# The robustness of Montane irrigation systems of Thailand in a dynamic human-water resources interface<sup>1</sup>

By

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#### ABSTRACT

As an initial effort to understand the Asian irrigation systems dynamism and their robustness overtime, this paper examines two irrigation systems of Kok river system within Mekong river basin in Northern Thailand in the context of changing governance mechanisms and evolution of technological and market forces. Since the processes involved in first starting collective action are different than those of maintaining them overtime, the paper examines dynamism over three stages; initial, medium and long-term. During the initial stage of starting an irrigation system various attributes of the users including the benefits they could obtain from starting an organization to the skill of public entrepreneurs of brining them together affecting trust have been examined. The medium stage of irrigation systems development inquiry includes the process of development of rules, and the level of autonomy to develop their own rules over time. The long term stage focuses its analysis of external factors affecting the sustenance of these irrigation systems with special reference to the impact of changes in economic prices and labor mobility on the one hand and changes in the authority over irrigation and the availability of funding for irrigation on the other. The analysis is based on the framework developed by Ostrom, Anderies and Janssen (2003) in the linkages and relationship between the five elements, namely: resource, resource users, public infrastructure, public infrastructure providers and external disturbances. Thus, the paper evaluates the dynamism and robustness of irrigation systems overtime at operational and collective choice levels of analysis.

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## **INTRODUCTION**

About 250 million hectares, or 17 percent of the world's cropland, is irrigated and produces one-third of the world's food with almost three-quarters of this irrigated area in the developing countries and 60 percent in Asia (Geizer et al. 1996). Since the 1950s, the total irrigated area in the world has expanded rapidly with almost three-fold of its increase between 1950-1980 and 50-60 percent of its contribution to a huge increase in agricultural production has taken place in developing countries from 1960-1980 (Ostrom 1992). The expansion of irrigated land has been the greatest factor affecting the quantity of rice produced in Asian countries like India, Indonesia, Pakistan, the Philippines, Sri Lanka, and Thailand (Ostrom 1992). Given these large scales of contribution on national economy of the Asian countries, irrigation development and management has been the main agenda on these countries' national development plan beginning from the colonial era, through the Cold War period and into the new era of globalization (Barker and Molle 2004).

Prior studies in some of these countries suggest that farmers in different settings tend to adopt different strategies to cope with the changing environment, and these different strategies tend to bring about very different patterns of institutional development as well as different institutional designs (Lam 1998, Shivakoti and Ostrom 2002). The level of irrigation system performance is directly related to the capacity of appropriators' self-governing abilities and their individual level of participation based on design principles of governing the commons. The importance of 'design principles' in 'long-enduring' self-organizing irrigation institutions is highlighted by Ostrom in which she cautions blanket approach of policy analysis and recommendation (1990, 1993). The large number of case studies documented over the nearly three decades suggests that improvement in the performance of irrigation and other resources is enhanced by systems of polycentric governance with some degree of autonomy, rather than centralized institutions (McGinnis 1999, 2000). Also several variations in interventions and in performances of irrigation systems have been documented extensively and major policy lessons have been documented (Medagama 1987; Hussein et al. 1987; Shivakoti 1992; Tang 1992; Pradhan 1989; Lam, Lee and Ostrom 1997; Lam 1998; Hilton 2002; Shivakoti and Ostrom 2002). However, a very large proportion of early work on irrigation institutions as well as other common property institutions focused on static arrangements and efforts were focused on analysis of cross-sectional data. In a few cases there are studies carried out to study overtime such as in the case of an innovative intervention approach of farmer-to-farmer training adopted by Water and Energy Commission Secretariat and International Irrigation Management Institute in Sindhupalchok District of Nepal (Lam and Shivakoti, 2002).

The issue of overtime dynamic study has become important in order to facilitate policies which have to be evaluated in light of the changes that have taken place during the last several decades, which have direct bearings on the performances of irrigated agriculture in Asia. These include population growth, urbanization, globalization, integration of local communities into national society, and economy, commercialization of agriculture, labor mobility, movement of the younger generation out of agriculture, increasing competition for land and water resources, high costs of irrigation systems development and rehabilitation, and environmental degradation (Vermillion et al., 2004). Vermillion et al. (2004) further warn that socioeconomic and ecological changes, in general, are racing well ahead of the pace of institutional change based mainly on the principles of quick-fixes and panaceas.

As an initial effort to look at the issues of dynamics of irrigation systems this paper examines two irrigation systems diverting water from the Fang river, one of the tributaries of Kok river system in Fang district within the Mekong river basin in the Northern Thailand in the context of changing governance mechanisms and evolution of technological and market forces. Dynamism in the resource use pattern can be analyzed by examining the changes in institutional arrangements within a Socio-Ecological System (SES). The entities in a socioecological system include the resource itself, the resource users, public infrastructure providers, public infrastructure and external disturbance (Ostrom, Anderies and Janssen 2003). This paper uses the framework developed by Ostrom, Anderies and Janssen by identifying the entities involved and their inter-linkages in irrigated social ecological systems (Annex Table 1 and 2). Moreover, the overtime flow of people, money, and markets which are defining features of the regional political and economic landscape in which the irrigation systems respond takes place at varying level; and, these factors influence since the beginning of the construction as well as operation and maintenance of these systems (Baker, 2004).

The two irrigation systems, namely, Mae Sao and Thai Yai are located within the vicinity of Fang and Mae Ai district in the northern part of Chiang Mai province of Thailand. There are several traditional irrigation systems in the Northern part of Thailand. In 1950s, the Government of Thailand provided some kind of assistance to many local areas for the development of the existing traditional irrigation systems. Due to the assistance the weir of some Muang Fai systems (Farmer-Managed Irrigation Systems) are built of concrete or are reinforced at foundation with permanent materials. In this way, the Muang Fai systems have gradually integrated new technology and materials. The change in either the whole structure or a part of the structure may lead to adjustments in the pattern of relationships among the water users. The change is probably more rapid when a Government sponsored and centrally planned irrigation system has been established to cover the area of several existing Muang Fai systems. A direct approach introduces a new technological, social, and institutional arrangement to local communities. The Government irrigation organization, working under the Royal Irrigation Department (RID), would usually be established to manage the irrigation activities required, from the system level to the level of small working units in the fields. Furthermore, when the Government began extensive development activities in agriculture around 1959, the irrigation administration in several areas was transferred to the central administration under the RID.

