized where felt necessary, appropriate and not in conflict with any party. Even in some cases entire torrent has been trained in such a way that losses are minimized and benefits are optimized. By doing so new areas were brought under agriculture in those days. This in fact had helped for in migration to spate irrigation areas from near by areas and villages. Politically it has several advantages and impact on a whole in those days; grain production increased on the far most region of British Indian empire which has positive impact on non-controlled tribal population, spate irrigation brought stability, rest and peace due to permanent agriculture, nomads stopped or at least decreased and local population became happy and passive. New areas under agriculture has resulted more humans to settle, cultivate and use these fields as tenants.

Communal work required to construct *sadds* and other structures need institutional support. According to traditional laws local water user association was responsible for providing labor, animals and associated material. British officers soon realized that alone local users association is not enough therefore facilitated the construction process during the peak season and emergency situation. Any members not participating in Kamara will have to pay fine at the rate of half rupees in those days when Indian rupee was equal to British pound. Besides this British officers realizing the constraints of shareholders limited capacity, started providing labor on the government behalf from nearby villages. This practice has helped to strengthen the system but also to win the hearts of people by providing livelihood opportunities in the form of labor contract.

Present Situation:

Unfortunately scientists and policy makers do not properly understand spate agricultural system, as it is not a part of curricula in academic institutions. Therefore scientific research on its various important aspects such as civil structure, social organization, varieties of strain and its improvement has not taken place on wider scale. Farmers still use the old and traditional varieties, which are quite fit under the eco system but yields poorly. However, alls spate areas have considerable number of livestock mostly depending upon fodder, residuals, stalks, trees, bushes and shrubs naturally grown after flooding in this area.

In DI Khan and Tank districts spate irrigation system receives water from two sides of these districts, i.e. Suleman range form western side and Laki-Marwta ranges from northern side. Water is controlled in the hill torrent through a temporary dam (soil structure) and diverted to nearby fields – sometimes directly but usually through sub streams. Incase of sub streams again another dam (soil structure) is constructed and water is diverted to fill the fields locally know as bund, bundra or bundari. Upon filling of these fields dam is broken. After filling the first portion now water in the main torrents starts flowing down stream and is controlled by another similar structure. Fields on both sides are filled and then dam is broken and so on.

Area/Location:

Presently spate irrigation is prevailing in Tank district, Kullachi Tehsil and upper portion of DI Khan district. The total area of two districts DI Khan and Tank is 22.15 million acres. Out of which 1.7 million is irrigated. Among irrigated area approximately 0.63 million cares is cultivated through spate irrigation (GOP, 1989) every year. Here many of these hill torrents also have considerable discharge of perennial flow that is quite different than other hill torrents of Suleman range and other regions. Since area did not have other alternatives of irrigation therefore, spate irrigation system was dominant till Chashma right bank canal project was completed in 2000. However, importance and magnitude of spate system is still extra ordinary and potential remains there. Since the start of Chashma right bank canal (CRBC) area east of canal is no more irrigated by spate flow. However, area in western direction is still irrigated by spate flow as previously and there is a potential to increase larger area under this system.

Water Use and Institutional Support:

According to estimates of local farmers even today 20 to 25 % spate flow in DI Khan and Tank districts is utilized and rest is drained into Indus River. The department of Rod-Kohi has no engineer and depends upon agricultural engineering department for heavy earth moving machinery. Agricultural engineering department has about 10 bulldozers while according to magnitude and scale of work at least 100 bulldozers are required throughout the year. Moreover, bulldozer operators do the construction work without guidance from engineers. The result is that more time and funds are wasted in this way. Revenue department does help by providing instruction to bulldozer operators and similarly local water association and farmers help in construction design but it is not enough. The high demand of machines by farmers compelled to finish the job as early as possible thus technical faults in construction work performed by bulldozers remain there

Major Hill torrents:

Major hill torrents originate from western side Suleman ranges. The spate irrigation system of this area is unique in terms of magnitude, scale and other different characteristics. In these two districts some of hill torrents have characteristics of perennial flow also. Hill torrents having perennial flow are called river and or Zam in local language.

