Water-Rights and Water-Allocation Procedures of Farmers' Managed Perennial Spate Irrigation Systems of Mithawan Watershed, D.G. Khan, Pakistan

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A study was conducted on water rights, water allocation and local institutions prevailing in the perennial spate irrigation systems of Mithawan watershed of D.G. Khan District of Punjab. The Study Area was selected in the Mthawan watershed on the D.G. Khan-Quetta Road almost 70 kms from D.G. Khan and10 km away from the road, representing real-life operating systems. Small-scale isolated and large-scale contiguous perennial spate irrigation systems were selected for study. A three-prong methodology was designed covering: (a) interactive dialogue of the focus groups to document the community-perceptions regarding systems' water-rights, water allocation and local institutions prevailing in the area;(b) structured interviews to document systematic data regarding some of the study-aspects; and (c) diagnostic surveys to document some of the measured data regarding scheme performance.

Water rights and allocation procedures both in small-scale isolated and large-scale contiguous perennial spate irrigation-systems are very clearly defined and do not change with time and space. Local institutions like 'Biradri' and 'Muchi' take care of just allocation of water. An irrigator is deputed who takes care of allocated time among various tribes. At the same time, the community is bringing more area under irrigation. Obviously it has increased water-requirements and in turn management of irrigation system. Previously they were reconstructing the diversion structure only. Present expansion in irrigated area has increased the necessity of maintaining the water-conveyance network more frequently, particularly at critical sections. However, the realization regarding water-losses still needs to be promoted. The linkages of resource-management with water-productivity are going to be the future area of consideration in these systems, due to expansion of the system largely because of increased population and urge to increase their livelihood.

1. INTRODUCTION

1.1 Description of Study Area

The Sulaiman ranges on the western part of Pakistan's provinces of NWFP and Punjab contribute runoff for spate irrigation systems in Punjab, NWFP and Balochistan. Mithawan watershed is one of the large watersheds (having geographical area of around 729 km²) contributing perennial and non-perennial flows, which are being used for spate irrigation in D.G. Khan District (Figure 1).

The Study Area represents the largest perennial spate irrigation system (locally named as '*Kalapani*') of the Mithawan watershed, located in the Tribal Area of D.G. Khan District. It is part of the Sulaiman ranges with latitude of 30° 00' north and longitude of 70° 07' east and located at about 70 kms from D.G. Khan city. It is connected to D.G. Khan-Quetta Trunk road through a 10 km long unmetalled hilly track. The area predominantly consists of mountain ranges running in the north-east and southwest directions. Within these mountains, there is a valley of isolated commands served by the perennial spate irrigation systems.

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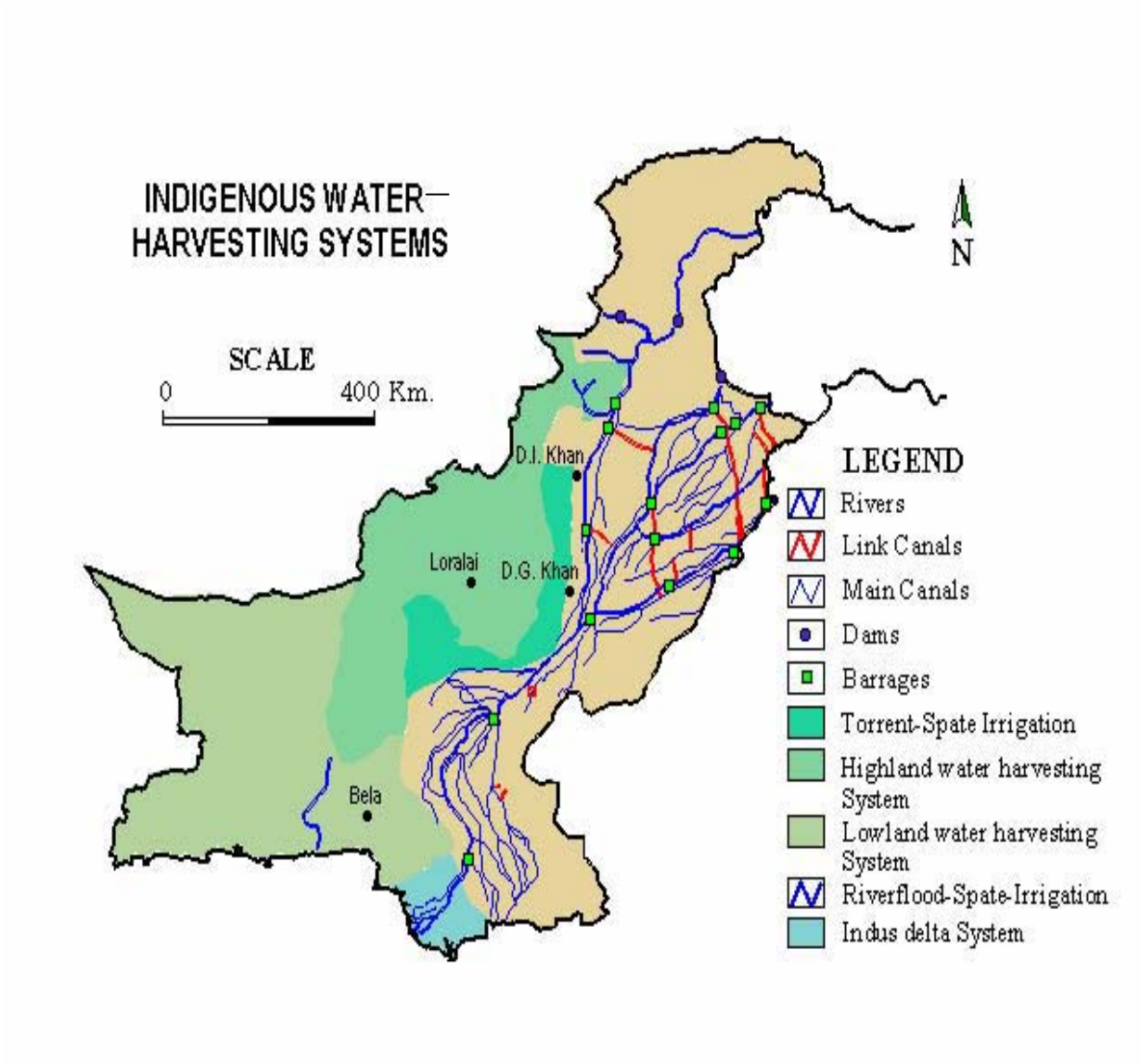

