Irrigation Resources of East Chitwan and Their Hydrologic and Institutional Interlinkages: Results from an Inventory Study*

K.N. Pandit, A.K. Shukla**, K.P. Gajurel***, G.P. Shivakoti**** and other members of IMSSG**

ABSTRACT

Irrigation Resource Inventory of East Chitwan (an inner terai region of central Nepal) was carried out by a multidisciplinary team of Irrigation Management Systems Study Group (IMSSG) at the Institute of Agriculture and Animal Science (IAAS), Rampur, Chitwan, Nepal during May 1992 to January 1993. Group interviews and system walkthrough were the principal methods employed to gather information for the study. The focus of the inventory study was on documentation of history of development, physical characteristics, operation and management, agricultural systems, nature and development of irrigation organization, social and institutional characteristics of 88 community managed irrigation systems in East Chitwan. The findings of the inventory study are presented in a report entitled "Irrigation Resource Inventory of East Chitwan" IMSSG, IAAS, Rampur, 1993.

A small section of the study focusing on hydrologic aspects of irrigation systems with regard to nature and usage of water resources in the study area has been discussed in this paper. The findings indicated that all the 88 irrigation systems originate from 15 different water sources including perennial rivers/streams, seasonal streams, springs and depressed areas (popularly known as *Ghols* in local dialect). The systems which fall within the flood plains of Rapti river have complex hydrologic networks in relation to their service areas. Evidences like water drained from one system as an assured source of supply for other systems have been commonly encountered in a substantial number of irrigation systems.

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** **Lecturers in Agricultural Engineering, IAAS, Rampur**

*** **Assistant Lecturer in Agricultural Extension, IAAS, Rampur**

**** **Lecturer in Agricultural Economics, IAAS, Rampur**

Other members of the IMSSG include K.R. Adhikari, Rabi Poudel, T.B. Thapa, S.M. Shakya, A.P. Shrestha, D.N. Yadav and N.R. Joshi

INTRODUCTION

Irrigation Development

The existence of farmer developed and managed irrigation schemes, that are adequately operated and managed to the extent of capability of local resources, have been reported from different parts of the country. There has been a substantial contribution of farmer managed irrigation systems (FMIS) in the irrigation development of Nepal. A recent estimate indicates that the irrigated area under FMIS to be 675,000 hectare (ha) as against 275,000 ha under public sector irrigation schemes (Ansari, 1991). FMIS account for over 70 percent of the irrigation development of the country. It is estimated that FMIS support the irrigation needs of 21 percent of cultivated land as compared to 11 percent under public sector irrigation schemes. Approximately 40 percent of national cereal crop requirement is produced from irrigated farming under FMIS (WECS, 1981).

On the other hand, despite high priority and substantial investment in public sector irrigation development, existing irrigation schemes have failed to meet the objective of substantially improving agricultural production in Nepal. The effective irrigated area of many irrigation schemes has been found to be far short of the projected area. The reasons for such results, among others have been found to be : ill conceived planning, unrealistic design, unsound construction, deficient operation and untimely maintenance (WECS, 1981; APROSC, 1982; Pradhan, 1983).

The irrigation development in the Chitwan valley includes both government and community developed irrigation schemes. The government built irrigation projects include Chitwan Irrigation Project which is a huge irrigation development program started in 1974 with the loan agreement of US$ 19.5 million between Asian Development Bank (ADB) and His Majesty's Government (HMG) of Nepal. The project comprises of three schemes namely the Narayani Lift Irrigation Project (8600 ha), the Khageri Irrigation Scheme (6000 ha) and the Panchakanya Irrigation Scheme (600 ha). Pithuwa Irrigation Scheme (600 ha) is a government built irrigation system which is now operated and managed by the local farmers through their water user's organization.

In addition to above government built irrigation schemes several farmer developed and managed irrigation systems exist in the valley. A major concentration of these FMIS have been observed in East Chitwan, especially south of the East-West highway (IMSSG Report, 1993).