Spate flow occurrence is in spring and summer mostly. Spring season rains resulting from Mediterranean showers bring flows and summer season floods are result of monsoon rainfall on Suleman range and Laki-Marwat hills during July-August.

Table: 1. Total Number of Major and Minor Hill Torrents and their Peak Discharge DI Khan and Tank Districts

S. No	Name of Nullah	Peak Flood Discharge (in cusecs)
1	Pezu Nullah	9250
2	Paniala Nullah	36400
3	Tank Zam	35000

4	Kiriana Nullah	12,000
5	Takawara Nullah	54000
6	Hausz Khad	40500
7	Soheli Nullah	52000
8	Gomal River	100,000
9	Gomal Nullah	35000
10	Loni Norh Nullah	60000
11	Mochiwala Nullah	7000
12	Bhuar Nullah	5350
13	Khad Haranwali	2500
14	Luni South Nullah	39000
15	Sheikh Haider Zam	35400
16	Toya Nullah	53600
17	Daraban Zam	71800
18	Khad Waruki	24200
19	Chaudhwan Zam	49190
20	Kaura Khad	8820
21	Gudh Nullah	53600
22	Gajsitan Nullah	14500
23	Velhari Nullah	9000
24	Sheranna Nullah	19000
25	Ramak Nullah	25800

Source: Rod-Kohi Symposium, PARC, Islamabad, 1989

Besides these major hill torrents there are several minor hill torrents also. The major hill torrents have perennial discharge also throughout the year except during the spate flow. Crops of *rabi* season and fodder are irrigated through this perennial flow in the area.

Water quality depends upon the soil characteristics of catchments area or portion of it from where water has come or passed. In most aces water quality is found fit for

irrigation. According to a survey and test made of water quality from 21 Nullahs five were unfit for irrigation. This is due to high salinity and sodicity. Similar is the case of soils characteristics in all spate-irrigated areas.

Table. Hill Torrents, Spate Irrigation Area, Perennial Flow, Area under Perennial Flow and Total Area under Spate Irrigation

	Name of Zam/Nullah	**Area with Flood water Rights Cultivated (acres)**	**Perennial Flow (Cusecs)**	**Area under Perennial Rights (acres)**	**Total Water Rights (acres)**
1	Gomal	250044	100	21384	281428
2	Tank	101304	40	28750	130054
3	Daraban	30980	35	2489	33449
4	Choudwan	39635	20	4230	43867
5	Sheikh Haider	53355	10	1100	54455
6	Sub Total of zams	485320	205	57933	543253
	Other Nullahs	51,840	-	-	51840
7	Total	537,160	205	57933	595093
	Panyala Circle	98600	-	-	98600
8	Total with Panyala	635760	205	57933	693893

Source: **On –Farm Water Management Field Manual, Volume X, Government of Pakistan, 1996**

Institutional Arrangements:

Tribal elders and users groups have decided the rights of spate irrigation long ago. British rulers have documented these rules and procedures with the revenue department during the first settlement of 1872 in the area.

In this area documentation form of these rules and procedures is called Kulliat-e-Rod-Kohi or Kulliat-e-abpaashi. Kulliat means the comprehensive form. It is also called Riwajat-e-Rod-Kohi – Riwajat means *practices*.

These procedures were documented and written down by settlement officers, responsible for land affairs, after long and intensive consultation and scrutiny process where cross checking and verification took several years before conclusion. After this process all users and their elders agreed and had to sign the final version. This complete record is available in the form of cadastral record with revenue departments at four levels:

- Patwar – at cluster of villages where Patwari operates,
- Tehsil (sub district) where Tehsildar and rest of Rod-Kohi staff operate, and
- District level where Deputy coordination Officer and Executive Officer revenue operates. All original and final copies of record are kept here.
- With farmers, tribes, tribal heads and individuals in the shape of maps, Musawi (field record showing borders, directions, area and rights), Maps of torrents, with rights of irrigation and sites of controlling structures, Fard-e-Malkiat (ownership papers), some reference from the court decision at any time for particular issue
- The fine and penalties to violation of these rules are also explained in detail as a part of land settlement rules. Records explain the dynamics of spate flow and accordingly steps to be taken for controlling, diverting, storing and passing down water.