Figure 1. Map showing D.G. Khan and Indigenous Water-Harvesting Systems in Pakistan

The valley comprises four Mauzas and sub-commands of the Sri nullah (Dholi, Kothi, Soharbun and Khand), which are part of the large-scale contiguous perennial spate irrigation system. Within the Study Area, there lies a small-scale isolated perennial spate irrigation system of Mauza Irsind. It is an independent system and not part of the large contiguous system of the Siri nullah and having command-area of only 36.8 ha (Figure 2). Both the large contiguous and small isolated systems were selected for study, to represent variations in water-rights as a function of system-size (Figure 3).

1.2 Climate of the Study Area

Average annual rainfall of the Study Area is around 382 mm. About 79% of it is received during the *Kharif* (summer) season during April to September. The *Rabi* (winter) season rainfall is around 80 mm, most of which is received during March (Table-1). The mean pan evaporation during the *Rabi* and the *Kharif* seasons is 555 and 1388 mm, respectively. The climate is arid during the *Rabi* season and semi-arid during the Kharif season. Thus, irrigation is essential to meet crop evapotranspiration requirements.

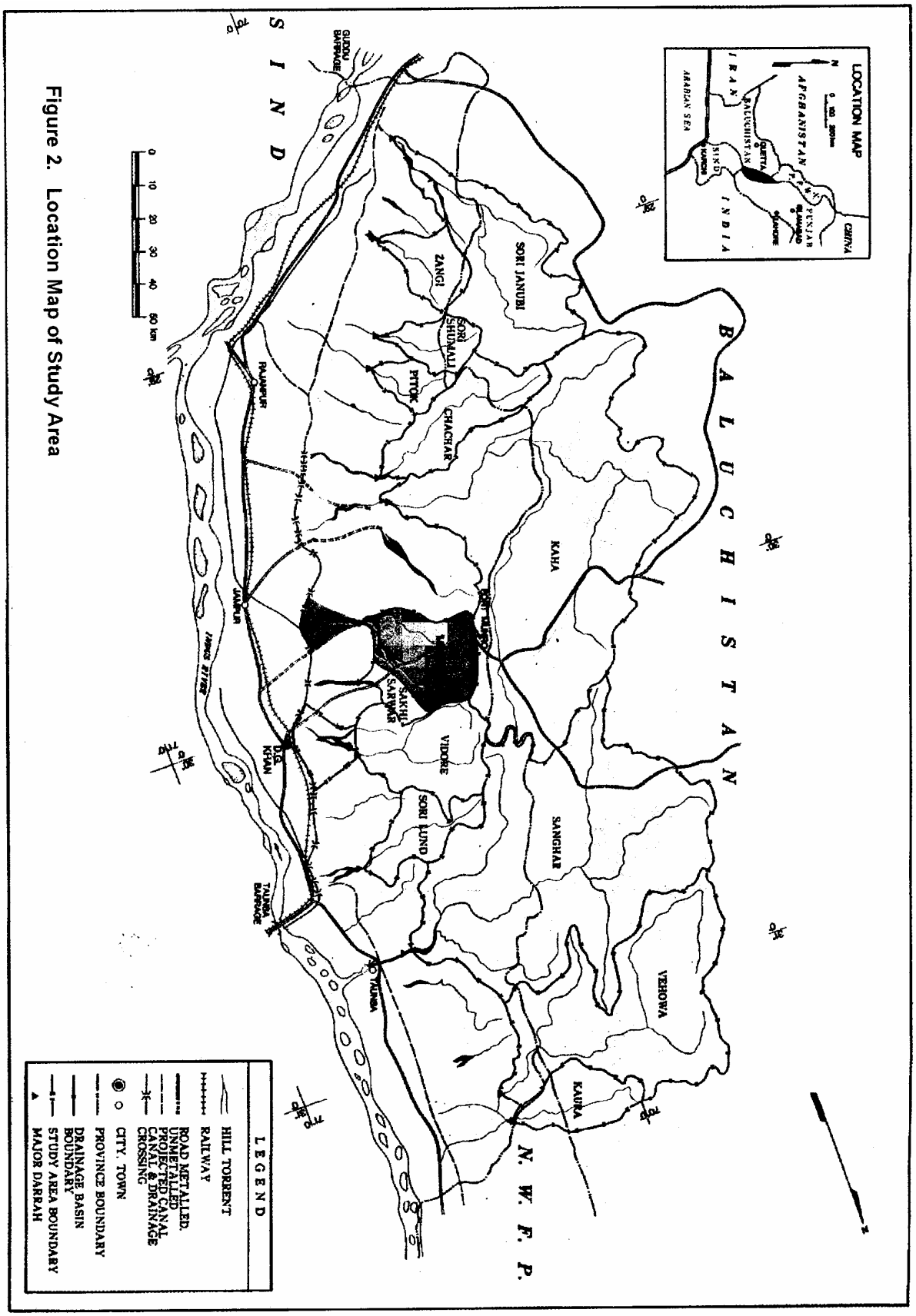

Figure 2. Location Map of Study Area

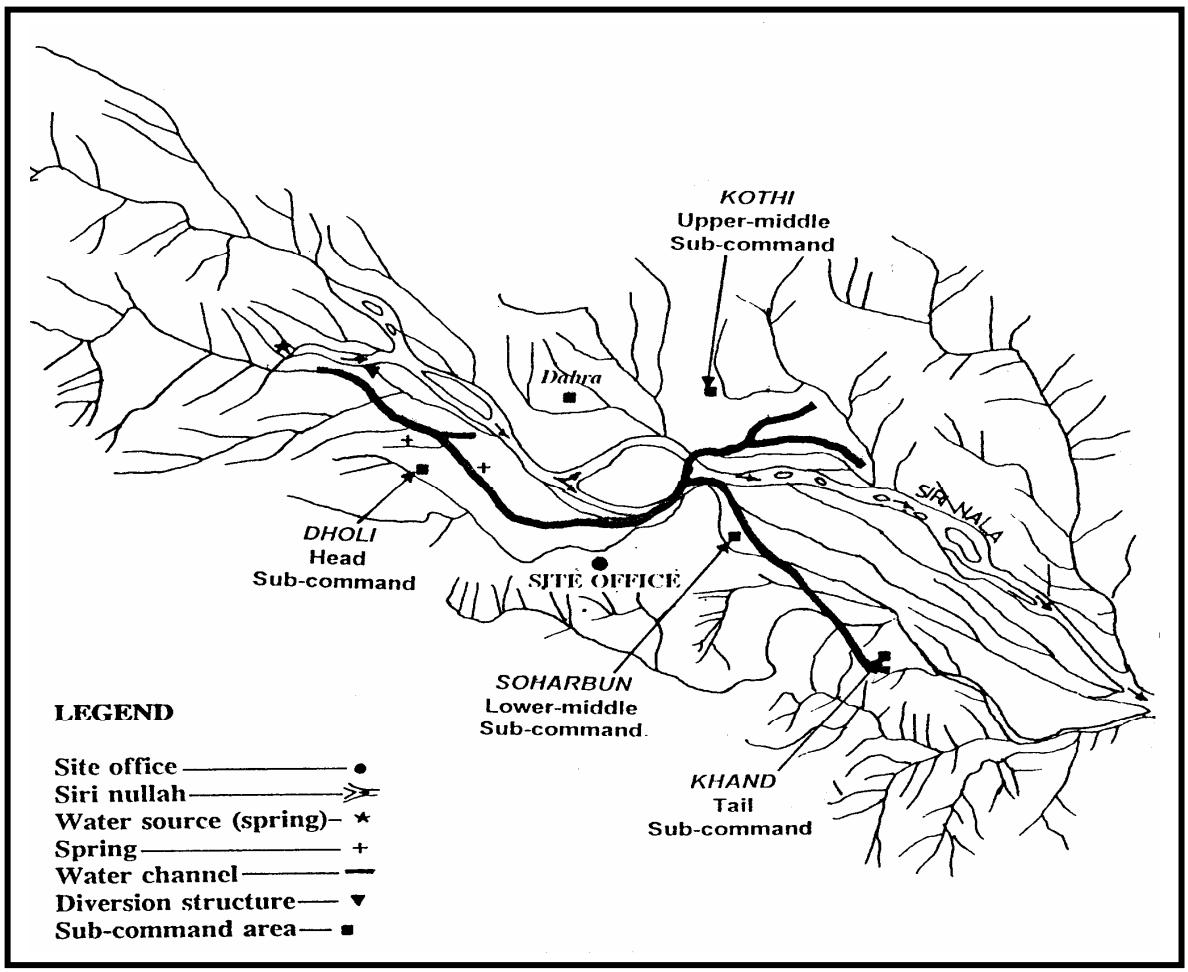

Figure 3. Stream network of Contiguous Spate Irrigation System

Table-1: Climatic Data of Study Area, Mithawan Watershed, D.G. Khan, Pakistan.

Month	Daily Max Temp (°C)	Daily Min. Temp (°C)	Rainfall (mm)	Mean Evaporation (mm)	Mean Sunshine (hrs)	Mean Humidity (%)