The Government also intervened in Mae Sao Irrigation Project in Fang river basin by providing the permanent construction, which was supported by the cooperation between the Thai Government and the German Government, and completed in 1981. The Mae Sao Irrigation Project consists of three main canals and has used the same administrative organization as before the intervention. But due to the increased number of canals and the lengths of the canals the number of Kae Muang (local irrigation leaders)) and assistants have been changed.

The nature of the collective actions required in constructing as contrasted to maintaining irrigation systems are different. At the beginning, the resource is a relatively untamed water source. The infrastructure may be not very well developed either in terms of physical or institutional terms. The users may be able to be their own public infrastructure providers or they may have to draw on others. Therefore, a useful strategy for analysis of irrigation

dynamism can be divided into three stages: initial, medium and long-term. In these three stages, several external factors affect the performance of irrigation systems, and hence, the sustainability of the systems. These relate to broad economic and political changes and the subsequent changes in the rules of these irrigation institutions. Since the central theme of the paper is to assess the impact on irrigation systems and inter-systems robustness due to changes in economic prices and labor mobility vis-a-vis- the changes in the authority over irrigation and the availability of funding on the other, the level of inquiry has focused on the operational and collective choice levels within the irrigation systems themselves as they respond to external disturbances.

## Brief overview of study methodology

Viriyasakultron (1984) analyzed different aspects of irrigation management comparing the situation before and immediately after the government intervention in Mae Sao Community Irrigation Project. This research has considered the same aspects studied by him. But along with the Mae Sao Community Irrigation System, this study also covers the Thai Yai Irrigation System which is situated in the upstream area of the Mae Sao system. With the changes in social, economic, technical and institutional arrangements overtime, the need for water has also changed dramatically in the Mae Sao Community irrigation system thereby affecting the water balance in the river, and, hence on the upstream Thai Yai irrigation system.

For the analysis of changes that occurred during the last decade or so we have selected a total of 61 sample households. Among them 22 households were from head water distribution area of Mae Sao system, 21 households from tail water distribution area of the same system and 18 households from the Thai Yai Irrigation System. The data were collected from these households during 2003 though household survey by using the same set of questionnaire used by Viriyasakultron in 1984.

## Participation on irrigation and agricultural production activities

One of the immediate impacts of intervention on the traditional irrigation systems was in performing different agriculture and irrigation related activities. There were sharp decline in performing certain activities immediately after constructing the new weir in Mae Sao community irrigation system. The activities like cleaning and repairing the ditch and offering to the spirit of weir declined considerably immediately after the intervention (Table 1).

The changes in different activities differed in the traditional Thai Yai Irrigation System and Mae Sao Community Irrigation System (Table 2). The changes in activities were also not the same in head water distribution area and tail water distribution area within the Mae Sao system. The cleaning and repairing of the ditches have significantly decreased in the Mae Sao system after intervention, this may be mainly due to improvement in canal lining.

	Participation (in percentage)				
Activities	Before 1981	Immediately After	20 years after		
Activities		intervention in	intervention		
		1984	(2003)		
Clearing and repairing the ditch	98.0	62.2	67.4		
Offering to the spirit of weir	37.9	2.9	18.6		
Preparing seed bed of rice	99.0	97.0	72.1		
Allocation of water	74.4	74.0	67.4		
Diverting water into paddy field	97.0	95.1	67.4		
Plowing for transplanting paddy	98.0	97.0	74.4		
Sowing	87.4	83.0	79.1		
Requesting water from another weir	1.9	1.9	14.0		

Table 1. Irrigation and agriculture production activities before-after intervention and 20years later in Mae Sao Community Irrigation System, Chiang Mai, Thailand

Source: Viriyasakultron (1984) and Field Survey (2003)

Similarly, different ritual activities such as offering to the spirit of weir and praying for rain ceremonies have decreased considerably in the Mae Sao where as the rituals have been followed almost same as before in traditional system with only a slight decline. Overall it can be said that there is a declining trend in the practice of ritual since the newly built concrete canals provided much more convenience in the usage of irrigation water. In addition, the structural improvement of the irrigation system has in fact reduced the participation of people in different activities (Box 1).

 Table 2. Irrigation and agricultural production activities before and after new weir construction

Activities	Mae Sao (Head) (n = 22)		Mae Sao (Tail) (n = 21)		Thai Yai (n = 18)		Total $(n = 61)$	
	Before	After	Before	After	Before	After	Before	After
Cleaning and repairing of the ditches	95	70	95	71.4	75	71.4	89.3	70.9
Offering to the spirit of water	10	0	61.1	40	40	35.7	35.8	25
Praying for rain ceremonies	5.3	0	31.6	10	0	0	13.5	3.9
Making seed bed	81	83.3	90.5	80	80	66.7	84.2	77.4
Allocation of water	65	61.1	100	90	76.5	68.8	81	74.1
Diverting water into paddy fields	80	7.8	90.5	75	80	66.7	83.9	73.6
Plowing for transplanting	90	88.9	100	80	86.7	73.3	92.6	81.1
Sowing	80	88.9	100	90	87.5	73.3	88.9	84.9
Requesting water from another weir	10.5	0	33.3	30	0	0	15.7	11.8

## Box 1 Structural improvement and participation in activities

In Fang and Mae Ai districts of Chiang Mai Province in Northern Thailand, there are still several traditional community managed irrigation systems. While some irrigation systems have received government assistance for repair and maintenance of the intake and main canals, others have been deprived of such assistance due to farmers not having official land use entitlement certificates. This lack of clarity in land rights emerged in recent years when the government declared the adjoining forest area to be a protected area. This included the community and farmland within the protected areas.