Rod-Kohi Department:

Government at that time established a wing within revenue department, called Rod-Kohi section only to deal this important sector. In many cases still this wing exists in spate irrigated regions. Detail maps were prepared and rules/procedures were documented where indigenous knowledge and expertise were utilized effectively. After documentation the local elders and stakeholders endorsed these procedures for any further clarification and arbitration. This initial practice still serves as basis in matter related to spate irrigation in the area. Before devolution of 2001 the officers and staff pf spate irrigation was as under:

Assistant commissioner – One

Tehsildar – One

Assistant Tehsildar – three

Qanoongo – seven

Patwari – six and further helped by a group of 17 patwari ar field lvel.

Other lower staff – 33 (temporary jobs)

Assistant commissioner and Tehsildar act as magistrate also in matter related to spate irrigation. For petty issues assistant Tehsildar and other staff handle the situation and help farmers in the area. This staffs is experienced and learn from seniors. They are in frequent interaction with local key informants and water user association. The final authority in disputes/conflict resolution associated with spate irrigation is district coordination officer.

Landowners including tenants contribute in the construction work. Every Sadd/Ghandi has allotments of person days to work among users and every farmer and village knows this record. Incase of non-participation he is fined and this amount is deposited into a Sadd/Ghandi fund established for each torrent/Sadds with revenue department. From the start of communal work at *Sadds/Ghandi* Rod-Kohi staff issue warrants of arrest for farmers not participating. Failing to participate in construction work results as arrest or fine imposing. This is done under a law of minor irrigation prevailing in the country. It is worth noting that construction work seems a village/area fair where farmers enjoy work and music program is even organized by them. Meals are prepared while during construction period.

In extreme cases when revenue department sees that local farmers are not able to participate then nearby village farmers are invited to participate and paid by the government. However in some cases local farmers having right to that particular structure is only paid half of existing payment.

Moreover, government also helps to raise the funds through special allocation in the budget.

Sometime this fund also receives money from special development programs from provincial and federal government.

Presently the government instead of cash contribution to this fund also practices allocation of bulldozers hours for the construction work.

In some cases government also supply diesel expenditure when local farmers work through tractors for joint construction of *Sadds/Ghnadi*.

Local Institutions:

To operate this system a social organization responsible for irrigation and other associated aspects does exist in the area. Locally it is known as ***Kamara***. Kamara originates from kaam means work.

- The social organization for each hill torrent is different and for all levels differs.
- In some cases this social organization is confined to village and Mouza level.
- Every Sadd/Ghandi has a guard called Raakha. Raakha looks after the exact position of Sadds/ghandi while construction starts. Just before the rain season starts he is watching the structure and points out any weaker section, hole(s) made by rodent or cracks appeared through manmade or natural phenomena.
- Raakha is present round the clock while spate flow is passing in the torrent.
- Raakha has communication flow with individual field owner, water user association, down stream farmers and with revenue department. Any visiting official of spate irrigation system consults him before making a decision. Raakha is also a witness when Sadd/Ghandi/wakra is breached. Raakha has close contacts with Rakha of next/down structure(s) .

However in all cases these social organizations are part of umbrella water user association in the entire hill torrent command area. Due to formal linkages and physical jointness (of fields streams, nullah and lands) such all social organizations need to have formal linkages with upstream, mid level and down stream owners and users.

Sadds/Ghandi and other common structures are repaired jointly. This work starts usually before the rainfall season in catchments area. It is done on yearly basis. However, construction and repair work can be done whenever there is a need.