Context of Inventory Technique in Irrigation Development and Management

Inventory techniques have been used for a variety of purposes in irrigation development and management n Nepal and elsewhere. Some of the advantages of inventory study include: identification and prioritization of farmers problems, rational decision making and identification of potential capabilities of local resources for development and improvement/rehabilitation of irrigation schemes (Shukla et al., 1993). The purpose of an inventory study varies from provision of preliminary information on existing planned use of water for irrigation in an area or region to project identification for development and rehabilitation. One such inventory is district-wise Water Resource Inventory of 59 districts in Nepal carried out by Water and Energy Commission Secretariat (WECS), now being extended to cover the other districts (Tuladhar et al., 1992). In an action research conducted by WECS and International Irrigation Management Institute (IIMI), inventory of farmer managed irrigation systems in Indrawati River Basin in Sindupalchok district was used as a basis for project identification for rehabilitation and improvement (Yoder and Upadhyay, 1987, WECS/IIMI, 1990). In a different inventory the existing and potential usage of irrigation water in Dhading district, has been collected under WECS/GTZ supported inventory study (Tuladhar et al., 1992).

Rationale

The objective of the study was to capture and document the physical, social, institutional, agricultural and managerial characteristics of various irrigation systems operated and managed by various mixes of the community in the East Chitwan.

Some of the key questions which focus on the nature of water resources, physical settings of the irrigation systems, water acquisition and allocation, service area, multiple usage of irrigation water need to be analyzed further for better understanding of the interrelationship among different irrigation systems.

East Rapti Irrigation Project (ERIP), a public sector irrigation development and rehabilitation program is underway in East Chitwan under credit assistance from Asian Development Bank. A major portion of the project activity includes rehabilitation and improvement of several farmer managed irrigation systems in the project area. The output of the Irrigation Resource Inventory of East Chitwan in general and the analysis of interlinkages regarding physical and institutional aspects among different irrigation systems in particular could be a valuable set of information for ERIP especially during the process of making rational decisions and prioritizing them.

The major factor building a linkage among many irrigation systems in East Chitwan is a substantial amount of continuous drainage discharge which is used to irrigate the areas adjacent or downstream to the region where it originates from. The final effect of the sometimes called considerable losses in one irrigation system can, at least partly, be reduced by applying this so called return flow to another area in the vicinity. Accordingly,it is envisaged that return flow has a significant role of linking many irrigation systems in East Chitwan.

METHODOLOGY

The methodology used in this study include preparatory works prior to the field study and use of an inventory checklist to facilitate guided interviews for field data collection. The preparatory works prior to the field study included collection of all available information about the study area including previous reports and maps from such sources as District Irrigation Office (DIO), District Development Committee, Chitwan Irrigation Project (CIP), Agricultural Development Bank (ADB), East Rapti Irrigation Project (ERIP) and District Agricultural Development Office.

An inventory checklist was first prepared in English which was modified in several stages through pre-testing and experiences gathered from the field. The English version of the inventory checklist could not capture and retain most of the information as the discussion progressed in native language using many local dialects. Finally, Nepali version of the checklist was found useful in improving the communication between interviewer and respondents. The terms of irrigation management activities used in local dialect (mostly used by indigenous Tharu community) of the study area were incorporated in the checklist to improve the efficiency of information gathering. Group interviews were conducted in each of the irrigation systems in the study area using the inventory checklist. The respondents included water users, functionaries of water users' committee and local leaders. Attempts were made to make the group interviews as participatory and iterative as possible.

The study team walked from the head to tail end of the system along with the beneficiaries of the system and recorded the information on physical characteristics of the system. The system walkthrough also helped cross checking and validating several information obtained from the respondents.

RESULT AND DISCUSSION

Irrigation Resources of East Chitwan

The location of irrigation systems discussed in this study are presented in Fig. 1. All the 88 irrigation systems have been coded based on their location and source of origin. For example, the irrigation systems originating from Rapti river have been represented by "R" and their location at different reaches has been designated by 1,2,3,4.... etc. R4 would therefore mean the 4th irrigation system starting from the head reach of Rapti river.

Hydrology of water resources, type of irrigation systems, inter irrigation system water use are some of the aspects discussed in this section.

Hydrology of Water Resources

On the basis of source and hydrological characteristics, four types of river systems are prevalent in Nepal: namely, Snowfed rivers, Mahabharat and Midland rivers, Churia and Terai rivers; and Terai rivers (Sharma, 1983). Rapti river of Chitwan falls under the category of Mahabharat and midland rivers which possesses considerably large catchment area and carry water round the year. Rapti river and its tributaries are major water resources in the study area. All the tributaries of Rapti river are major water resources supplying water to the community managed irrigation systems in the study area (Fig. 1). Springs and *Ghols* are also potential water resources in East-Chitwan supplying water to few irrigation systems.

