Institutional diversity, market pressure and performance of irrigation systems: Comparative perspective in Nepal and Thailand

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Abstract

This paper assesses institutional dynamics and performance of irrigation systems amid change in political, economic and social settings in the country. Taking cases of 50 irrigation systems each from Nepal and Thailand, we analyze these issues both at cross-national and intra-country level. In Nepal new irrigation policy brought out after the political changes of 1990 laid emphasis on participatory approach of irrigation management in the form of transfer of management responsibility from government to users. With the changes in irrigation policy the management responsibility of many government-built irrigation systems has been transferred to users. The water users associations of traditional farmer managed irrigations systems are also registered formally to related authorities. In Thailand with the adoption of participatory irrigation management policy government encouraged people's participation in irrigation management. At present, users are directly involved in management of large irrigation systems at tertiary canal level. Similarly, traditional communal irrigation systems at northern Thailand received support for system infrastructure improvement but with some interference in governance. Market pressures and other related economic factors have significant influence on institutional arrangements. In Nepal the command areas of majority of irrigation systems include cereal-based subsistence farming with only few systems having commercial farming. But market-led economy of Thailand has created condition for diversification in farming practices resulting into increased area under high water demanding commercial crops. The changing water demand scenario has ultimately influenced collective action for irrigation systems management.

Key words: Irrigation, institutional arrangements, market pressure, collective action, performance

1. Introduction

The rapid economic development and political and social changes in Asia has posed a new setting to irrigation management (Moore, 1993), which has influenced the collective action of farmers and also government's willingness to invest in agriculture (Lam, 2001). In many Asian countries irrigation management is most important concern due to significant contribution of agriculture in their national economy. But the performance of irrigation sector is not satisfactory despite of efforts on irrigation development and management (Barker and Molle, 2005). In this context the assessment of institutional dynamics and its influence on performance of irrigation systems is of utmost importance.

Irrigation and water resource related researches in the past mostly focused on use and efficiency of water resources. Some efforts have been made on institutional decomposition and analyzing institution-performance interaction at national level (Saleth and Dinar, 1999; 2000; 2004), issues at system level remains unanswered. More importantly, those studies did not measure exogenous influencing factor explicitly. Some research focused on analysis of system level performance (Lam, 1998) but did not focus on influence of institutional aspects. This paper focuses on comparative analysis of irrigation sector of Nepal and Thailand. These countries have large irrigation sector and institutional arrangements for irrigation management have often changed amid economic and political changes in country. The questions regarding design of effective irrigation institutions and proper role of state need to be answered with reference to the changing context.

This paper examines how irrigation institutions evolve and adapt to changing economic, social and political environment and ultimately affect on performance of irrigation system. The analysis is based on propositions that water institutions existing in a country depend on stage of formalization of its water economy, which ultimately depends upon overall economic evolution of that country (Shah, 2005).

2. Data and methods

The analysis focused on both at cross-country and intra-country level. The discussions are based on extensive survey of 100 irrigation systems, 50 each from Nepal and Thailand. Irrigation systems have been selected in such a way that it covers major river basins across all regions of these two countries. Irrigation systems are selected based on three criteria; ecological region, economic characteristics and management structure.

2.1 Sampled irrigation systems

We selected 50 irrigation systems from Nepal covering major river basins and representing different ecological regions. Similarly, in terms of selecting systems within basins, we have covered from both ecological regions (hills and plains); and represented systems from various forms of governance: farmer managed; agency managed, jointly managed and management transferred systems. Table 1 provides a quick view on distribution of sampled systems in Nepal.

Table 1 Distribution of sampled irrigation systems in Nepal

Regions and Basins	Ecological regions		Total
	Plain	Hill (and valley)	
Eastern Koshi	7	5	12
Central Koshi	-	3	3
Central Gandaki	6	3	9
Western Gandaki	4	8	12
Mid-Western Karnali	3	6	9
Far Western Karnali	2	-	2
Far Western Mahakali	3	-	3
Total	25	25	50

Among the sampled irrigation systems majority are the systems initiated and managed by farmers themselves. Out of 50 sampled systems 41 are the farmer managed irrigation systems. The remaining 9 systems were agency initiated systems, out of which 3 systems are under joint management and in case of other 6 the management at various level is transferred to the users.