After first flood repair works starts and continues till the flood seasons ends. It may take two months even.

During this time shareholders participate according to pair of bullocks. Pair of bullocks, locally known as *jorra* is a unit of work in spate irrigation construction and repair work. Field is also measured in terms of *Jorra*; one pair of oxen can cultivate a specific amount of land determines that a particular field will be cultivated by so many pair of bullocks. The shareholder has to participate with his oxen or equally he has to contribute in some other form – cash payment or share in tractor work. This is mutually agreed by seeing the construction work amount.

In case of violation Rod-Kohi wing of revenue department can arrest him and put fine. Usually the nearby villagers come first to construct the *Sadds/Ghandi* as no body can afford to wait for others. Socially it is extremely felt badly if one does not participate intentionally. Therefore every shareholder participates even without bullock but remains present to serve and boost the workers. Local elders and senor farmers are present to guide the construction work and encourage farmers to work hard.

Spate Irrigation System Procedures – Step by Step:

Hill torrent enters into plain area and diverted through a controlling structure across the main stream. The plain area called Damaan is formed of piedmont plains through sediments brought through spate flows and other natural phenomena. The controlling structure made across the torrent is made of soil usually constructed through oxen and tractors. Locally it is known as *Sadd* or G*handi*. This structure at first levels controls the heavy flow and at second level diverts water to side-by-side sub streams. On several torrents first structure is crucial and important as its function is :

- To controls water intensity
- Distribute water into further small torrents known as *wah*

These small torrents (*wah)* further controlled by other structures in order to divert water to tertiary level. This structure is called *ghandi, Gatta* or *wakra*. Each structure controls and diverts water according to size of stream/Nullah. Water at tertiary level enters into fields. It is already decided that which side of stream will be irrigated. Usually right side has natural slope as topography in the region supports it. It is relatively difficult to divert water on left side (northern). However, a considerable amount of land having irrigation rights are on left side also therefore, special consideration are allowed by user association

and under customary laws to divert water on that side. Deviation to it is not allowed under local always.

Procedures:

There are few but comprehensive rules prevailing for spate irrigation system. It is important here to clarify that rules and regulation for major and minor streams differ considerably due to amount of water, intensity of network of distributaries and command area.

Among local rules the first most important is locally known as *Saroba-Paina* System . *Saroba* refers to head and *Paina* means down or tail in local and official languages of governments before the British period. Both words have origin and derived from Persian language that used to be official language before the British period. Saroba and Paina are integral part of spate irrigation system and equally important. One can't be strengthen on the cost of former and similarly ignorance of one means death of later is proverb of local languages. The *Saroba-Paina* is applied through another system called *Wandaara* – *Wandaara* means distribution/dividing in local language. Wandaara exactly describes the division of water into different streams, villages, areas, individual fields including timing and amount.

The local farmers have drawn rules that certain areas have irrigation rights only and these command areas are know as *Raqba Mutlalliqa* – literary meaning "area concerned". It is also called lands having rights of irrigation locally known as *Peech*. The details of "concerned areas" or *Peech*, including type, size, ownership, user rights, amount of and timing, is recorded during land settlements of this region – Kulliat Rod-Kohi and Riwajat Rod-Kohi.

- The upstream farmers have first right of water filling in the fields as much he (they) can. Incase of smaller flow water is then applied only there and *sadd/ghandi* is not broken and remains there till next flood.
- Upon occurrence of second flood/flow then depending on the requirement, season, climate, and wish of upstream users water is applied to *Saroba* fields or either allowed flowing down.