Most of the Water Resources of East Chitwan which originate from Mahabharat Hills (Lekh) are either ephemeral in character or remain almost dry during dry season. The section of land north of the East-West Highway usually suffers from the shortage of water due to highly porous nature of the beds of these streams.

Degradation of the upstream watershed has resulted in high peak floods and low dry season discharge in the study area. As a result of massive movement of boulders and gravels during monsoon floods in the Rapti river, the river bed is rising every year.

Type of Irrigation Systems

The classification of irrigation systems into seasonal or perennial types, depending upon availability of water in more than one season, indicated a total of 49 (55.7 per cent) irrigation systems to be perennial and 39 (44.3 per cent) irrigation systems to be seasonal in nature. A system was considered perennial if irrigation water was available in both spring (March-May) and monsoon (June - September) and considered seasonal if available only during monsoon. During the winter season either no irrigation is practised or the area irrigated is too small in the study area.

A sorting of number of perennial and seasonal irrigation systems by source indicated large number of perennial irrigation systems in Dhongre, Budhi Rapti and Rapti rivers (Table 1). Almost all the irrigation systems getting their supply from major rivers (Rapti, Lothar, Budhi Rapti and Dhongre) were found to be perennial.

The total cultivated area under 88 irrigation systems included in this study account for 10,658 ha of which 6,580 ha of land was found to be irrigated under perennial and 4,078 ha irrigated under seasonal irrigation systems (Table 2). Table 2 also presents a summary of total irrigated area under all the irrigation systems in the study area during monsoon, winter and spring season.

Inter Irrigation System Water Use - Inter irrigation system water use was observed in several of the irrigation systems in the study area (Table 3). A maximum of 11 irrigation systems were