Similarly, in Thailand also, we selected 50 irrigation systems covering all six regions and 7 major basins out of 25 basins of the country. Depending on diversity of management and existence of number of irrigation systems, we have selected two basins from northern region, where as one each major basins in other regions. Ping basin in north region is most diverse in terms of management regimes and is also the home of a large number of traditional irrigation systems in Thailand. Kok basin is also important in northern region as it finally flows towards Mekong basin, represents Mekong basin as well. Similarly, in case of East coast basin, industrialization and introduction of other less-water consuming crops have slightly reduced the importance and diversity in surface irrigation systems, thus we have included relatively fewer number of systems from that basin. From other selected basins also we have selected systems proportionately considering the diversity in management and other characteristics. The sampled basins, regions and the number of irrigation systems from each regions of Thailand are presented in Table 2. This sample covers systems representing different ecological domain and management regimes, allowing us to look upon variations in management and influencing factors.

The sample includes irrigation systems representing various management domain and economic characteristics. The management domain includes systems from various mode of governance; farmer managed irrigation systems (FMIS), agency managed irrigation systems (AMIS), and jointly managed irrigation systems (JMIS). Out of 50 systems 30 are FMIS[1], three are AMIS and 17 are under joint management.

[1] FMIS includes 12 (24%) management transferred systems as well

Table 2 Distribution of sampled systems in Thailand

Regions and Basins	Ecological regions		Total
	Plain	Hill (undulating terrain)	
North-Ping	10	7	17
North-Kok	2	3	5
North-East-Nam Chi	4	3	7
Western-Mae Klong	3	3	6
Central-Chao Phraya	6	-	6
Eastern-Rayong	3	-	3
South-Songkhla	3	3	6
Total	31	19	50

2.2 Analytical framework

The analytical framework used for the assessment of performance of irrigation systems is presented in Figure 1. According to the framework; state policies, economic pressure, physical attributes of the system, and other social and institutional variables influence the use of water resource and performance of irrigation systems; but their effect is mediated by local irrigation institutions that help guide human activities. In the subsequent sections of the paper we discuss about the state policies, physical attributes of the irrigation systems, the changing context in the form of market pressure to the farming practices and their ultimate affect on performance of irrigation systems.

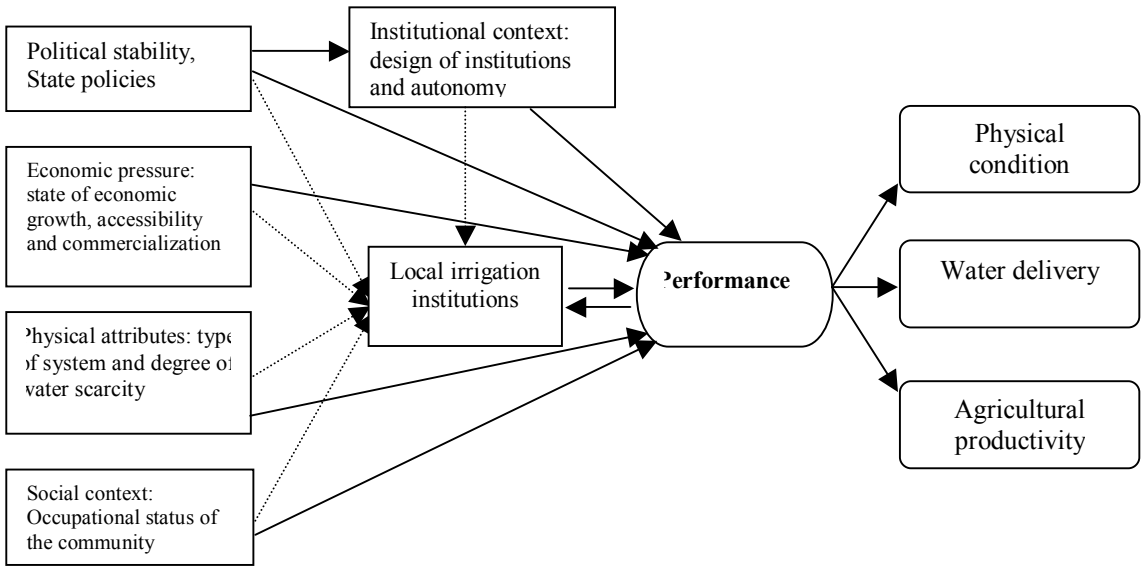

Figure 1. Analytical framework for assessing performance of irrigation systems

3. Irrigation development efforts at national level

3.1 Irrigation Development in Nepal: Important Milestones

Nepal's water resource utilization history dates back to Religious Era (Aryal, 1982). Farmers in Nepal have been developing and managing irrigation since time immemorial alongside the advancement of agricultural technology. The irrigation seems to have been used for replacing or supplementing rainfall with water from another source for growing crops. During ancient period irrigation structures were found to have been developed to enhance productivity with clearly defined rules on water distribution to avoid disputes (Baral, 2001). The construction of water control structures in local rivers in Kathmandu valley started as early as during the first half of fifth century. Majority of the existing irrigation systems in the valley are more than 100 year old (Dulal and Pradhan, 2002).