January	16.6	7.0	14.3	2.0	7.3	52.9
February	19.7	10.0	6.4	3.2	8.2	53.2
March	24.1	15.3	35.3	4.1	8.5	56.5
April	30.7	21.9	49.5	7.3	9.0	46.3
May	34.3	26.3	45.0	8.9	9.4	43.1
June	37.0	28.6	56.1	8.7	10.5	54.3
July	36.7	29.9	49.3	7.8	10.3	63.7
August	34.9	27.2	87.4	6.5	9.6	68.4
September	34.7	26.6	14.1	6.3	8.9	60.3
October	28.2	19.7	18.9	3.9	7.3	63.9
November	23.4	14.8	2.4	2.9	5.7	62.6
December	18.8	9.1	2.8	1.9	3.9	85.7
Total			**381.5**	**63.5**		

Source: Rod Kohi Project WRRI/NARC/PARC D.G. Khan (1996-2004)

1.3 Geology and Soils of Study Area

Geology of Mithawan watershed consists of consolidated cretaceous and tertiary sedimentary rocks of early Paleocene and Eocene era. The cretaceous rocks consist of sandstones and limestone. On the other hand, tertiary rocks consist of shale, grit and clay. Old, harder rocks are on the west and younger, softer on the east.

The soils of the area are very shallow and stony in nature, with alluvial deposits at the base of hills and valleys, while sandy patches are found on flatter sites (GOP, 1997).

1.4 Objectives of the Study

The objective of the study was to document water-rights, water-allocation and local institutions prevailing in the perennial spate irrigation systems of Mithawan watershed. The perennial system of the Study Area depends on the underground flows, which come out of the terrain in the form of springs. The water is sediment-free. These perennial flows are damaged by the flash floods in the ephemeral streams, particularly during the monsoon season, as the two waters (perennial and non-perennial) flow in the same stream.