- On smaller hill torrent *Saroba Sadd/Ghnadi* can remain till water is applied to all fields having rights of irrigation (*Raqba Mutalliqa or Peech*). The *Sadd* can remain there for even several years till intensity of flood forces it to breach or intentionally broken by *Saroba* farmers under the local laws already described.
- Incase command are of upstream is extremely large then limits are fixed for irrigation in that particular *Saroba* zone.
- In above-mentioned case then water is allowed to flow down stream (*Paina*) and fields are irrigated.
- In above case when first flood is over. Saroba farmers will construct Sadd and can use water again. Usually the second irrigation seldom applied but law has provision for it.
- Upstream portion farmer has the duty to clear the torrent and let water flow down stream otherwise can be even fined.
- Upstream (*Saroba*) farmers cannot extend their area of filed in any case nor they can sell or share water with a farmer/filed having no rights (*Peech*).
- During spate flow farmers of next turn to *Saroba* closely watch the irrigation fields and when found necessary and appropriate will inform their fellows who are present near the *Sadd* to cut it. During night time they use signals to cut the Sadd immediately and for this purpose special indicators of lamps lights are used. At daytime special signals are communicated and even one person with faster speed will run to inform other for breaching the structure.
- In minor and controlled torrents water is applied to *Saroba* areas and upon natural breaching of his Sadd, *Saroba* farmers cannot divert it even it appears that flood flow is enough.
- Incase of smaller torrent the first distribution point/site, where another *wah*/sub stream originates, is not treated to raise the level or deepen it. The deepen streams may continue for several years to flow in the same manners till another flood divert the flow to opposite side or farmers mutually agree to divert it.
- Incase of major hill torrents when distribution site is badly damaged then Rod-Kohi officer will visit the site and enquire about the position. He may decide to

allow repair so that equal or agreed share can flow in the sub streams according to its original course. Farmers cannot treat this site on their own.

- In case of major hill torrents, after the mid position of command area when water is beyond control then every body can irrigate fields in way that partially spate flow continue to pass downstream areas (through Chhaab only).
- In the down stream time of controlling each structure of every type is fixed.
- Overflow through side channel is not allowed in extreme upstream portions especially, i.e. *Saroba* lands, rather it is preferred to breach the structure. In case of minor torrent actually since the start of spate flow in command area every farmer or at least representative of *Paina* area is present on first structure watching the flow and irrigation dynamics. If felt that *Saroba* fields are near to filled or any danger is expected to streamsides or structure then immediately *Sadds* will be cut down even without any notice. Incase over flow is experienced and yet *Saroba* farmer has not cut the *Sadd* himself and in result some loss can occur then *Saroba* farmer(s) can be fined even.
- Rights to irrigate the fields in a proper order are followed accordingly. In this case next farmers) is watching closely and overfilling is not possible.
- The duration and depth to irrigate a field is also agreed among farmers.
- Side channels for over flow are not allowed as danger of deepening the Nullah arises. In this case purposely breaching of main *sadd* is preferred and practiced.
- The first users may be group of farmers or a cluster of villages or even a single village. Tenants in many cases are inherited but not necessary.
- Under spate irrigation rules *Sadds* are not broken before allotted time and incase overflow is experienced then purposely breaching is made, even still the fields are not enough filled, to avoid un-control spate flow and save down stream structures. When purposely broken then its control and distribution in down stream is relatively easier.
- On some hill torrents a few of the Sadds/Ghandis are necessary to remain for a year or two on the way because these check the speed of spate flow and save the Nullah bed from deepening process. Nest year(s) these *sadds* are broken only when to avoid heavy silting, overflow on the banks and erosion to the fields.

- After first *Sadd/Ghandi* further down there are points/sites fixed for constructing *Ghnadi/Gatta/Wakra* across the stream/Nullah and are known to every user.
- The construction of these structures is responsibility of users and user may be a lineage group, tribal group, whole or partial villages or even cluster of villages or Mouzas.
- In some hill torrents command area, first right of irrigation is to right bank fields only but in others it may be both banks at the same time.
- Influential landlords in down stream sometimes may control more water than the actual rights therefore, Rod-kohi staff makes it sure that laws are obeyed and practiced.
- It is highly important to note that there is hardly any permanent structure on any hill torrent especially down to mid level. The reason is that heavy percentage of silt coming through erosion can fill and cover the whole bed of torrent and next year water flowing may damage more than benefits. Therefore, farmers try to maintain the natural flow and bed of torrent in all possible manners.
- Permanent structure is practiced at tail only on minor torrents where further down areas have no irrigation rights. In this case tail farmers can benefit form extra water and irrigate only their own lands.