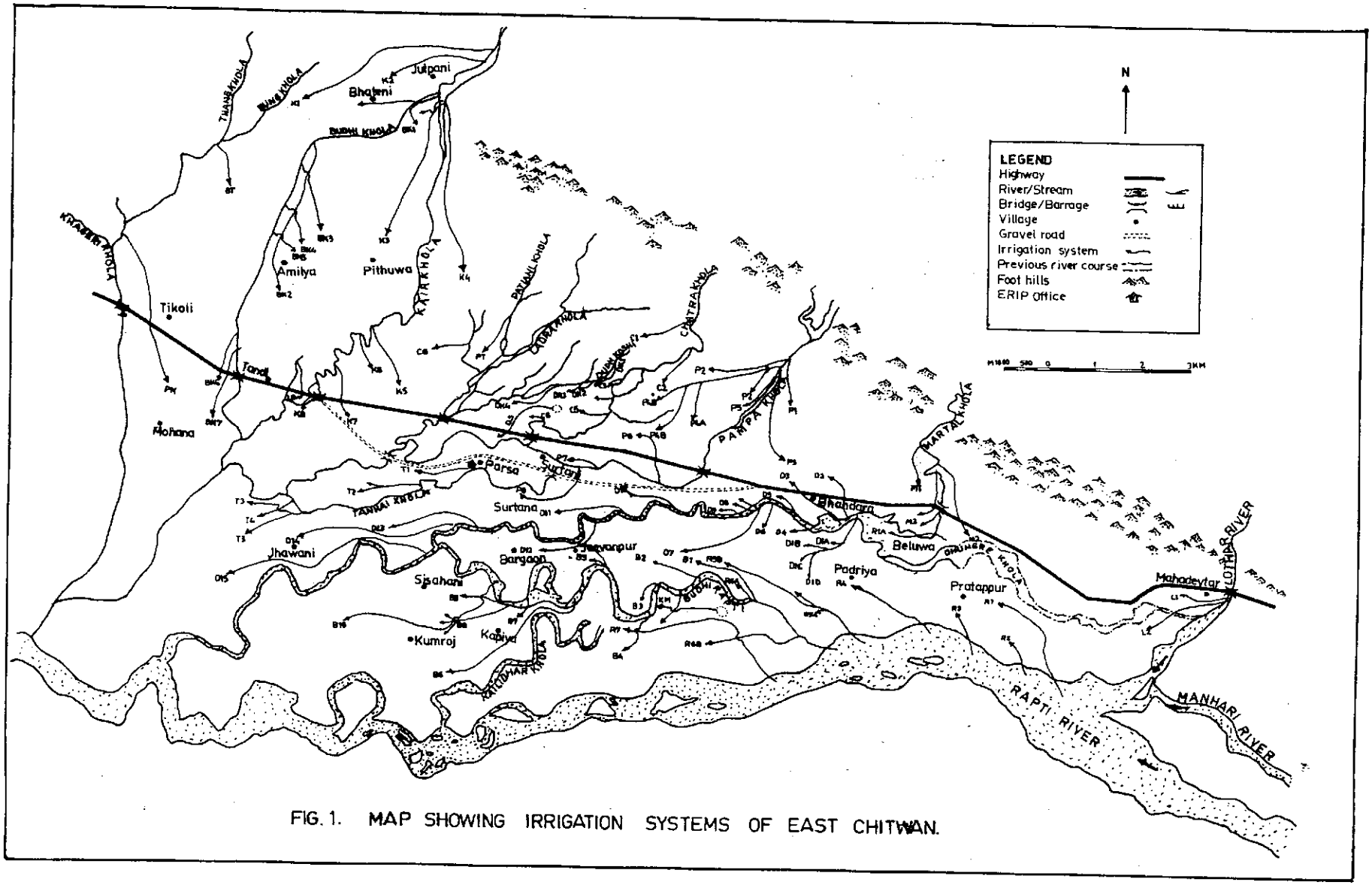

FIG. 1. MAP SHOWING IRRIGATION SYSTEMS OF EAST CHITWAN.

found to be using water from other systems and 12 of the irrigation systems were found to be providing water to other irrigation systems. However, these numbers may vary depending upon the adequacy and genuine need of the water between the systems which provide and the systems which demand respectively. Provision of water to two irrigation systems was observed in 3 out of 12 irrigation systems providing water to other systems. The basis for water acquisition from other systems was found to be cash and labour mobilization in repair and maintenance in most of the systems. Cash payment, genuine demand, mutual consensus of water users and resource contribution in the initial construction were among the other bases. In some cases, the new system seeking access to water use was found to pay a fixed sum of money to the system that agreed to provide the access. In addition to formal acquisition, 9 of the irrigation systems were found to be using drainage water from other systems.

Table 1 Number and Types of Irrigation Systems by Source

Source	Number of irrigation system		Total
	Perennial	Seasonal	
Lothar river	2	0	2
Rapti river	8	0	8
Lothar + Rapti	1	0	1
Rapti drain	1	0	1
Martal khola	0	3	3
Dhongre khola	15	1	16
Budhi Rapti river	10	0	10
Dhongre + Budhi Rapti	2	0	2
Pumpa khola	3	6	9
Tanhi khola	1	3	4
Chatra khola	0	6	6
Dudh koshi khola	2	1	3
Ladra + Dudh koshi	0	1	1
Patiani khola	0	1	1
Kair khola	0	8	8
Budhi khola	1	6	7
Thang khola -Bung khola	0	1	1
Pancha nadi (Khageri river)	1	0	1
Spring and ghol	2	2	4
Total	49	39	88

Irrigation systems inside the area/polygons as presented in Fig. 2 indicate a strong interrelationship in terms of their hydrologic and institutional characteristics. These areas/polygons do not indicate the command boundary of the systems rather the regions of interlinkage among different systems. One interesting example of such interlinkage is Badgaon Irrigation System (D12)

getting water supply from both Dhongre *Khola* (khola stands for seasonal/perennial streams in Nepali) and Budhi Rapti river and Jeevanpur Irrigation System(B5). Jeevanpur Irrigation System (B5) and Badgaon Irrigation System (D12) offtake at the same point in Budhi Rapti river with the agreement/settlement that Jeevanpur is entitled to receive $^{2}/_{3}$rd of the supply at the intake. On the other hand, Badgaon system(D12) gets $^{1}/_{6}$th of the supply from Dhongre Khola as agreed upon with

Table 2 Irrigated Area under Perennial and Seasonal Irrigation Systems by Seasons

System type	Perennial	Seasonal	Total
Service Area (ha)	6626.0	4078.0	10,704.0
Irrigated Area by season (ha)			
Monsoon	6580.0	4078.0	10,658.0
Winter	5294.0	123.0	5,417.0
Spring	5556.0	-	5,556.0