The government involvement in irrigation development began in early 1920s but at limited scale. The first public sector irrigation scheme was constructed during 1922-28 with state fund. During 1932-50, several public sector irrigation schemes were initiated in the central and western Nepal (Shukla and Sharma, 1997; Shah and Singh, 2000). The planned involvement of government in irrigation development started only after 1951. The Department of Irrigation established in 1952. Since 1956 Nepal entered into the era of planned development, starting the first five year development plan (1956-1961). With the start of development plans, the government began its active involvement in irrigation development in the country. Basic irrigation infrastructures were developed between the First and the Third Five Year Plan periods (1956-70) with bilateral grant assistance of India and USA mainly for irrigation infrastructure development. Several major construction works were done by the state during this phase (Shah and Singh, 2000).

The focus during 1970-85 shifted from investments in infrastructure development to production enhancement programs such as intensive command area development and comprehensive approach to irrigated agriculture. These included development of tertiary canals, service blocks and irrigation command area, rehabilitation of Farmer Managed Irrigation Systems (FMISs), and introduction of appropriate agricultural technology in irrigated areas. The worldwide decline in investment on irrigation sector forced to shift focus on maximization of water use efficiency and management improvement was considered an important step towards this direction. Thus, strategies such as proper utilization of available water resources through reservoir irrigation, rainwater harvesting, lift irrigation and multipurpose irrigation projects were considered as useful efforts in increasing the arable land under year-round irrigation. Thus, the Seventh Plan (1985-90) made a major change in the irrigation development approach by emphasizing on: (a) renovation, reconstruction and expansion of FMISs; (b) participation of beneficiaries in development and management of irrigation infrastructures; (c) development of groundwater irrigation in areas where surface irrigation is limited; (d) involvement of Non-government Organizations (NGOs) in irrigation development; and (e) use of improved and appropriate agricultural technology and materials in irrigated farmlands to maximize outputs (NPC, 1985).

By the end of the Ninth Plan irrigation facilities was developed in 952,322 ha (Table 3) which accounts to 54 percent of the total 1,766,000 ha irrigable area (NPC, 2002). This includes 82 percent surface and 18 percent groundwater areas. At present, there are more than 20,000 small to medium FMISs scattered all over the country covering 66 percent of

the total irrigation facilities and the public sector irrigation schemes termed as Agency Managed Irrigation Systems (AMISs) covering the rest 34 percent. Run-off-the-river diversion providing irrigation to the paddy crop during monsoon is the most common feature of both surface FMISs and AMISs. AMISs have formal rules and regulations whereas community rules still prevail in most FMISs.

Table 3 Irrigation development in Nepal

Development phases	Periodic plan periods	Irrigation development (ha*)			
		Target	Achievement	Percent	Cumulative
Early Phase	Before plan period (till 1956)	-	-	-	6228
Infrastructure Development Phase	First Five Year Plan (1956-61)	20785	5200	25.0	11428
	Second Three Year Plan (1962-65)	32544	1035	31.8	12463
	Third Five Year Plan (1965-70)	50645	52860	104.4	65323
Intensive Development Phase	Fourth Five Year Plan (1970-75)	253711	37733	14.9	103056
	Fifth Five Year Plan (1975-80)	230220	95425	41.5	198481
	Sixth Five Year Plan (1980-85)	233432	172649	74.0	371130
Integrated Development Phase	Seventh Five Year Plan (1985-90)	235493	179337	76.2	550467
	No plan period (1990-92)	6800	48751	71.7	599218
	Eighth Five Year Plan (1992-97)	293895	206401	70.2	805619
Contemporary Phase	Ninth Five Year Plan (1997-02)	224400	146703	42.6	952322
	Tenth Five Year Plan (2002-07)**	241600	-	-	-
Grand total		1836724	905540	57.8	-

Sources: Periodic Plan Documents of HMGN/National Planning Commission, Kathmandu, Nepal. Nepal Agriculture Sector Strategy Study, Vol. I, and II. 1982. HMGN and ADB, Kathmandu, Nepal. *It includes new area brought under irrigation, rehabilitation and improvement of FMISs by various agencies. **Target at estimated growth rate (whereas target at usual growth rate is 204,200 ha).