The downstream Mae Sao community irrigation system received assistance from the government for construction of a permanent weir and partial canal lining. A government technician was assigned to conduct maintenance. However, the upstream Thai Yai community irrigation system within a kilometer distance did not receive any assistance due to its location within the so-called protected area. While the traditional system of labor contribution for maintenance continues in the upstream irrigation system it has been replaced in the downstream system by staff hired by government to maintain the system. In the Mae Sao scheme, whereas collective action was mobilized for system maintenance in the past, after rehabilitation and assignment of government staff to the system, collective action has virtually disappeared at main and branch canal levels.

The effect of intervention on Mae Sao community irrigation system has been reflected on the frequency of different activities after construction of the weir. The majority of the people responded that the frequency of these activities have changed very much. While in case of traditional Thai Yai system the change was slightly less than the Mae Sao system.

## Participation in irrigation activities

It is seen that people's participation in different irrigation activities significantly decreased immediately after the construction of the new weir. The sharp decline was found mainly in building of weir reducing to 10.7 percent from 86.4 percent, and in case of reconstruction or repair and cleaning of weir reducing to 23.3 from 88.3 percent (Table 3). This happened because after the intervention of government there was no rationale of people's participation in such activities and which changed the nature of collective action of the people (Box 2). People declining participation on collective action is mainly due to the fact that after the construction of new weir they thought that it is not essential to put any effort to the maintenance of the weir. Similarly, some people hired others to contribute to the maintenance of the weir should be a joint responsibility of the members of the community and those who need irrigation water.

Irrigation Activities		Participation (percentag	ge)
	Before	Immediately after	20 years after
	intervention	intervention in 1984	intervention
			(2003)
Building of weir	86.4	10.7	25.6
Reconstruction or repair & cleaning	883	23.3	18.8
of weir	00.5	25.5	40.0
Meeting to elect weir leader	93.2	73.8	67.4
Membership of water management	18	1 0	20.9
committee	4.0	1.7	20.7
Participation in the resolution of	87	20	23.3
conflict about water use	0.7	2.9	25.5

 Table 3. Participation of farmers in irrigation activities before and after intervention in

 Mae Sao Community Irrigation System, Chiang Mai, Thailand

Source: Viriyasakultron (1984) and Field Survey (2003)

Similarly, if we compare the case of participation in different activities within different location in the Mae Sao system, people of head water distribution area are involved in building the weir more than the people from tail water distribution (Table 4). In case of traditional Thai Yai system also there is declining participation of the people in the activities related to irrigation management.

Activities	Mae Sao (Head) (n = 22)		Mae Sao (Tail) $(n = 21)$		Thai Yai (n = 18)		Total $(n = 61)$	
	Before	After	Before	After	Before	After	Before	After
Building a weir	73.7	64.7	81	23.8	81.3	50	78.6	64.8
Reconstruction or repair and cleaning of weir	75	52.9	76.2	57.1	75	50	75.4	53.7
Meeting to elect weir leader	66.7	72.2	81	76.2	68.8	50	72.4	67.3
Membership of water management committee	21.1	6.3	33.3	40	43.8	31.3	32.1	26.9
Participation in conflict resolution of water	16.7	6.7	44.4	45	12.5	12.5	25	23.5

 Table 4. Participation in irrigation activities before and after the completion of the new weir

### Box 2. Reduction in collective action after intervention

Both Mae Sao and Thai Yai irrigation systems were traditional irrigation systems built, managed and operated by the local people. Before the intervention most of the activities related to the irrigation management were performed by the people themselves on a collective way. Their collective actions were guided by the Sanya Muang Fai and traditional customs and managed under the leadership of Kae Muang. They used to contribute in construction of weir, reconstruction or repair and maintenance of the weir. But as the government intervened in the Mae Sao community irrigation system replacing the temporary weir by permanent one as well cement lining of the canal, the nature of the collective action of the people changed

significantly. Their participation reduced many fold in such activities mainly relying on the government appointed employees who are responsible for managing those activities. Similarly due to the intervention the rationale of people's participation in certain activities remains no longer valid.

The changes were not seen only in the downstream system, it also affected the upstream Thai Yai areas which did not receive any support from the government due to its location inside the protected area. After construction of the new weir they suffered more competition on the water source resulting into more scarcity. Similarly, more involvement of people from other areas, mainly plain areas of Chiang Mai, also affected on the collective action of the people resulting into the decline in collective action.

# Role of local leader in changing context

In traditional irrigation systems in the Northern Thailand, Kae Muang (the local leaders) has played a very important role in water management, both in administrative work and in mechanical work. They are elected/selected by the water users to supervise all activities concerning irrigation and to enforce the rules. In general, the organization is divided into two levels: the system level organization locally called as Mu Muang Lak meaning the organization designed to carry out activities, while the canal level organization is called Mu Muang Soi meaning the administration of individual canals. At the system level, the top leader called Kae Muang is the highest authority and makes final decisions in all affairs. The Kae Muang usually works with a group of canal level leaders to coordinate the work of the entire system, such as seasonal maintenance of the weirs and canal cleaning. Similarly, they are supported by assistants and water messengers. Their role was most prominent in the traditional irrigation system. However, after the construction of new weir and intervention in operation and maintenance their role has not declined. The majority of the people still give emphasis on the role of Kae Muang and responded that it is not possible to manage without the local leader (82%). The role of Kae Muang is considered more important in Thai Yai system and tail water distribution area of Mae Sao system as compared to head water distribution area.

Similarly, the people give more emphasis on the group work for irrigation management. The water users are responsible for the management of their irrigation system. The majority of the people were responsible for water management. The group responsibility for irrigation management was higher in Mae Sao system as compared to Thai Yai system (Table 5).