Water-rights have been identified as key factors in management of spate-irrigation systems (Van Steenbergen, 1997). Even though there are rules and regulations to allocate water, coordination among farmers is essential to divert water and repair the damaged channels. There is little or no time for verification of waterways or trying to divert water according to the agreed water-rights. Tribal traditions determine different perceptions and attitudes towards natural-resource management. Thus, water-management of perennial spate-irrigation and agriculture is both technically and socially complex. The overall purpose of the present research was to enhance the understanding of interactions of water-rights and allocation-rules with resource management.

2. STUDY METHODOLOGY

The study methodology was designed considering three-prong strategy, comprising:

- Interactive dialogues with the focus-groups selected from the sub-systems, to document the perceptions of the community regarding water rights, water allocation and local institutions prevailing in the area, including the listing of issues, constraints and adaptations made by the community (Figure 4);
- Structured interviews for specific aspects, to get systematic information regarding selected aspects of water rights and allocation procedures; and
- Diagnostic surveys, to document description and performance of the isolated and contiguous Spate-Irrigation Systems covering all the sub-systems and verify some of the issues and constraints identified under the focus group dialogues (Figure 5).

Figure 4. Focus group interactive dialogue at Mauza Dholi, Mithawan area.

Figure 5. Diagnostic surveys for conveyance-losses at Mauza Kothi, Mithawan area.

3. FINDINGS OF THE STUDY

3.1 System Description

3.1.1 Small-scale Isolated Perennial Spate-Irrigation System: The perennial spate-irrigation system of the Mauza Irsind emerges out of the hills of Mithawan torrent at *Khuldan*. It receives the perennial flow of about 25 springs. The discharge of these springs turns into stream-flow and, after traversing a distance of about 7 km, enters into a wide section at *Khuldan*. At this point, farmers of the Irsind command divert water through loose stone diversion-structure, to allow the flow of water into three independent water-channels for three isolated subsystems i.e. *Rahandan* (head reaches), *Thakdaf* (middle reaches) and *Irsind* (tail-end reaches).

The command area of *Rahandan* and *Irsind* lies on the left bank of *Siri* nullah. The channels irrigating these areas are constructed independently in succession along steep and rugged mountainous topography. Old tribal rivalry is the main reason for constructing independent channels. These channels are subject to damage due to upslope landslides and bank cutting of the *Siri* nullah. The farmers have to reconstruct these channels at several places after every torrent. The repair and maintenance of these channels is very risky due to steep slopes and have so far cost six human lives. *Thakdaf* command area lies on the right bank of *Siri* nullah. The channel, which provides water to this sub-command, is relatively stable and is less affected by bank cutting or landslides.

3.1.2 Large-scale Contiguous Kalapani System: The large-scale contiguous perennial spate-irrigation of the Study Area comprises four major sub-commands of Dholi, Kothi, Soharbun and Khand. It originates from the flows of several springs concentrated at a place named *Bazdee* in the Sulaiman ranges. Initially, the main water-channel was constructed by the Pathans who were expelled by the Balochs in the 16th century. The stream-flow adopts its route in an ephemeral stream named as Siri nullah and diverted to the command area at a point called 'Bandha'. Locally, 'Bandha' is a term used for diversion structure. At this point, the farmers of the four sub-commands have jointly constructed a loose stone diversion-structure. The water is diverted through a channel, along the contours of the steep terrain, for gravity-flow irrigation. The diversion-structure is normally damaged or completely washed away during flash floods of the monsoon season. In addition, the channel-erosion of the Siri nullah and upstream runoff from adjacent slopes very often damages the channel and so the supply of water is interrupted. However, the damages are less common during the *Rabi* season, because of lesser rains and low flood-flows.

The estimated command-area of small and large-scale systems selected for the study, are presented in Table-2.

The management of small isolated perennial water-resources in Pakistan and other countries is almost similar (Pradhan, 1989 and Vander Velde, 1992). Likewise, the community of Study Area use to construct the diversion-structure and repair the water-channel before the onset of the *Rabi* season for growing of wheat. However, recently they have also started growing cotton and vegetables during the Kharif season.

Table-2: Command area of small and large-scale perennial Spate-irrigation systems of the Study Area, Mithawan watershed, D.G. Khan, Pakistan.

System Size	Name of Sub-command	Command Area (ha)	System Command Area (ha)
Small-scale System (*Irsind*)	*Thakdaf*	3.0	36.8
	Rahndan	1.6	
	Irsind	32.2	
Large Contiguous System (*Dholi*)	*Dholi*	88.3	265.1
	Kothi	97.2	
	Soharbun	21.5	
	Khand	58.1	
Total		**301.9**	**301.9**

Due to increased cropping intensity, the farmers are now maintaining the channel more frequently. The labour is shared among the water users, based on water allocation. Contrary to the Irsind small-scale system, the damages to the water-channel, because of erosion and upstream runoff from adjacent terrain, are less; hence the maintenance is less risky.

The *Dholi* sub-command is located at the head of the large-scale perennial Spate-irrigation system while the Kothi and Soharbun sub-commands are in the middle and the Khand sub-command at the tail (Figure 3). From the end of the Dholi sub-command, the water channel is extended downward along and within the Siri nullah-bed and divided into two branch-channels. One branch of the channel irrigates the Kothi sub-command, while the other supplies water to Soharbun and Khand sub-commands. So, each sub-command in turn is having its conveyance system-providing water to the command area, with fields located at head, middle and tail reaches. Therefore, each sub-command can be considered as a sub-system.

The water-losses in the channel are very high (40-70%) due to seepage, overspills and breaches, largely due to deferred maintenance (Figure 5). In addition, the perennial water-flow is interrupted during the flash floods in the Siri nullah and the irrigation-supply is discontinued (Figures 6 &7).

Figures 6 & 7: Perennial spate-water flowing in the dry bed of seasonal spate-water.