The irrigation master plan was formulated with the funding support by United Nations Development Program (UNDP) and the World Bank. It was in early 1989; Ministry of Water Resources formally issued the 'Working Policy on Irrigation Development for the fulfillment of the Basic Needs Program (1985-2000)' which led to the enactment of Irrigation Policy 1992, which was subsequently amended in 1997 and 2003. The new irrigation policies brought out after the political changes of 1990 laid emphasis on participatory approach of irrigation management in the form of transfer of management responsibility from government to users. These policies endorsed farmers' involvement in irrigation development from planning to implementation, giving them the responsibility for operation and maintenance of the rehabilitated FMISs, which farmers have been practicing for centuries. The result showed that with the changes in irrigation policy the management responsibility of many government built irrigation systems has been transferred to the users. The water users associations of traditional farmer managed irrigations systems are also registered formally to related authorities.

3.2 Irrigation Development in Thailand: Important Milestones

In Thailand, traditional farmer managed irrigation systems (FMIS), are mostly found in northern part of the country, which were established as early as seven hundred years ago (1296), in the period of king Mengrai (RID, 1970; Surarerks and Chulasai, 1982). The first large scale water control projects in Thailand were begun as private enterprises in the Chao Phraya plain in the 1890s. The Royal Irrigation Department (RID) is the main agency responsible for country's irrigation development and management which was established in the year 1902 (Plusquellec and Wickham, 1985; Suiadee, 2002). The systematic and modern development of irrigation management started only after 1950s through national development plans. During 1960s to mid 1970s it was influenced by external development ideas, loans and grants. During the period, RID mainly focused on infrastructure development especially focusing on Large-scale water storage projects mainly in the Central Region. During the period, the Chao Phraya Barrage, Bhumibol Dam (1952) and Mae Klong Project were constructed to stabilize water supply. Most of the large irrigation schemes are managed by RID in Thailand.

Since 1961, Thailand's water development for irrigation was implemented under the strategy and direction of comprehensive National Economic and Social Development Plans (NESDP). At the beginning, the emphasized target was construction of large and medium scale irrigation projects to increase new irrigable areas as much as possible to guarantee or reduce the risk of a lack of water in the agricultural sector (Budhaka et al., 2002). The progress and trends of water resources development during different NESDP is presented in Table 4. As a result of development in earlier phases, Thailand was able to expand irrigable areas to large portion of its total agricultural land. But, later the strategy and policies in irrigation development changed as the result of competition in economic development as Thailand changed from being primarily agricultural economy to having an increasing emphasis on the industrial export sector as a newly- industrialized country.

Table 4 Progress and trends of irrigation development in Thailand during different National Economic and Social Development Plan (NESDP) periods

NESDP periods	Irrigation Area (million *rai*)	% Irrigation area over total Area	% increase in capacity over previous plan
First Plan (1961-1966)	9.72	3.03	NA
Second Plan (1967-1971)	10.96	3.42	4.19
Third Plan (1972-1976)	14.38	4.48	61.46
Fourth Plan (1977-1981)	15.84	4.94	4.58
Fifth Plan (1982-1986)	18.71	5.83	12.6
Sixth Plan (1987-1991)	20.71	6.46	5.34
Seventh Plan (1992-1996)	21.68	6.76	4.84
Eighth Plan (1997-2001)	22.39	6.98	2.06
Ninth Plan (2002-2006)	28.49	8.88	13.26
Tenth Plan (2007-2011)*	30.71	9.58	7.25

Source: Office of Budget Programming and Project Planning
Note: 1 hectare = 6.15 *rai*; *denotes projected figure.

During the 1980s more focus was given on distributing development to rural areas and hence small-scale projects were implemented. In the 1990s, the development started to take the basin approach under which potential water deficit areas were located and new development projects were identified especially in the Chao Phraya and East Coast Basins. During the past 10 years, there was a major shift in the approach to water resources development and the focus was on the construction of small-scale projects instead of large and medium-scale projects. These measures represented a new conceptual approach towards integrated water resources management in Thailand.

The direction of water resources development for irrigation at present is reflected in Thailand's National Water Policy and Vision (Budhaka et al., 2002). It concentrates on increasing irrigation water use efficiency in existing irrigation projects instead of new water resources development and extension of irrigable areas. RID has attempted to emphasize farmers' participation in on-farm water management with the aim to promote the most effective use of irrigation water as well as to prevent conflicts among farmers during any water use crisis. It also emphasizes on creating water management organizations both at national and river basin levels with supportive legislation. The national organization is responsible for formulating national policies, monitoring and coordinating activities to fulfill the policies. The river basin organizations are responsible for preparing water management plans through a participatory approach.