Responsibility	Mae Sao (Head) (n = 22)	Mae Sao (Tail) (n = 21)	Thai Yai (n = 18)	Total $(n = 61)$
Hardly responsible	2 (9.1)	1 (4.8)	0 (0)	3 (4.9)
Responsible to certain extent only	6 (27.3)	7 (33.3)	9 (50)	22 (36.1)
Largely responsible	11 (50)	11 (52.4)	4 (22.2)	26 (42.6)
Fully responsible	3 (13.6)	2 (9.5)	5 (27.8)	10 (16.4)
Total	22 (100)	21 (100)	18 (100)	61 (100)

<b>Fable 5. Group</b>	o responsibilit	y for irrigation	management.
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Note: Figures in parentheses indicate percentage

Similarly regarding the performance of water users in irrigation management, it is seen that they are effectively participating in irrigation management. Like in the case of group responsibility, the effectiveness of group efforts in managing irrigation system is higher in Mae Sao system as compared to Thai Yai system (Table 6). The lower level of group responsibility and effectiveness may be due to the fact that in Thai Yai system area the contract farming is common. This can be considered as the effect of globalization and market economy on occupational pattern; changes in farming practices from traditional upland farming to contract farming in this case. Due to increasing contract farming practices, it is seen that people's participation in group activities and their effectiveness is lower in Thai Yai system as compared to Mae Sao system. Principally, it would be the reverse case, because the Thai Yai system lies in the upstream area and inhabitants are mainly tribes and therefore there should be more participation of these peoples in group activities.

Effectiveness	Mae Sao (Head)	Mae Sao (Tail)	Thai Yai	Total
Effectiveness	(n = 22)	(n = 21)	(n = 18)	(n = 61)
Hardly effective	2 (9.1)	1 (4.8)	0 (0)	3 (4.9)
With limited effectiveness	7 (31.8)	6 (28.6)	8 (44.5)	21 (34.4)
Effectively	11 (n = 50)	12 (57.1)	6 (33.3)	29 (47.6)
Most effectively	2 (9.1)	2 (9.5)	4 (22.2)	8 (13.1)
Total	22 (100)	21 (100)	18 (100)	61 (100)

Table 6. Effectiveness of groups in managing irrigation system.

Note: Figures in parentheses indicate percentage

Even though most water users responded that they were responsible and could manage effectively, they still thought that the Kae Muang is necessary for managing the irrigation system (Box 3). Thus the fact that people thought that the water users could not manage without the Kae Muang although the groups were responsible and capable to manage irrigation effectively by themselves may precisely result from the existing conditions where the water users are organized in the groups and obliged by the Sanya Muang Fai under which they have institutionalized the supervision by as well as of the Kae Muang.

Another important aspect in this situation is the performance of Kae Muang. The majority of the respondents (83.6%) thought that the Kae Muang is doing a god job in assisting the people in irrigation management (Table 7). Similarly, if we look at the level of satisfaction of towards the way in which the Kae Muang was carrying out his duties and responsibilities, a stronger majority (90.2%) of the people are satisfied with the performance of Kae Muang.

Response	Mae Sao (Head) $(n = 22)$	Mae Sao (Tail) $(n = 21)$	Thai Yai (n = 18)	Total $(n = 61)$
No	0 (0)	1 (4.8)	1 (5.6)	2 (3.3)
Indifferent	3 (13.6)	2 (9.5)	3 (16.7)	8 (13.1)
Yes	19 (86.4)	18 (85.7)	14 (77.7)	51 (83.6)
Total	22 (100)	21 (100)	18 (100)	61 (100)

Table 7. Response towards the Kae Muang doing the job satisfactorily.

Note: Figures in parentheses indicate percentage

# Box 3 Importance of Kae Muang in modern irrigation system

In both Mae Sao and Thai Yai system Kae Muang are playing important role in managing the irrigation system. Not only in the case of traditional Thai Yai system they are considered equally effective in case of government intervened Mae Sao irrigation system as well. In the issue of whether the traditional leaders are still important in a modern and government intervened system or not, majority of the respondents (63.9%) emphasized on their importance in managing the irrigation system.

Response	Mae Sao (Head) $(n = 22)$	Mae Sao (Tail) $(n = 21)$	Thai Yai (n = 18)	Total $(n = 61)$
Yes, to a certain extent	5 (22.7)	1 (4.8)	0 (0)	6 (9.9)
Yes, definitely	7 (31.8)	4 (19)	5 (27.8)	16 (26.2)
Yes, very much so	10 (45.5)	16 (76.2)	13 (72.2)	39 (63.9)
Total	22 (100)	21 (100)	18 (100)	61 (100)

Table 3.1 Response towards importance of traditional weir leader in a modern irrigation system

Note: Figures in parentheses indicate percentage

It was also reflected through their role on these irrigation systems after the construction of the new weir. Regarding their role after the completion of the new weir almost 93 percent respondents said that the role of weir leader has not changed and remained same as before. Only few people had the view that with the changed context the role has also changed.

From these facts it can be noted that the importance of the Kae Muang and their role has not decreased due to the changing context. Rather, they have gained importance in the centrally planned modern irrigation system.

People give importance to the certain qualifications while selecting the Kae Muang. They relate to the kind of activities they prefer and also depend on individual preferences. Regarding the qualifications of the desired leader, they have diverse preferences and among them honesty (17.9%) and responsible man who works for the community (17.9%) were important criteria (Table 8).