However, several factors need to be considered in fully understanding the system and then deciding the functioning and operating it accordingly. **Time/season** of spate flow is an important factor to decide the irrigation amount and depth of water. This refers to early floods and late floods. Incase of early spate flow which may occur during June and early July then water is filled in the fields keeping in view the sorghum crop requirement. The second factor is **type of soil** that influences the decision of applying water amount. Incase upstream fields have loamy and or sandy soils then millet and chickpeas are preferred which can be lately cultivated. In this situation up stream farmers may allow water to go down partially. **Size of flow** is third most important factor influencing decision of water application. Usually in this situation rules are set apart and maximum utilization is allowed keeping in view the erosion effects.

There are other principals also in practice under spate system. **First** that spate flow must pass to the main bed in original manners. Overflow is not allowed as it can cause heavy

erosion that ultimately is the biggest problem in repair and construction of *sadds/ghandi/wakra*. **Secondly** incase main bed of torrent/ravine became too deep that danger of washing away by spate flow seems obvious then a permanent structure for few year is agreed by local farmers. When to cut down this structure depends upon the silting process till the original level of bed is ensured through natural process. The revenue department officials carefully monitor the spate flow and if found necessary can cut any structure when areas/fields having rights found fully filled. This is also applicable even area with rights have not fully irrigated but danger is guessed that water may over flow. This is to ensure that equitable distribution between upstream and down stream is followed and dominancy of wealthy and influential landlords is avoided. **Thirdly** when water is in excess then every farmer has right to partially control and divert water to his field and let remaining water flow down stream.

The whole niche of spate system is that water needs to be controlled and diverted and applied in hours and days time (ranging from a few hours and to only a few days) and not in weeks and months. Therefore, a strong and vigilant social organization is required to handle the spate flow with maximum participation of all users. Loosing chance of one spate flow may mean deprivation for one season which is highly unlike to be afforded by subsistence farmers.

Dispute over rights of water and construction of *sadds/ghandi/gatta/wakra* are resolved by Rod-kohi department and final appealing authority was deputy commissioner in previous system and now district coordination officer.

Presently use of machinery has facilitated the construction of *Sadd(s)* in spate areas. The issues faced in spate regime are of negligence in research, lack of appropriate technology, absence of subsidies, and lack of understanding the system and leading to poor investment at institutional level.

The un-controlling of spate flow is attributed towards inefficiency of local water user association rather to understand the occurrence of extra ordinary floods of hydrological cycle once in a 50 or 100 years. Once such extra ordinary flood damages the beds and passage and controlling structure it is then difficult to repair timely by water user association. Prolong drought and decreased rainfall in catchments area has directly

consequences in the form of local population migration. Absence of farmers from one area results that relevant controlling structure is not prepared during that particular year/season. This puts extra pressure on next down stream controlling structure and may damage it as more flow is now flowing. This goes on all along the down stream areas. Absence of any controlling structure and inefficiency of any water users association may result damaging the entire down stream command area. Therefore, an integrated network of users and water users association is needed to function the entire spate system in the area.

Fact is that spate flows in several cases is so rapid and of short time that farmers have hardly enough time to control it at first instance of breaching the *ghand*. In such case rules are kept aside and water is made available to fields. However, about this particular phenomena local farmers know very well and it is not applicable to every torrent and situation.

Spate flow is influenced in different ways and similarly results too. The reasons behinds are what we call here "internal" and "external". Internal factors include type of soil in Damaan area where controlling structures are made:

- According to local farmers percentage of harmful salt contents in terms of soil mechanics properties are not favoring longer life and strength.
- Landscape especially sharp slopes increase acceleration of flow and structure may wash easily.
- Less distance between hill pass and first structure is another important factor for the vulnerability and lesser life of dam/*sads*.
- Deepening of Nullah bed equally contributes to weekend the structure.