The first attempt of participatory intervention of government started in the year 1962. The government emphasized Common Irrigators' Organization framework to integrate local people (beneficiaries) into the irrigation systems (Shivakoti, 2000; 2003). Then it was followed by the model of "head irrigators", which was borrowed from indigenous irrigation systems of Northern Thailand. In 1967, RID introduced the concept of Water User' Association (WUA) in Northeast Thailand and in 1968 in Central Thailand. During the time, it was expected that farmers were to take control over operation and maintenance activities at farm level. The WUA was initially established as multipurpose organizations to deliver production inputs and mobilize manpower and funds for irrigation operations and maintenance. For the effective implementation of irrigation project and encouraging people participation, the government initiated land consolidation program in the year 1969, under the leading role of RID. This was the most advanced stage in the progressive intensification of participatory intervention of government for water resource development in the country. The main objective of the program was to delegate irrigation and drainage control to farmers. The government emphasis on irrigation systems development can be manifested by its huge budget allocation and investment (Kanoksing, 1991).

The farmer-managed systems in the country have been facilitated and supported only after the well recognition of people's participation and governance on irrigation systems operation and maintenance by the government. As a result, the Office of Co-operation and Accelerated Water Resources Development have been involving local people, at all stages– planning, implementation and operation and maintenance, in irrigation projects and issuing rules, regulation and guidelines to carry out activities in long-run. Similarly, government owns the large and medium scale irrigation systems, but management responsibilities are divided into both government and farmers at two different levels. The farmers are responsible to manage on-farm irrigation canals, while government organizations managed the main systems such as reservoir and head works maintenance, discharge and allocation of water into different irrigation systems.

In recent decade, Thailand has been growing as a newly industrialized country. As industrialization and urbanization have been taking place in faster rate in one hand, the irrigation system is in a transition state on the other hand. Most of the earlier constructed irrigation structures have already been obsolete. However, rice export is still the country's most important foreign exchange earning sector. The government, therefore, have been emphasizing decentralization policy in the operation and management of water resources, particularly in irrigation systems. More and more involvement and participation of local farmers is one of the main thrusts of decentralization policy. As a result, the RID has been delegating more responsibility to farmers' organizations for on-farm operation and maintenance of irrigation systems.

In overall, after the adoption of participatory irrigation management policy, government encouraged people's participation in irrigation management. At present, users are directly involved in management of large irrigation systems at tertiary canal level. Similarly, traditional communal irrigation systems at northern Thailand received support for system infrastructure improvement including some interference in governance as well.

4. Variations in irrigation infrastructures

As proposed in the analytical framework, physical attributes of the irrigation systems have been considered one of the important aspects affecting the performance of irrigation systems. The earlier discussion on the irrigation development milestones of these two countries provides a glimpse on the possible differences in the physical condition of the irrigation infrastructure. In both countries, it has been noted that traditional farmer managed irrigation systems are predominant mostly in hill/foot-hill areas and those systems feature the infrastructure made-up with the use of local construction materials. However, with change in government policies, those traditional irrigation systems have also received support to improve their infrastructure. In Thailand, most of the traditional *Muang Fai* systems have changed their headwork as permanent concrete structure instead of using traditional construction materials which often needed annual repair and maintenance.

We noted that both countries focused on expanding irrigation areas after the initiation of planned development efforts during 1950s. As a result many large scale irrigation infrastructures were built in both countries. However, it differed across the countries and within countries itself. In Thailand they focused on construction of large scale irrigation canals supported by storage facilities, which were mostly concentrated on central plain areas of the country. Subsequently, the irrigation infrastructures were expanded to other regions of the country as well. In Nepal most of the medium-large scale irrigation systems are built in Terai and valley areas and they are mostly of run-off-river types. Based on sampled systems, the main physical features of the irrigation systems, comparative scenario, in Nepal and Thailand are discussed hereunder.

The distribution of sampled systems based on their age, command area and number of users is presented in Table 5. It showed that the average age of the systems is higher in Thailand, largely due to the systems from North. In terms of command area and number of users also, Thailand has higher average compared to the irrigation systems in Nepal.