Characteristics	Mae Sao (Head) $(n = 22)$	Mae Sao (Tail) $(n = 20)$	Thai Yai (n =14)	Total $(n = 55)$
Well known man	5 (22.7)	1 (5)	1 (7.1)	7 (12.5)
Knowledgeable in irrigation work	3 (13.7)	0 (0)	1 (7.1)	4 (7.1)
Person who has a field at the end of an irrigation	0 (0)	2 (10)	0 (0)	2 (3.6)
Honest man	5 (22.7)	2 (10)	3 (21.5)	10 (17.9)
Just man	0 (0)	1 (5)	1 (7.1)	2 (3.6)
Responsible man who works for the community	4 (18.2)	4 (20)	2 (14.3)	10 (17.9)
Person who has practical knowledge in irrigation	0 (0)	2 (10)	3 (21.5)	5 (8.8)
Wealthy man	2 (9.1)	0 (0)	0 (0)	2 (3.6)
Big land owner	2 (9.1)	4 (20)	1 (7.1)	7 (12.5)
Others	1 (4.5)	4 (20)	2 (14.3)	7
Total	22	20	14	56

Table 8. The desired qualifications of the Kae Muang.

Note: Figures in parentheses indicate percentage and total number include only those responded.

### **Conflict in water management**

Usually conflict arises in water management due to different factors. In this area also, about 53.4 percent people responded that there are conflicts in water management (Table 9). The conflict situation is seen more in tail water distribution area (77.8%) of the Mae Sao community irrigation system followed by Thai Yai irrigation system (44.4%). In case of these irrigation systems, conflict in water management is prominent due to the different uses of irrigation water and sharing the same sources for irrigation management.

Conflict in water	Mae Sao (Head)	Mae Sao (Tail)	Thai Yai	Total
management	(n = 22)	(n = 18)	(n = 18)	(n = 58)
No	13 (59.1)	4 (22.2)	10 (55.6)	27 (46.6)
Yes	9 (40.9)	14 (77.8)	8 (44.4)	31(53.4)
Total	22 (100)	18 (100)	18 (100)	58 (100)

 Table 9. Conflict in water management at present.

Note: Figures in parentheses indicate percentage and total number include only those responded.

There are several kinds of water management conflict present in this area such as having not enough water, water availability to the head distribution area only, over use of the water, dispose of chemical in the water, delivery of water in the field and operating the water regulating gate (Table 10). Among these conflicts, the most prominent one was having not enough water (57.6%) followed by water availability only in the head distribution area (15.2%) and delivery of water (12.1%). The water management conflict was due to several causes and the most severe one was water scarcity (37.2%) followed by water delivery

mechanism (11.7%) and others. The other causes were stealing of water, abundance of supply, problem of drainage, irrigation schedule and ineffective law.

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Kinds of conflict	Mae Sao (Head)	Mae Sao (Tail)	Thai Yai	Total
Kinds of conflict	(n = 8)	(n = 17)	(n = 8)	(n = 33)
Not enough water	2 (25)	13 (76.5)	4 (50)	19 (57.6)
For the people of the head	2 (25)	2(11.75)	1 (12 5)	5 (15 2)
only	2 (23)	2 (11.73)	1 (12.3)	5 (15.2)
Over use of water	1 (12.5)	0 (0)	1 (12.5)	2 (6.05)
Dispose chemical in	2 (25)	0 (0)	0 (0)	2(6.05)
water	2 (23)	0(0)	0(0)	2 (0.03)
Delivery of water	1 (12.5)	2 (11.75)	1 (12.5)	4 (12.1)
Open and close gate	0 (0)	0 (0)	1 (12.5)	1 (3)
Total	8 (100)	17 (100)	8 (100)	33 (100)

## Table 10. Kinds of conflict at present.

Note: Figures in parentheses indicate percentage and total number include only those responded.

Such type of water management conflicts were among different kinds of persons ranging from water users within the same village to the local officers of the relevant agencies (Table 11). Generally, water users from the same village (41.3%) were involved in the conflict followed by conflict between users of the different village (19.6%) and conflict with Kae Muang (15.2%). Kae Muang are playing important role in settling and managing the conflict. In case of such conflict situation water users mainly prefer to consult with the Kae Muang (83.5%). Similarly, few people also consult with the Irrigation officer and Local Government Officers. Among these persons Kae Muang was the most effective person to solve the conflicts. The majority of the people (90.1%) responded for Kae Muang placing less importance to others in solving the conflict (Annex Table 3 and 4).

Persons involved	Mae Sao (Head) $(n = 17)$	Mae Sao (Tail) $(n = 18)$	Thai Yai (n = 11)	Total $(n = 46)$
Water users in the same village	3 (17.7)	8 (44.4)	8 (72.7)	19 (41.3)
Water users in the different village	5 (29.4)	3 (16.7)	1 (9.1)	9 (19.6)
Kae Muang and users	4 (23.5)	3 (16.7)	0 (0)	7 (15.2)
Local Govt Officers	0 (0)	0 (0)	1 (9.1)	1 (2.2)
Others	1 (5.9)	0 (0)	1 (9.1)	2 (4.3)
More than one of the above	4 (23.5)	4 (22.2)	0 (0)	8 (17.4)
Total	17 (100)	18 (100)	11 (100)	46 (100)

#### Table 11. Persons involved in the conflict.

Note: Figures in parentheses indicate percentage and total number include only those responded.

Similarly, regarding on what to rely in reaching the best resolution on conflicts, the majority of respondents stated that consulting with a conciliator (36.2%) or disputants themselves (26.2%) or through kinship and family system (19.7%) or falling back on leadership (13.1%) were the proven and promising approaches. This also shows the importance Kae Muang on resolving the conflict (Table 12).

Delience upon	Mae Sao (Head)	Mae Sao (Tail)	Thai Yai	Total
Kenance upon	(n = 22)	(n = 21)	(n = 180	(n = 61)
Culture	1 (4.5)	0 (0)	0 (0)	1 (1.6)
Tradition	1 (4.5)	0 (0)	0 (0)	1 (1.6)
Leadership	4 (18.2)	3 (14.3)	1 (5.6)	8 (13.1)
Conciliator	8 (36.4)	9 (42.9)	5 (27.8)	22 (36.2)
Kinship & family system	2 (9.1)	4 (19)	6 (33.3)	12 (19.7)
Law and regulations	0 (0)	1 (4.8)	0 (0)	1 (1.6)
Disputants themselves	6 (27.3)	4 (19)	6 (33.3)	16 (26.2)
Total	22 (100)	21 (100)	18 (100)	61 (100)

Table 12. Conflict can be resolved through reliance upon.