3.2 Water-Rights

Water-rights in spate-irrigated areas, whether perennial or non-perennial, are essential for conflict resolution. However, there is a categorical difference between water rights in spate-irrigation systems and neighbouring canal-irrigation systems in arid lands (Varisco, 1983). The perennial spate-irrigation systems of the Mithawan watershed is normally considered a part of the non-perennial spate irrigation, but these two systems are completely different.

The perennial spate-irrigation system basically originates from the springs fed by the aquifer, but is subject to devastations caused by the floodwater from hill torrents supporting non-perennial spate-irrigation system. Therefore, perennial spate-irrigation system is an integral part of overall stream-network of the floodwater from hill-torrents. The water-rights of the perennial spate-irrigation system are often sharply defined in fixed and even exchangeable proportions of the flow and allowed usage-time compared to the non-perennial spate irrigation system, where water-rights are reactive. However, water-rights of the perennial spate irrigation system are also disturbed in terms of availability of water at the source or at any point in the conveyance channel due to medium-term changes in the river-morphology, scouring, siltation and change of river course (Ahmad *et al.,* 1998). However, the changes in water-availability do not affect the time-bound rights of the sub-tribes or individuals in the Mithawan watershed.

3.2.1 Small-scale Isolated Perennial Spate Irrigation System: Agriculture of the Irsind small-scale perennial spate irrigation system mainly depends on the flow of 25 springs of various sizes. The access to this water-source is very difficult due to rugged and steep slopes. The water from the main source at *Khuldan* is diverted into irrigation channels by erecting loose stone diversion-structures. The water is conveyed in an earthen channel, along the contours, to irrigate a particular sub-command and then conveyed through field channels in order to irrigate fields. The water at *Khuldan* is diverted into three independent channels, serving the *Rahndan, Thakdaf* and *Irsind* sub-commands for head, middle and tail reaches of the system, respectively. The capacity of these three channels varies and the flow ranges from 0.5 to 1.0 cusecs. The highest flow is in the channel serving the Irsind tail-end system and provides water to a sub-command of around 32.2 ha. The channel serving the middle-reaches of the system provides a discharge of 0.5 cusecs to the *Rahndan* sub-command and irrigates an area of 1.6 ha. The discharge available to the channel serving the head-reaches at *Thakdaf* sub-command is around 0.7 cusecs and irrigates an area of 3 ha. The length of three channels serving *Rahndan, Thakdaf*, and *Irsind* is around 376m, 398m and 896 m, respectively. The discharge of the springs is reduced during the May-June period and it varies considerably due to the temporal variability of rainfall.

The non-perennial spate-irrigation system during heavy rainfall affects the perennial spate-irrigation system, especially in the monsoon season when the system is damaged normally 10 to 12 times. The damages during the winter season are less due to less frequent and low flows of torrents. In the past, farmers used to cultivate their lands only during the *Rabi* season. However, since the last 3 years, they have also started cultivating crops during the *Kharif* season. Wheat and oats are grown in the *Rabi* season, whereas millets, cotton and some vegetables are grown in the *Kharif* season.

3.2.2 Large-scale Contiguous Kalapani System: Agriculture of Dholi, Kothi, Soharbun and Khand sub-systems of the large contiguous system mainly rely upon irrigation from perennial spate-irrigation system. The source of water lies at a place called Bazdee in the Sulaiman ranges and inflow is coming from several springs. After traversing a distance of 3-4 kms through hills, it emerges out at a place known as Bandha, from where it is diverted into irrigation channel by erecting a loose stone diversion-structure. The water is diverted by a channel along the slopes in order to provide irrigation to the four sub-commands. Total length of main water-channel from diversion structure up to the head of the Khand sub-system is 8.0 km. The length of water-channel from diversion structure upto the head of different sub-systems is 1.6 km, 5.4 km, 5.6 km and 8.0 km for the Dholi, Kothi, Soharbun and Khand sub-systems, respectively.

Dholi sub-system: Water rights of the sub-system are 2 Bails (24 hours), which are fixed irrespective of the extent of the sub-command area. Out of 2 Bails, water-allocation time for the 20 Hajbani sub-tribe is 1.5 Bails (18 hours) and that of the Kaloi sub-tribe is 0.5 Bails (6 hours). By virtue of its location at the head of the system, the conveyance-losses are less and thus water-availability is better than any other sub-system. Moreover, sub-system is also having an access to an additional water-source from a spring with discharge around 0.4 cusecs. It contributes to the main water-channel, thus enhancing water supply to all the sub-systems. The spring provides assured water supply.

Kothi sub-system: The main watercourse is extended from the Dholi sub-system to the Kothi subsystem. It reaches Kothi sub-command after a distance of 3.8 km within the dry bed of Siri nullah. Water supply to the sub-system is interrupted by flash floods in the *Siri* nullah. Moreover, water-losses in the water channel are high, due to overspills and breaches. The water-channel improvements, using lining of sensitive reaches, plastic lining and installation of panel control-structures, and field inlets, by WRRI-NARC helped to reduce the conveyance losses. The water allocation to the subsystem is based on allocations made for the *Hajbani* and the *Kaloi* sub-tribes.

Soharbun sub-system: The Soharbun sub-system is relatively a new command, which has been brought under irrigation for the last 10-15 years. Thus, water-rights do not exist. However, farmers having land in other sub-systems can use their water-allocations for irrigating lands in this

sub-system. Water diverted from the water-channel irrigates the Soharbun sub-system prior to the delivery to the Khand sub-system. A section of this water-channel lies within the bed of the *Siri* nullah and is damaged during torrent floods; thus the water supply is discontinued to the Soharbun and Khand subsystems. Apart from irrigated area, the sub-system is also having rainfed area. Rainwater is harvested from adjacent mini-catchments for irrigation, by constructing earthen bunds across the slopes. The surplus water is allowed to irrigate the successive fields. Sorghum and millets are grown in such areas. The ownership of catchment contributing runoff mainly rests with the *Hajbani* sub-tribe.