Table 5 Distributions of sampled systems by age, command area and number of users in Nepal and Thailand

Characteristics	Country	Minimum	Maximum	Mean	Std. Deviation
Age (yr)					
	Nepal	10	>200	46.0	37.3
	Thailand	10	>300	66.4	62.2
Command area (ha)					
	Nepal	15	6200	501.0	985.5
	Thailand	80	55097	4672.1	10548.6
Number of users (hh)					
	Nepal	28	8000	868.9	1609.3
	Thailand	47	27100	2001.6	5044.3

The majority of the irrigation systems in Nepal were of run-off-river type (Table 6). The key difference we can see is the proportion of storage type system in Thailand. In Nepal, due to the existence of large number of local streams and topographic suitability, systems operated through gravity flow are common, which are cost effective as well. However, due to flood in monsoon and low water level during dry season (observed in data collection period also), this kind of system has low reliability compared to storage type. Similarly, in the context of growing competition in water use, storage and pumping systems provide opportunity for manipulating water supply and irrigation scheduling.

Table 6 Distributions of sampled systems in terms of provisioning water from source, and physical characteristics

Features	Nepal		Thailand	
	Frequency	Percentage	Frequency	Percentage
Type of system				
Run-off-river	49	98	22	44
Storage type	-	-	22	44
Pumping (incl. groundwater)	1	2	6	12
Headwork				
Temporary	15	30	3	6
Permanent	35	70	47	94
Canal lining				
Not lined	4	8	13	26
Partially lined	44	88	31	62
Completely lined	2	4	6	12

If we look on the type of headwork, again in case of Nepal a significant portion of systems have temporary headwork (Table 6). Due to lack of budget, many systems in the hilly areas of Nepal have headwork made-up of wooden, stones and other local materials. This adds to low reliability of the run-off-river type of system found in Nepal. But, in contrary, in case of lining of canal [concrete] the proportion of canal having at least partial lining is higher in Nepal (Table 6). Not-lined canals are common in Thailand as compared to Nepal. It is not clear though, but the existence of relatively higher proportion of systems with partial lining in Nepal may be due to the fact that in case of irrigation systems present in hilly areas of Nepal, they must have to build some lined portion in difficult terrain.

5. Changing context: Performance of irrigation systems

5.1 Market pressure, farming practices and collective action

It has been noted that market pressures and other related economic factors have significant influence on institutional arrangements. In Nepal the command areas of majority of irrigation systems include cereal-based subsistence agriculture with only few systems having commercial vegetable farming. But the market-led economy of Thailand has created condition for diversification in farming practices resulting into increased area under high water demanding commercial crops. The changing water demand scenario has ultimately influenced the collective action for irrigation systems management.

During the recent period the Thai agriculture has experienced significant transformations in cropping pattern. The framing system which was mostly dominated by wet season rice farming has gone through several changes. As a result land use pattern and crop combinations are changing overtime in many areas of Thailand including; cereals to orchard; cereal to other farming activities; and shift to non-agricultural activities. These changes in types and number of crops grown overtime are due to the influence of external economic pressures (Shivakoti and Bastakoti, 2006; Bastakoti and Shivakoti, 2008).

Rapid development of urban and industrial sector has increased the competition for water resources among different sectors (Cohen and Pearson, 1998). With the commercialization of agriculture and increasing water demand, *muang fai* systems have difficulties to provide a steady supply to all users and to exclude non-members from use. Centralization of resource management and expansion of state-run irrigation system have undermined local management systems and have weakened social cohesion and collective action.

5.2 Performance of irrigation systems

Various criteria have been used in the assessment of performance of irrigation systems in Nepal and elsewhere. We use some important criteria used by Lam (1998) and as proposed in our analytical framework. Among the performance criteria, the overall physical condition seems better in Thailand (Table 7). It represented users' response regarding whether the physical condition of the system is maintained in economically feasible way considering the land topography and technology available to the users and/or agency managing the irrigation systems. But when users were asked to compare the costs of operating and maintaining their irrigation systems with the incremental benefit obtained from those operation and maintenance activities, the indicator represented as 'short run economic-technical efficiency, the situation was not much different. Rather the irrigation systems from Nepal were relatively better than Thai irrigation systems

Table 7 Overall physical condition and economic technical efficiency of the irrigation systems as the performance indicators

Performance criteria	Nepal		Thailand	
	Frequency	Percentage	Frequency	Percentage
Overall physical condition				
Very bad	1	2	2	4
Poor	14	28	3	6
Good	33	66	43	86
Excellent	2	4	2	4
Short run economic-technical efficiency				
Highly inefficient	-	-	2	4
Inefficient	7	14	3	6
Efficient	38	76	35	70
Highly efficient	5	10	10	20

Similarly, despite of superiority in terms of physical condition of Thai irrigation systems, the result showed that cropping intensity was significantly higher in case of Nepal. The average intensity both at head and tail end of the system was well above 200 percentages (Table 8). However, one important point we should note here is that the total command area of the irrigation systems has been considered while calculating the intensity at system level. As there are many fallow areas and peri-urban areas in command area of Thai irrigation systems it obviously shows less intensity in those cases. If we compare commercialization and intensification in farming; in many areas they are at more advanced stage compared to Nepali irrigation systems.