External factors may include:

- Heavy rainfall and tremendous flow, which may occur once in a ten or twenty years.
- Some hill torrents bring more silt from their catchments area, depending upon the soil geology, than others and cause heavy silting in *Rod, Kas, Khad, wah* and bunds.

- Some of command area has loose soil and not very suitable for constructing soil structure (sad/ghandi/wakra) and even fields and result are that frequent breaching is experienced just the spate flow reaches there during each flood.

Non-availability of bulldozers during peak season can cause weaker structure made only by animal power. Due to influence of any local landlord sometimes some structure may breach before time.

Table. Hill Torrents, Discharge and area under Spate Irrigation

	Name of Zam/ Nullah	**Area with Flood Water Rights Cultivated (acres)**	**Maximum Flood Discharge (Cusecs)**	**Number of *Sads/Ghandies***	**Length of Networks (Miles)**	**Catchments Area Sq. Miles**
1	Gomal	250044	160,000	128	165	13908
2	Tank	101304	120,000	61	191	910
3	Daraban	30980	70,000		28	423
4	Choudwan	39635	55,000	90	143	351
5	Sheikh Haider	53355	40,000	18	83	175
6	Sub Total of Zams Other Nullahs	485320 51,840	445000 6837	297 60	610 132.4	15759 98.2
7	Total Panyala Circle	537,160 98600	451837	357 -	742.4 141	15875.2
8	Total with Panyala	635760	451837	357	883.4	15857.2

Cropping Pattern:

Spate irrigation still helps the poor farmers in the entire area. Local farmers like it, as inputs are low cost, farming system is integrated, pest and chemical fertilizer free crops are grown. Mixed cropping pattern helps for production of food and fiber items both for human and animal population. According to local farmers it also helps to maintain the fertility of soil as silt is deposited every year and leguminous crops contribute in increasing nutrients into soil.

There are 12 soil series in this area and are further divided into three soil groups, i.e. clayey soils, loamy soils and sandy soils. The subsistence agriculture is practiced under this system according to soil classification and amount of spate water applied into filed. Cropping season is extra lengthy due to uncertainty of flow occurrence. It may start from May to September even. Early cultivation of sorghum is preferred as animals get fodder earlier and in some cases summer rains can even supplement the crop. Mix cropping is common framing practices by local farmers. Early summer floods of July and first half of Augusta are better fro sorghum, millet, fodder and beans. While after this period then *Rabi* crops are sown. *Rabi* crops are dominant by wheat, barley, chickpeas and mustered crops. While *kharif* crops are mostly sorghum and millet. Guar beans are also occasionally cultivated.

Sorghum, millet, wheat, guar, mongbeans, and chickpeas are the famous crops under spate irrigation in this area. Moreover, seasonal vegetables and trees like date palm also depend upon spate flow in this area. These crops, vegetables and trees are part of food habits and other uses since long time. Flood water even passing through torrent/Nullah helps a lot for the growth of trees, bushes and shrubs. These trees are the backbone of locale farming system and economy, all construction needs whether permanent or temporary during the crop season are met from these tress. Moreover, branches of these trees are used to divert the spate flow to fields. Therefore, trees protected

Table: Crop Rotation under Spate Irrigation in DI Khan and Tank Districts

1	Wheat	Sorghum	Fallow
2	Wheat	Fallow	Wheat
3	Gram	Melon	Gram
4	Barley	Sorghum/millet	Fallow
5	Melon/Sorghum	Fallow	Melon/Sorghum
6	Barley	Fallow	Barley

Source: agricultural Statistics, Government of NWFP, 1987-88

Livestock:

Local breeds of cattle, camel, sheep and goat are common animals in the area. In fact livestock is the backbone of spate farming system. These livestock are sold in the times of drought and most of the requirements are met through this sale. Spate agriculture is also dominant by livestock economy point of view, as crops of fodder and grain value are preferred to be cultivated. Livestock numbers in the area/village influences cropping pattern also. Cattle and camel are used for plowing, bund making and transportation purposes besides meeting the meat requirement also. Cattle are mainly used for construction of *Sadds/Ghandi* and embankments of field. Trees/shrubs of tamrix are fed of camels in the area. Goat and sheep use other trees, bushes and shrubs throughout the year mainly. These trees, bushes, shrubs and wild grasses are protected fro this purpose.