Table 3 Inter Irrigation System Water Use

Provision		Number	Percent	System Code
Use of water from other systems	From 1 system	11	12.50	R2,D1A,D1B,D1C, D1D,P3,P5,C5, BK4,BK5,BT
	From 2 systems	-	0	
	Drainage water	9	10.20	R3,R5B,R1A,P4B, P7,P8,T1,C4,DK4
	None	68	77.30	
	Total	88	100.00	
Provision of water to other systems	To 1 system	9	10.20	L1,L2,D11,B10, P2,P3,C5,DK4,K2
	To 2 systems	3	3.40	R1,R4,R5A
	None	76	86.40	
	Total	88	100.00	

Surtana System (D11). These systems do not have any permanent water measurement structures to deliver a specific share, however, their strong institutional interrelationship coupled with capabilities of local resources have helped to sustain the irrigation systems for many generations.

The basis for inter system water allocation at the source was found to be mutual consensus among the water users of the upstream and downstream irrigation systems in the majority of the irrigation systems. This was found to be practised particularly during the water deficit periods. Usually the users from the downstream irrigation systems approach the water users committee of the upstream systems through the functionaries of their committee and make an informal request for the share of water. Cases of stealing of water by breaking the diversion structure of the upstream system were also observed in some irrigation systems. Often the conflicts between upstream and downstream irrigation systems originate due to such stealing of water.

As many systems in the study area are interdependent either in receiving or supplying water (Fig. 2), the delineation of the hydraulic command area of a particular irrigation system is a complicated task unless a drastic change in topography is encountered.

CONCLUSIONS

1. Majority of the perennial irrigation systems fall in the southern part of East -West highway indicating a high potential of water resources in this region. The reason for such potentiality could be sub-surface seepage contribution from Rapti river.
2. Several irrigation systems in the study area were found to have been meeting their irrigation water needs by receiving part of their supply either on request or by formal acquisition from other systems as well as drainage water from those systems which are in the upstream side of the service area.
3. User's possess a strong indigenous knowledge base in allocating and distributing irrigation water by employing local resources like wooden stakes, bushes and soil slices for near proportionate release of water in absence of permanent distribution structures.
4. Because of the land fragmentation problem in the study area, many farmers were found to have been holding land in more than one irrigation systems. Consequently, their participation in more than one irrigation system as an active member of the Water Users Organization, has developed strong institutional linkages among different systems.
5. The rules and regulations related to allocation and distribution of water, resource mobilization for repair and maintenance, monetary fine and/or social sanctions, and penalties for the defaulters depending upon the severity of rule violations developed by the Water Users Organization are some of the strong indicators to sustain the linkages for longer duration among different irrigation systems.
6. Inter-system and intra-system water allocation based on mutual consensus and genuine demand of needy users have been found to be more prominent in the study area. Indigenous knowledge and skills employed by the users in the rotation of water supply, use of water control methods in absence of permanent water distribution structures and monitoring mechanism while patrolling the irrigation canals are the major governing factors for a most proportionate and relatively less biased distribution of water in most of the irrigation systems.
7. Presenting the complex interrelationships among physical, social and institutional attributes alongwith cross comparisons of these attributes and performance of several irrigation