Table 8 Cropping intensity at head and tail end of the system

Intensity	Country	Minimum	Maximum	Mean	Std. Deviation
Cropping intensity at head end					
	Nepal	130	300.0	245.5	51.1
	Thailand	80	265.0	161.0	65.4
Cropping intensity at tail end					
	Nepal	144	300.0	238.2	47.9
	Thailand	50	250.0	159.3	63.0

As proposed in analytical framework, the further analysis on how the variations in local level institutional arrangements have influenced the performance of the irrigation systems showed different pictures. In Nepal FMIS are performing better compared to the large scale irrigation systems built and managed by state irrigation agencies. Even the cases of management transferred systems are same, which was mostly due to unclear responsibility of the water users' organization now responsible for the management after handover of the system. The situation was almost similar, like Nepal, in Thailand. The traditional irrigation

systems were efficient in terms of performance. It was noted that they have adopted various coping strategies to adapt with the adverse situation resulted due to the increased water demand (Bastakoti and Shivakoti, 2008). Thus as we earlier proposed, the well functioning local institutional arrangements are playing important role in maintaining the performance of irrigation systems through providing various alternative management options which ultimately mediate the external pressure created to the irrigation systems in the changing macro-meso level context.

6. Conclusions

In Nepal the new irrigation policy brought out after the political changes of 1990 laid emphasis on participatory approach of irrigation management in the form of transfer of management responsibility from government to users. The result showed that with the changes in irrigation policy the management responsibility of many government built irrigation systems has been transferred to the users. The water users associations of traditional farmer managed irrigations systems are also registered formally to related authorities. In Thailand, government focused on building more irrigation capacity thus constructing large irrigation systems in many parts of the country. The result showed that after the adoption of participatory irrigation management policy government encouraged people's participation in irrigation management. At present, users are directly involved in management of large irrigation systems at tertiary canal level. Similarly, traditional communal irrigation systems at northern Thailand received support for system infrastructure improvement including some interference in governance as well.

The market pressures and other related economic factors have significant influence on institutional arrangements. In Nepal the command areas of majority of irrigation systems include cereal-based subsistence agriculture with only few systems having commercial vegetable farming. But the market-led economy of Thailand has created condition for diversification in farming practices resulting into increased area under high water demanding commercial crops. The changing water demand scenario has ultimately influenced the collective action for irrigation systems management.

Our observation implies that the broader policy changes have resulted into different institutional arrangements. Though the emphasis has been given to direct involvement of users in management, insufficient attention to the autonomy and unity of traditional irrigation systems and changing water demand scenario has significantly affected overall performance of irrigation systems. Similarly, the result showed that traditional irrigation systems, both in Nepal and Thailand, have been effective to mediate the external influence through their local institutional arrangements thereby maintaining the performance of the systems.

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References

Aryal, I. R. 1982. Naya Nepal ko Itihans. Ratna Pustak Bhandar, Kathmandu, Nepal. pp. 10-21. (In Nepali language)

Baral, R. R. 2001. Nepal ko Itihans. Ratna Pustak Bhandar, Kathmandu, Nepal. p. 21. (In Nepali language)

Barker, R., and F. Molle. 2005. Perspectives on Asian Irrigation. In G. P. Shivakoti, D. Vermillion, W. F. Lam, E. Ostrom, U. Pradhan, and R. Yoder, eds. Asian Irrigation in Transition: responding to the Challenges. New Delhi: Sage Publications.

Budhaka, B., M. Srikajorn and V. Boonkird. 2002. Thailand country report on investment in water. In "Investment in Land and Water" Proceedings of the Regional Consultation at Bangkok, Thailand, during 3-5 October 2001. Food and Agriculture Organization of the United Nations, Bangkok.