Note: Figures in parentheses indicate percentage.

As we see that people mostly consult the Kae Muang when conflict occurs and they rely on their own rules for solving the conflict, people believe that there is no requirement of agency intervention on solving the conflict. The majority of the respondents (85.8%) in Mae Sao community irrigation system stated that disputants themselves agree to compromise if there is no agency intervention to settle the conflicts. However people urge that it is necessary to make certain changes for future improvements in conflict resolution. Among different possible changes, people give emphasis on changing the present law and order (22.8%) for better management of the conflict in the future (Table 13).

Changes	Mae Sao (Head)	Mae Sao (Tail)	Thai Yai	Total
Changes	(n = 10)	(n = 8)	(n = 4)	(n = 22)
Changes in law and order	3 (30)	2 (25)	0 (0)	5 (22.8)
Administrative change at	1 (10)	1 (12 5)	0 (0)	2(01)
higher level	1 (10)	1 (12.3)	0(0)	2 (9.1)
Administrative change at	0 (0)	1 (12 5)	2(50)	2(12.6)
lower level	0(0)	1 (12.3)	2 (30)	3 (13.0)
Personal qualities of	2 (20)	1 (12 5)	0 (0)	3 (13.6)
officers at higher level	2 (20)	1 (12.3)	0(0)	3 (13.0)
Others	4 (40)	3 (37.5)	2 (50)	9 (40.9)
Total	10 (100)	8 (100)	4 (100)	22 (100)

Table 13. Changes to be made for future improvements in conflict resolution.

Note: Figures in parentheses indicate percentage and total number include only those responded.

The occurrence of conflict also varies by the seasons because there is variation on water requirement during different seasons (Annex Table 5). The most priority season for irrigation water in this area is dry season (74.5%) followed by rainy season (21.6%), and cool season (3.9%). As already mentioned, the top priority season for irrigation water requirement is dry season, therefore most of the water management related conflicts occur in dry season (70.6%) followed by rainy season and cool season (Table 14).

Cassona	Mae Sao (Head)	Mae Sao (Tail)	Thai Yai	Total
Seasons	(n = 17)	(n = 19)	(n = 15)	(n = 51)
Dry Season	11 (64.7)	14 (73.6)	11 (73.3)	36 (70.6)
Rainy Season	2 (11.80	1(5.3)	2 (13.3)	5 (9.8)
Cool season	0 (0)	0 (0)	1 (6.7)	1 (2)
More than one season	4 (23.5)	4 (21.1)	1 (6.7)	9 (17.6)
Total	17 (100)	19 (100)	15 (100)	51 (100)

 Table 14. Conflict occurrence in different season.

Note: Figures in parentheses indicate percentage and total number include only those responded.

However, the conflicts do not get widened and people manage the conflicts by different means. The majority of the respondents (82%) stated that conflicts get confined rather than widening. In case of conflict people generally used to compromise each other through group meeting. Similarly they discuss with leader and sometimes the leaders decide themselves after examining the cases of conflict. From the findings it appears that the Kae Muang is the first and often only person with whom the villagers consult in cases of conflict

## **Rules and regulations**

There are very old customs in Northern Thailand concerning water management which the people still respect. The water users of the Mae Sao community irrigation system do not use the irrigation laws which were issued by the government but, as a matter of fact, conform to their water management customs. Although these underwent certain alterations, they remained basically unchanged, they consist of agreements between water users, which are called Sanya Muang Fai. They contribute decisively to effective water management by defining regulations to ensure a just repartition of water and work, and also establish a social contract between people in the community.

The people were not much aware of them as rules because only slightly more than half of the people (55.9%) know about the existence of rules and regulations relating to water management at farm level. And less than half of the people were able to mention the few examples of the rules existing in the farm level (Table 15). But, it is not true that there are not rules and regulations existing in water management at farm level. The matter is that in practice these rules are known and respected in their totality. It is because people consider these rules as customs and has become a part of the institutions of the community.

Existing rules	Mae Sao (Head)	Mae Sao (Tail)	Thai Yai	Total
Existing fules	(n = 11)	(n = 14)	(n = 6)	(n = 31)
Pay fine	1 (9.1)	9 (64.4)	3 (50)	13 (41.9)
Inform before using water	1 (9.1)	1 (7.1)	1 (16.7)	3 (9.7)
Open and close outlet	4 (36.35)	1 (7.1)	0 (0)	5 (16.1)
Participation in canal cleaning	4 (36.35)	0 (0)	2 (33.3)	6 (19.4)
Equal distribution of water	1 (9.1)	2 (14.3)	0 (0)	3 (9.7)
Regular meeting	0 (0)	1 (7.1)	0 (0)	1 (3.2)
Total	11 (100)	14 (100)	6 (100)	31 (100)

Table 15. Existing rules and regulations relating to water management at farm level.

Note: Figures in parentheses indicate percentage and total number include only those responded.

People still respect local customs rather than modern laws in water management. Most of the respondents (95.2%) stated that the Sanya Muang Fai and local customs are still in use after the completion of the new weir. The rules and local customs are not only in use they are very much effective (92.3%) in managing the irrigation system. While some people say that these rules and customs are less effective than as before (Annex Table 6 and 7). The people who consider these rules and customs still effective gave the reasons that these rules are obeyed by everybody and the water users feel more responsible due to these rules. Similarly, those who thought these rules and customs are less effective than before because the customary law was abolished, it was too old and it is no longer important. There are no much variations in the practice and effectiveness of these rules and customs in different locations of the system. Another important feature of the local rules and regulations are that they are crafted and stipulated by people themselves during the course of time (Box 5).