Khand sub-system: The sub-system is located at the tail of the large perennial spate-irrigation system. Thus, the water users are facing problems of water-deficiency. The water users of the Chakrani sub-tribe residing at this sub-system are having less share of water. The length of water-channel conveying water to this sub-system is about 8 km from the diversion structure. It further adds to the water shortage, due to conveyance losses.

3.3 Inheritance System and Fragmentation of Lands

The water rights are normally linked with the land. Water rights are divided proportionately among the heirs during the division of the land. Water rights are also sold with the land. However, the seller of the land possesses the absolute right to sell whole or some of his water share. Nonetheless, if the case is registered in the court by any affectee then the water rights have to be sold with the land. The water rights of these systems are linked with lands which were registered after land settlements of 1970.

Random sequences of water turn coupled with land fragmentation are posing serious concerns for efficient irrigation in the small-scale irrigation systems. However, no concern has been shown by the water users due to adequate supply of water in all the sub-commands of the small-scale isolated system. The water users do practice exchange of water turn in case any user feel problem in irrigating a particular field for complete irrigation. Some of the water users provide water to others within the allocated water rights provided the excess water is available.

The fragmentation of land in the four sub-commands of the large-scale contiguous perennial Spate irrigation system is posing serious concerns as water users are already facing problems of water shortage. Therefore, inadequacy of water is a major factor instead of the size of the bunded units. If some landless clears the land and makes it cultivable, the community shows helping attitude towards him. They contribute by donating some of their water share for irrigation despite limited supply.

3.4 Water Allocation Procedure and Allocation-Time

3.4.1 Small-scale Perennial Spate-Irrigation System: The water allocation among various sub-tribes follows a rotation of 12 days (24 Bails, one Bail is of 12 hours), which is being practiced in the *Irsind* sub-command of the small-scale isolated perennial spate irrigation system. The water is used during day and night time. The allocated water turn to sub-tribes is further divided to various landholders. The landholders from various sub-tribes form groups of water users based on their convenience and requirement of water utilization. Draws are normally made for water turn among various water users' groups which is a good indication of their mutual agreements. The water users can exchange their water turn within the respective users groups. The details of water allocation time are presented in Table-3.

The total hours of 288 are because of the 12 days rotation. The selection of 12 days rotation is different than 7 days rotation commonly followed in the canal irrigated areas, having an advantage that every farmer gets water at same time and day of the week. The water rotation of 12 days is an indicator, that farmers managed systems are more demand oriented and these communities can fix the rotation considering the requirement of the command area and water users.

3.4.2 Large-scale Contiguous Perennial Spate Irrigation System: The water rights of large-scale contiguous perennial spate irrigation system are allocated to the sub-tribes according to the historical uses by their ancestors. Though the demolishing of diversion structure by hill-torrent flows or breaching of channel makes the water availability uncertain, yet it does not affect the time bound water allocation rights of the sub-tribes or the individuals. For example, the

Bhawani and Qasmani sub-tribes have left the area permanently and their water share (1 Bail) is being used by the Kalois. Similarly the water share (1 Bail) of the Chief of the Leghari tribe is also being used by the Kaloi sub-tribe. Water allocation time of water users is given in Table-4.

The water turn in the large-scale contiguous system is of 9 days (18 Bails), which is subsequently distributed among the sub-tribes and their sections. The duration of water turn is 18 Bails, out of which 9.5 Bails are assigned to the Hajbanis and 8.5 Bails for Kalois. This water is further distributed among several offshoots of the Hajbani and the Kaloi sub-tribes. Water allocated time for several clans of the Hajbani sub-tribe is given in Table-5. Madrani, a section of Hajbani sub-tribe, sold their lands along with 2 Bails of their water share to their fellow sub-tribe. Similarly water allocation time for several clans of the Kaloi sub-tribe is given in Table-6.

Table-3: Water-allocation time for sub-tribes of *Irsind* small-scale perennial Spate-irrigation system of the Study Area, Mithawan watershed, D.G Khan, Pakistan.

Water Users' Groups	Sub-tribes	Water Allocation Time per Turn (hours)
I	Bijaani	48
II	Bijaani Shahwani	12 36
III	Ramdani Bijarani	95 1
IV	Smaliani-Mandwani Zanglani	34.5 12
V	Smilani-Jangyani Zanglani Bijarani	37.5 10 2
Total		**288**

**1Bail = 12 Hours*

Table-4: Water-allocation time for sub-tribes of large-scale contiguous perennial Spate-irrigation system of the Study Area, Mithawan watershed, D.G Khan, Pakistan.

Name of beneficiary	Water Allocation Time	
	(Bails)	(hours)
Hajbani in Mzuza Dholi	1.5	18
Kaloi in Mauza Dholi	0.5	6
Chief of Leghari tribe and family	1.0	12
Kaloi in Kothi and Khand sub-commands	6.0	72
Hajbani in Kothi and Khand sub-commands	8.0	96
Bhawani & Qasmani in Kothi and Khand sub-commands	1.0	12
Total	**18.0**	**216**

Table 5: Water-allocation time of clans of Hajbani sub-tribe of large-scale contiguous perennial Spate-irrigation system of Study Area, Mithawan watershed, D.G. Khan, Pakistan.

Offshoots of the sub-tribe	Water Allocation Time	
	(Bails)	(hours)
Saskani	2.375	28.5
Kalani	2.375	28.5
Shahlani, Rahwani, Chhalkani, Abdalani	2.375	28.5
Madrani	2.375	28.5
Total	**9.5**	**114**

** 1 Bail = 12 hrs.*

Table-6: Water-Allocation time of clans of Kolai sub-tribe of large-scale contigous Perennial Spate Irrigation System of Study Area, Mithawan watershed, D.G. Khan, Pakistan.