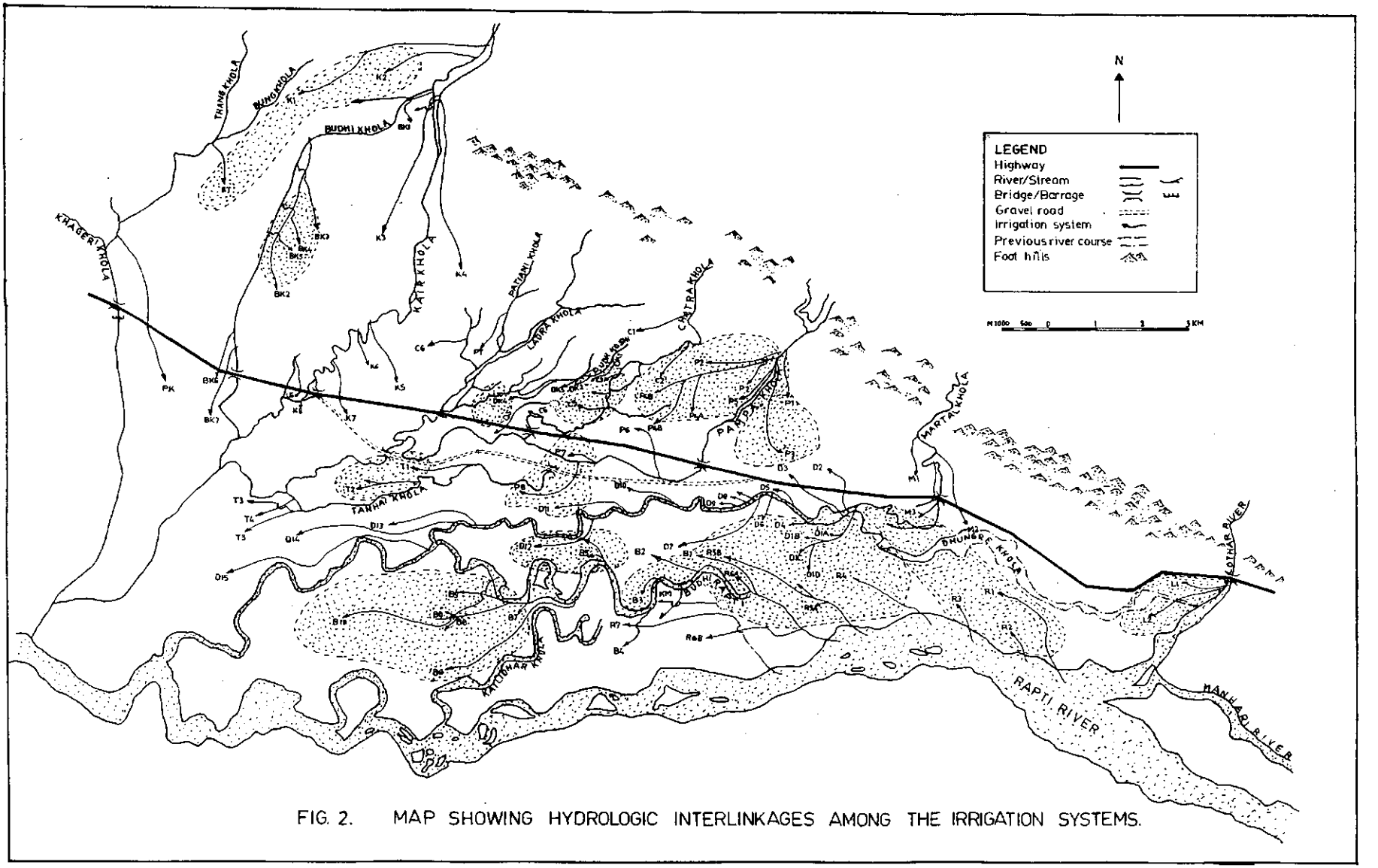

FIG. 2. MAP SHOWING HYDROLOGIC INTERLINKAGES AMONG THE IRRIGATION SYSTEMS.

systems existing in the same settings or from outside to the water users could provide them information on several options related to changes they are planning to make.

IMPLICATIONS

Many irrigation systems in East Chitwan have a large network of institutional arrangements through their Water Users Organization in terms of water acquisition at source; settlement of disputes aroused due to irrigation and other related activities; and protection of cultivated lands from deforestation, stream bank erosion and peak season floods. These institutions have developed through the efforts of many generations comprising of single and multiethnic groups. Any attempts to separate/disorganize irrigation organizations or merge many independent organizations into a single federation may have adverse effects on the social structure of the communities.

Irrigation systems of East Chitwan were found to have hydrologically linked to each other illustrating complex water rights. Surplus water drained from one system is used as a source of supply for other systems. Due to this complex hydrologic linkage, any change in the physical characteristics of one system could have linked effects on the functioning of other systems. This fact also applies to the sources such as Dhongre and Budhi Rapti river which get recharged, at least partially from the drained water of the irrigated lands.

East Rapti Irrigation Project (ERIP) which is currently underway in East Chitwan to improve and rehabilitate the Farmer Managed Irrigation Systems(FMIS) must analyze critically before conceiving and executing any major physical improvement works in this area. More specifically, critical attention is to be given while assisting systems to make their headwork permanent which have a chain of downstream systems. If due care is not given during physical improvement/rehabilitation of these systems it may lead to non-functioning of many systems due to complete checking/sealing of water at the source.

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