## Box 5. Specification of rules and regulations by people

Generally people have shown self-governing capacities while managing the common pool resources. In this case also, during the course of time they have specified different rules and regulations for the management of irrigation systems.

The users of these irrigation systems reported that they used to stipulate different assignments and rules for water management during the course of time. However, some people said they don't stipulate any rules. The major rules stipulated by the people were related to the quantity of water use and their quality aspects as well. Those rules were: should not use water over than need and do not throw garbage in canal.

After stipulating different rules and regulations they used to conform it to the Sanya Muang Fai and they become as a part their institution and customs. While doing so majority of the people accept it willingly.

## **Resources for operation and maintenance**

The users of these irrigation systems used to make their payment either through cash or labor contribution or by other means. It was found that majority of the users (80.4%) made their payment by cash which can be used for operation and maintenance of the irrigation system (Table 16). The labor contribution is very low. The scenario was different in case of Thai Yai system people contributing slightly higher labor in operation and maintenance of the system. However, it is seen that after the intervention there has been some changes in labor availability pattern in upstream areas due to the migration (Box 6).

<b>1</b>	J			
Payment	Mae Sao (Head) $(n = 22)$	Mae Sao (Tail) $(n = 21)$	Thai Yai (n = 13)	Total $(n = 56)$
In cash	19 (86.4)	21 (100)	5 (38.5)	45 (80.4)
In labor	1 (4.5)	0 (0)	5 (38.5)	6 (10.7)
Others	2 (9.1)	0 (0)	3 (23)	5 (8.9)
Total	22 (100)	21 (100)	13 (100)	56 (100)

|--|

Note: Figures in parentheses indicate percentage.

## Box 6 Migration and labor availability

The inhabitants of the upstream Thai Yai system area are mainly indigenous people. Their livelihood was mainly dependent on upland paddy farming. Similarly, they were also dependent on the forest products.

But later, the farmers from outside area started to come on these areas for contract farming. They started establishing fruit orchard and vegetable farming. Orange and Tea dominate the orchard farming and products area transported to Chiang Mai and then exported. Another change occurred in this area is the restriction on the forest activities in the protected areas. Similarly, in the downstream area also there was increasing demand for labor in orchards and vegetable farms.

These changes on farming practices, restriction on forest activities, and high demand for labor on downstream orchard and vegetable farms pushed the upland farmers for seasonal/permanent migration to the downstream areas. This has ultimately affected on the labor availability in the upstream areas.

### Farming system and water management

The intervention on the existing traditional irrigation systems has also affected on the different aspects of agricultural production. It has mainly affected on the types and number of crops

grown, their productivity and the cropping pattern (Table 17). The most significant changes seen in the agricultural aspect is increase in the number of crops (19.7%). People started to establish orchard mainly in the head water distribution area of the Mae Sao system. Similarly, in Thai Yai system area also the pace of establishing the orchard and contract farming is increasing. Due to the increase in the orchard area which are high water demanding, there are effects on rice production, one by reducing area and another competing with the irrigation water. Likewise, in tail water distribution area of Mae Sao people have shifted their cropping pattern from paddy to commercial vegetable farming. These transformations in farming system in the area have also created conflict (Box 7).

- m production and			
Mae Sao (Head)	Mae Sao (Tail)	Thai Yai	Total
(n = 22)	(n = 21)	(18)	(n = 61)
4 (18.2)	3 (14.3)	4 (22.2)	11 (18)
6 (27.3)	3 (14.3)	3 (16.7)	12 (19.7)
1 (4.5)	0 (0)	0 (0)	1 (1.6)
0 (0)	3 (14.3)	0 (0)	3 (4.9)
1 (4.5)	2 (9.5)	1 (5.6)	4 (6.6)
0 (0)	2 (9.5)	2 (11.1)	4 (6.6)
10 (45.5)	8 (38.1)	8 (44.4)	26 (42.6)
22 (100)	21 (100)	18 (100)	61 (100)
	Mae Sao (Head) $(n = 22)$ 4 (18.2)6 (27.3)1 (4.5)0 (0)1 (4.5)0 (0)10 (45.5)22 (100)	Mae Sao (Head) (n = 22)Mae Sao (Tail) (n = 21)4 (18.2)3 (14.3)6 (27.3)3 (14.3)1 (4.5)0 (0)0 (0)3 (14.3)1 (4.5)2 (9.5)0 (0)2 (9.5)0 (0)2 (9.5)10 (45.5)8 (38.1)22 (100)21 (100)	Mae Sao (Head) (n = 22)Mae Sao (Tail) (n = 21)Thai Yai (18) $4$ (18.2) $3$ (14.3) $4$ (22.2) $6$ (27.3) $3$ (14.3) $3$ (16.7) $1$ (4.5) $0$ (0) $0$ (0) $0$ (0) $3$ (14.3) $0$ (0) $1$ (4.5) $2$ (9.5) $1$ (5.6) $0$ (0) $2$ (9.5) $2$ (11.1) $10$ (45.5) $8$ (38.1) $8$ (44.4) $22$ (100) $21$ (100) $18$ (100)

Table 17. Changes in agricultural production after construction.

Note: Figures in parentheses indicate percentage.

Contract farming is on the rise for orchard and vegetable cultivation as well. The agroprocessing units and retailers provide the inputs and technical advice to farmers. Farmers are paid in advance both in kind and cash with a pre-agreed price for the product. This puts the farmers at a disadvantageous position for obtaining optimal prices. Similarly, vegetables need a lot of input and cash investments. The middlemen take advantage of this situation and advance money and inputs, including technical advice. Private entrepreneurs are not yet regulated by the government and, thus, farmers sometimes are at a disadvantage. Farmers are not only losing their share but due to heavy use of insecticides and pesticides, the quality of water is deteriorating every year.