Name of Offshoot	Water Allocation Time	
	(Bails)	(hours)
Chakrani	2.50	30.00
Jamalani	4.67	56.04
Noorani	1.00	12.00
Kamalani	0.27	3.24
Aliani	0.06	0.72
Total	**8.50**	**102.0**

** 1 Bail = 12 hrs.*

The Water is applied to fields, both at day and night time, depending upon the turn. A draw is made for the water-turn among the Hajbani and Kaloi sub-tribes. Within the sub-tribes, normally draw is not made and water turn is assigned with mutual consensus. However, there is no compromise on water-allocation time. The water-allocation time of a water-user starts from the diversion point, irrespective of channel length or any sort of losses. This creates problems for water-users, particularly those with limited duration of allocated turn. Therefore, water-users very often form irrigation-groups to avoid unnecessary wastage of time of irrigation-turn. If the water-supply is interrupted during the irrigation, it restarts from the same field, after the supply is restored. This break is locally termed as 'Nanga'.

The construction of diversion-structure and repair of water-channel is jointly undertaken by the Kaloi and the Hajbani sub-tribes. The work is started in October-November, before the onset of *Rabi* (winter cropping) season. The water-users gather at Mauza Kothi, have a lunch together and decide the day and time to start the maintenance work. The reconstruction of diversion structure and repair of channel is normally divided into four phases. Each phase needs a day for completion and ultimately the whole maintenance work is completed in four days. Every day, a goat or sheep is slaughtered and a feast is arranged for the field-party, through mutual contribution. This collective maintenance-work is undertaken up to Mauza Kothi, and then onward is the job of individual sub-tribe or water-users' group to repair and maintain the water-channel.

3.6 Rules of Water-Rights and Water-Allocation

The rules concerning water-rights of the small-scale isolated and large-scale contiguous perennial spate-irrigation systems are summarized, based on the study findings:

- **the construction of a diversion structure and obligations to increase height of the weir***;* presently, there are no obligations because of the adequate, rather excess, availability of water at the diversion of the small-scale isolated system. However, diversion of water in the large-scale contiguous system is limited by the capacity of the structure and availability of water;
- **the sequence and proportions for water-flow to various channels emerging from the source***;* presently there is no division at the source of small-scale isolated system, due to excess availability of water and very little chances of increasing the command-area except at the head-reaches of *Thakdaf* sub-command. However, for large-scale contiguous system a turn of 9 days is being practiced, to provide water to the four sub-commands;
- **normative rules on water-usage, like the entitlement to expand the command-area**; any user can expand the command-area within allocated water-rights.
- rights of tribes or individuals, based on prior appropriation;
- rights of sub-tribes within the command-area, or landholders if there is only one sub-tribe in a command area;
- agreements on transfer of water-rights fully or partially with the transfer or sale of land; and
- rights of riparian and agreements on the disposal of excess or unused water.

The water-rights are fixed with allocations made for various sub-tribes or landholders and do not change in space and time. Thus, these water-rights to some extent, are similar to the perennial canal-flow systems, contrary to the non-perennial spate-irrigation system. There are several water-allocation rules and it is usual to find that two or three are applied simultaneously. These rules basically emerged from the water rights and are more or less fixed. The water allocation rules, as practiced in the perennial spate irrigation system, are as under:

- **demarcation of the command-area that is entitled for diversion of perennial spate-irrigation system;** presently three sub-commands like *Rahndan, Thakdaf* and *Irsind* have been earmarked in the small-scale isolated system; whereas four sub-systems have been earmarked under the large-scale system, with water-rights and allocation rules for the three sub-systems, as no water-rights are given to Soharbun sub-system but water-users can use their water-allocations from other sub-systems;
- **the proportion of flow diverted to various channels**; rules are hardly followed in small-scale isolated system, due to excess supply of water. On the other hand, a turn of 9 days rotation is practiced in large-scale contiguous system;
- **the proportionate distribution of water-allocation to various sub-tribes of the command area**; in the small-scale isolated system, water-turn of 12 days is followed (24 Bails each Bail of 12 hours) and Bails are proportionately allocated to various sub-tribes of the Irsind sub-command. But for large-scale contiguous system, water-distribution is based on 9-days rotation (18 Bails) where fixed time is allocated for each sub-system, fixed allocated time of irrigation to a particular Mauza Dholi irrespective of the landholdings (Mauza Dholi is allocated 2 Bails of water i.e. 6 hours for *Kalois* and 18 hours for *Hajbanis* sub-tribes);
- **the proportionate distribution of allocated water-turn to various landholders within a sub-tribe**; this is followed in both the perennial spate irrigation systems:
- **the proportionate distribution of available water to various landholders in a command-area where only one sub-tribe exists**; this rule is practiced in the *Thakdaf* sub-command of the small-scale isolated system, where water turn of 6 days is followed (12 Bails each Bail of 12 hours) and Bails are equally divided – thus two Bails per landholder are allocated;
- **random sequence in which different water turns are scheduled to different land-holders**; presently random allocation procedure for water-turn is followed, irrespective of the location of bunded units owned by a landholder in the command area, which pose some concerns for efficient utilization of water: a procedure of draw is followed for random sequence among the sub-tribes (Hajbani and Kaloi) for first water-turn, the draw is valid for one crop season, the water-turn within a sub-tribe is commonly decided by mutual consensus;
- allocated time, based on landholding within a sub-tribe, and no restrictions for depth of irrigation, partial irrigation, exchange of water among water-users, etc.