Dulal, S. P. and Pradhan, P. 2002. Inventory of Irrigation Systems in Kathmandu District, Nepal. In: P. Pradhan and U. Gautam (eds.) 'Farmer Managed Irrigation Systems in the Changed Context', proceedings of the Second International Seminar held on 16-19 April 2002, Kathmandu, Nepal. Farmer Managed Irrigation Systems Promotion Trust, Kathmandu, Nepal.

HMGN (His Majesty's Government of Nepal). 2001. Jalashrot Ain 2049 (Water Resources Act 1992), Jalashrot Niyamawali 2050 (Water Resources Regulation 1993), and Sinchai Niyamawli 2056 (Irrigation Regulation 2000). Legal Document Management Committee of HMGN, Kathmandu, Nepal.

Kanoksing, P. 1991. Thailand–Country Report. In Management of Irrigation Facilities in Asia and the Pacific. Tokyo: Asian Productivity Organization.

Lam, W. F. 1998. Governing Irrigation Systems in Nepal: Institutions, Infrastructures, and Collective Action. Oakland, CA: ICS Press.

Lam, W. F. 2001. Coping with change: A study of local irrigation institutions in Taiwan. *World Development*, 29(9):1569 – 1592.

Moore, M. 1993. Economic structure and the policies of sectoral bias: East Asian and other cases. *Journal of Development Studies*, 29(4):79 – 128.

NPC. 1985. The Seventh Five Year Plan 1985-90. National Planning Commission, Kathmandu, Nepal.

NPC. 2002. The Tenth Plan 2002-2007. National Planning Commission, Kathmandu, Nepal.

Plusquellec, H. L. and T. Wickham. 1985. Irrigation design and management: experience in Thailand and its general applicability. World Bank Technical Paper Number 40, The World Bank, Washington D.C., USA.

RID. 1970. Royal Irrigation Department, September 28, 1970.

Saleth, R. M., and A. Dinar. 1999. Evaluating Water Institutions and Water Sector Performance. World Bank Technical Paper No. 447, The World Bank: Washington D.C.

Saleth, R. M., and A. Dinar. 2000. Institutional changes in global water sector: Trends, patterns, and implications. *Water Policy*, 2 (2000):175 – 99.

Saleth, R. M., and A. Dinar. 2004. The Institutional Economics of Water: A Cross-Country Analysis of Institutions and Performance. Cheltenham, UK: Edward Elgar.

Shah, S. G. and Singh, G. N. 2000. Irrigation Development in Nepal: Investment, Efficiency and Institution. Winrock International Research Report Series No. 47. Winrock International, Kathmandu, Nepal.

Shah, T. 2005. The new institutional economics of India's water policy. Paper presented in Workshop on 'African water laws: Plural legislative framework for rural water management in Africa', 26-28 Jan 2005. Johannesburg, South Africa.

Shivakoti, G. P. 2000. Participatory Interventions in Farmer-Managed Irrigation Systems in Northern Thailand: Dynamism in Resource Mobilization. Presented at "Constituting the Commons: Crafting Sustainable Commons in the New Millennium", the Eighth Conference of the International Association for the Study of Common Property, Bloomington, Indiana, USA, May 31-June 4.

Shivakoti, G. P. 2003. Facilitating Policies for Improved Governance and Management of Asian Irrigation Systems. Paper presented at a Colloquium at the Workshop in Political Theory and Policy Analysis, Indiana University, September 22, 2003.

Shivakoti, G. P., & Bastakoti, R. C. (2006) The robustness of Montane irrigation systems of Thailand in a dynamic human-water resources interface, *Journal of Institutional Economics*, 2 (2), pp. 227-247.

Shivakoti, G. P., W. F. Lam, and U. Pradhan. 2005. Asian Irrigation Problems and Prospects. In G. P. Shivakoti, D. Vermillion, W. F. Lam, E. Ostrom, U. Pradhan, and R. Yoder, eds. Asian Irrigation in Transition: responding to the Challenges. New Delhi: Sage Publications.

Shukla, A. K. 2001. Policies, Processes, and Performance of Management Turnover in Agencies Initiated Intervention. In: Ganesh P. Shivakoti and E. Ostrom (eds.) 'Improving Irrigation Governance and Management in Nepal'. Institute for Contemporary Studies: California, USA.

Suiadee, W. 2002. Thailand. In APO (2002): Organizational Change for Participatory Irrigation Management. Report of the APO Seminar on Organizational Change for Participatory Irrigation Management ,Philippines, 23–27 October 2000.

Surarerks, V., and L. Chulasai. 1982. Water Management and Development in Northern Thai irrigation Systems. Chiang Mai University. Chiang Mai.