Environmental Aspects:

- Some of these permanent *sadds* in the area are excellent water reservoir helping human and animal population to depend for drinking water.
- These sites are also favorable sites for migratory birds.
- These seasonal storage sites help in recharge of underground water.
- Under spate irrigation all crops are grown as organic farming. Use of pesticides and chemical fertilizer is not practiced and even not possible.

- Spate stricture are made of local material and are low cost
- Indigenous technology and skills are practiced for construction, repair and maintenance.
- Local seed and native crops are grown which have better taste and part of local food habits.
- Trees, bushes, shrubs and grasses grown through natural flooding of spate system are the main source of livelihood for local population.

***Recent Research**:*

National agricultural research center Islamabad has started a project on spate irrigation throughout the country. According to their findings several key issues need special attention for the improvement of system. The type of structure made by bulldozes are not technical feasible as design criteria is not followed by poorly trained bulldozer operator. This results in wastage of resources and time. Poor farmers can't afford such costly and unfeasible designs. Result is that farmers loose interest in again repairing the structure. Outsider bulldozer operator is not able to understand the dynamics of spate flow and soil structure necessary to observe during construction process.

NARC of Pakistan agricultural research council (PARC) has also tested cemented/brick-lined waterways from one field to another. These waterways are easily to make and operate and last longer. Use of cemented pipe to divert and pass water from one field to another reduces the chances of breaching and easily operate-able technique. Lining of torrents beds in high erosion pocket has helped to overcome the problem of deepening and cutting of fields. This is only been recommended in diversion channels and small torrents. Field improvement designs are also been tested by simple techniques where silting problem could be overcome. Design of semi-pucca nature such as gabion and stone are recommended instead of concrete and cemented. This can reduce the cost and increase the life of structure.

NARC is also seeing the improvement of spate irrigation system in much holistic way. NARC has also provided improved and low cost design of water filtration from spate flow to be used for drinking purpose by local population. This is an important intervention in bringing the socio-economic uplift of poor farmers. NARC also puts

emphasis on farming system improvement where livestock is highly important position in local economy.

Ministry of food and agriculture, government of Pakistan, has prepared field manual of On –farm water management dealing with water harvesting and spate irrigation. This manual has important documentation of spate irrigation and suggests that integrated approach is needed to address the issue of spate irrigation. Improvements in agronomic practices, use of improved technology, skills enhancement is highly recommended to overcome the problems faced in spate irrigation system management. Manual also offers designing of better civil structure to control and divert spate flow. These improved designs have provision of controlling silting process while water is controlled and diverted. It is highly recommend that local water user association; traditional knowledge and indigenous practices must be followed while intervening in the improvement of spate irrigation system.

Gomal Zam Dam Project

Recent announcement and start of work on Gomal Zam dam is a matter of debate where civil society and environmentalist groups heavily oppose. Opposition is argued by ignoring the present equitable features associated only with spate irrigation may look down under modern irrigation system. On the other hand bureaucrats and technical department favor this project mostly on the ground that reliable water availability will be ensured. According to design command area under Gomal Zam dam will be about 163100 acres. Some of the farmer complaint that spate water can't be permanently stopped by any structure, as down stream areas will loose the rights on permanent basis. Farmers have also doubts, on the basis of local knowledge and practices that such permanent reservoirs will be soon silted up as highest amount of eroded material is transported with every flood. Farmers believe that traditional distribution of water is better as equity can be ensured in or the other way and in case of permanent structure across the torrent only upstream farmers will be benefited.

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