3.7 Local Institutions

- The farmers in the area still practice the tradition named "*Hashar'* where they join for community actions to repair or maintain the water-conveyance system. The *Hashar* is presently followed within one Mauza for the small-scale system and jointly by the four Mauzas in the large-scale contiguous system. Based on the landholdings, cash contribution is collected from the water-users and spent for arranging a feast at the end of every day during the maintenance. This tradition and institution is quite effective.
- *'Biradari'* is an institution composed of the heads of families or various clan-groups of the sub-tribes. Issues, like construction and repair of water channel, allocation of water-turn and suggestions of penalty for water-thefts, are dealt with by the Biradari. In addition, social problems of minor nature are also handled by the *Biradari*.
- The '*Muchi'* is an institution responsible for joint meetings, where selected notables try to resolve issues related to

water-rights or land tenures. The decisions made by *Muchi* and *Biradari* are given much importance. Probably the reason is that *Muchi* and *Biradari* system is being practiced since the time of their ancestors and the community is well acquainted with these indigenous institutions.

- *'Jirgah'* is composed of Chiefs of several tribes and '*Moqadems'* of sub-tribes. *Jirgah* meeting was usually held at Fort Munro. It dealt with the armed clashes between the tribes, murder cases and other conflicts of very serious nature among and within the sub-tribes. But it is no more functional since 1971.
- *'Union Council'*, created during 1979 elections, is supposed to undertake the day-to-day developmental activities of the local people. However, it is not a conflict-resolving body. The main achievement of these organizations is that they have linked the community with input-delivery channels.

Of course, one should not over-estimate the functional and organizational capabilities of these institutions. Nevertheless, they do play a vital role in resolving daily issues.

3.8 Surveillance

The community is well interconnected, due to the tribal system, and thus tries to keep an eye on the happenings related to issues and unpleasant acts in the area. The joint actions regarding monitoring of the water-system and its repair and maintenance are still effective. The water users jointly enter into an oath that they will not enter into issues related to water-theft or any other action which disturb the water-allocation schedules or affect water-rights.

Water-theft is reported many times in the area, but the penalty for that is not of severe nature. In this case the affectee starts tracing the stealer and, after confirmation, brings the matter before the *Muchi* or *Biradari*. According to the decision, the stealer has to compensate the affectee by giving twice the water he had stolen or by serving the *Muchi* with a feast or as agreed upon. Sometimes they just rely upon rebuking the culprit; nevertheless, there is one precedent of severe punishment for water-theft, when the stealer had to compensate the affectee by giving him a share from his produce.

3.8.1 Conflicts and Conflict Resolution: Conflicts of serious nature on water have not been reported so far in the small-scale isolated system. The mutual and joint actions still followed by the water-users provide effective means to resolve the minor issues that emerge from time to time. Conflicts related to water distribution in the large-scale contiguous system are casually reported. Sometimes the conflict arises between the buyer and the seller after the transfer of land. The transfer of land is documented in the Revenue record, while the transfer of water is not documented but verbally committed in the presence of some witnesses in order to avoid possible reversion by the seller. In such cases, the community and the witnesses turn against the reverser and force him to abide by his commitment.

3.8.2 Adaptations: The most critical event in water-conveyance of the small-scale isolated system is the maintenance of the system, to take care of siltation and landslide-problems which is done through joint community actions. About 15 persons are required at a time to maintain the system. The community has already lost lives of 6 persons in repair and maintenance. The draw of water-turn is enforced for a crop season and then it changes for the next season. The one draw is for 4 Bails (48 hours) consisting of a group or a part of the water-users' groups. The decision regarding allocation of water-turn for various landholders within a draw or water-users' group is again decided through a draw. Therefore, the option for change of turn from night-time to day-time is dependent on the probability of the draw. Thus water-users are enjoying the chance of getting the turn on day-time or night-time. This is not an equitable system, in terms of water-turn for day and night timings.

In the large-scale contiguous system, the draw for water-turn is implemented for a crop season. The decision regarding the allocation of water-turn among various landholders of same lineage group is made with mutual consensus. The turn is exchangeable depending upon the convenience. If a farmer is having one Bail (12 hours) of water-share, he will be having his turn after 9th day and the farmer

adopts accordingly. The duration of irrigation-turn of a farmer starts from the diversion-point, irrespective of channel-length or losses. Farmers with limited irrigation-turn face difficulty. Such farmers have made irrigation-groups to handle the situation.

4. CONCLUSIONS

In summary, the small-scale perennial spate-irrigation system can be regarded as a case where potential for expansion of command-area is limited. Thus, the system can be viewed as an example with adequate availability of water. Actually, water is in excess and, therefore, no rotation is practiced at the diversion-structure, which provides water to three channels serving three sub-commands. However, a rotation is practiced at the sub-commands to provide water to the water-users. Hence, the system is described as continuous flow, non-rotational channel diversions, rotational for distribution to users, and water-rights based on prior appropriation.

On the other hand, the large-scale contiguous system is being operated under a rotation of 9-days interval for the four sub-commands. The water-user can get his turn after a period of 9 days. The rotation is practiced, as there has been many-fold expansion of the command-area during the last 4 years. Still, there is a potential for further expansion of the command-area. Thus, the system can be described as continuous flow, rotational and water-rights based on prior appropriation, to provide water for deficit or incomplete irrigation. The unit-discharge available during the dry period is around 22 litres/100 ha, which is in line with the allowance of the irrigated areas of perennial canal-commands in the Punjab province.

Water-rights, both in small-scale and large-scale perennial Spate-irrigation systems, are very clearly defined and do not change with time and space. Local institutions, like '*Biradri'* and *'Muchi'*, take care of just allocation of water. An irrigator is deputed who takes care of allocated time among various tribes. At the same time, the community is bringing more area under irrigation. Obviously, it has increased the water-requirements and, in turn, management of irrigation-system. Previously, they were reconstructing the diversion structure only. Present expansion in irrigated area has increased the necessity of maintaining the watercourse more frequently, particularly at critical sections. However, the realization regarding water-losses still needs to be promoted. The linkages of resource-management with water-productivity are going to be the future area of consideration in these systems, due to expansion of the system largely because of increased population and urge to increase their livelihood.

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