## Box 7. Transformation in farming system and conflict

The greater formal security of land tenure in the downstream Mae Sao system has enabled a transformation of the farming system from upland paddy cultivation to the establishment of fruit tree orchards and, in the lowland area, a shift from paddy to cultivation of vegetables. Due to this shift, water demand has been very high. Farmers have started pumping water both from the main canal and sub-surface below. This has reduced the supply of drinking water for the upstream community.

The situation was further aggravated when contract farmers from outside the province started contracting the transfer of land use rights of farmers in the Thai Yai community and

establishing orchards in the upland area. These farmers diverted water from several springs to their orchards and the drinking water supply started drying up for the community and the water flow in the Mae Sao River started to decline. This has not only created conflict between these two communities but also tension among the indigenous people and outside contract farmers.

# **Conclusions and implications**

This paper examined the dynamics of the two irrigation systems in Kok river basin of Fang district in the context of changing governance mechanisms and evolution of technological and market forces. The downstream Mae Sao community irrigation system received assistance from the government for construction of a permanent weir and partial canal lining. However, the upstream Thai Yai community irrigation system, did not receive any assistance due to its location within the so-called protected area. While the traditional system of labor contribution for maintenance continues in the upstream irrigation system it has been replaced in the downstream system by staff hired by government to maintain the system. In the Mae Sao scheme, whereas collective action was mobilized for system maintenance in the past, after rehabilitation and assignment of government staff to the system, collective action has virtually disappeared at main and branch canal levels.

But, the changes were not seen only in the downstream system, it also affected the upstream Thai Yai area in the long run. After construction of the new weir they suffered more competition on the water source resulting into more scarcity. Similarly, more involvement of people from other areas, mainly plain areas of Chiang Mai, also affected on the collective action of the people resulting into the decline in collective action.

In both Mae Sao and Thai Yai system Kae Muangs are playing important role in managing the irrigation system. Not only in the case of traditional Thai Yai system they are also considered equally effective in case of government intervened Mae Sao irrigation system. The importance of the Kae Muang and their role has not decreased due to the changing context, rather, they have gained importance in the centrally planned modern irrigation system.

Similarly, there are several kinds of water management conflicts due to the different uses of irrigation water and sharing the same sources for irrigation management. But in case of conflicts people consult with the Kae Muang and they rely on their own rules for solving the conflict. The conflicts do not get widened and people manage the conflicts by different means. People believe that there is no requirement of agency intervention on solving the conflict. However people urge that it is necessary to make certain changes in law and order for future improvements in conflict resolution. People of the area still respect the local rules and regulations, and traditional customs for water management. Rather than using the irrigation laws issued by the government they modify those laws and conform to their water management customs. They rely on their local rules and customs and are making necessary stipulations overtime.

Similarly other socioeconomic and policy related changes has also influenced on the irrigation management in this area. The changes on farming practices, restriction on forest activities, and

high demand for labor on downstream orchard and vegetable farms pushed the upland farmers for seasonal/permanent migration to the downstream areas. This has ultimately affected on the labor availability in the upstream areas. There has been a transformation in the farming system from upland paddy cultivation to the establishment of fruit tree orchards and cultivation of vegetables. Farmers started pumping water from canal and ground water due to the increased water demand which has ultimately reduced the supply of drinking water for the upstream community. Similarly, the establishment of orchards in the upland Thai Yai area by outsiders has also caused the drying up of water sources for drinking as well as reducing the water flow to the Mae Sao River. This has created conflict between upstream and downstream communities as well as tension among the indigenous people and outside contract farmers.

Thus we can clearly see that the processes involved in first starting collective action are different than those of maintaining them overtime. During the initial stage of starting an irrigation system various attributes of the users including the benefits they could obtain from starting an organization to the skill of public leaders (both community traditional leaders and agency intervention entrepreneurs) in bringing them together affecting trust have been reflected. During the medium stage of irrigation systems development we documented the process of development of rules, and the level of autonomy to modify the farmers' own rules over time. In the long term stage we focused our analysis of external factors affecting the sustenance of these irrigation systems with special reference to the impact of changes in economic prices and labor mobility on the one hand and changes in the authority over irrigation and the availability of funding for irrigation on the other. Thus, the paper has been partially successful on applying the framework developed by Ostrom, Anderies and Janssen (2003) in the linkages and relationship between the five elements, namely: resource, resource users, public infrastructure, public infrastructure providers and external disturbances. This implies that it is possible to evaluate dynamism and robustness of irrigation systems overtime at operational and collective choice levels of analysis.

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## Annex Table 1: Summary of variables examined in the paper

### Variables examined:

Dynamics of irrigation institutions reflecting robustness over time

### Three period of time:

Beginning during the construction period Initial operational phase Long-term phase

### Level of analysis:

Operational level Collective choice level Constitutional choice level

#### **External variables:**

Changes in economic prices Labor mobility Changes in the authority over irrigation Availability of funding for irrigation

### **Important interacting variables:**

The nature of Resource Resource users Public infrastructure Public infrastructure providers External disturbance

#### Linkages between:

Resources and resource users Users and public infrastructure providers Public infrastructure providers and public infrastructure Public infrastructure and resource Public infrastructure and resource dynamics Resource users and public infrastructure External forces on resource External forces on resource users

Linkage between	Montane irrigation	Emerging problem
entities	issues	
Resources and Resource	Water availability and	Too little water available due to
Users	timelines	competing demand
Users and Public	a. Resource contribution	a. Water stealing, Free riding
infrastructure providers	b. Monitoring providers'	b. Free riding
	performance	
Users and Public	a. Regular maintenance	a. Reduced
infrastructure providers	b. Monitoring and	b. Higher cost but reduced
and public infrastructure	enforcing	allocation
Public infrastructure and	a. Engineering works and	a. Ineffective due to lack of
resource	water availability	maintenance
	b. Institutional rules and	b. Rule breaking due to
	water availability	competing water demand
Public infrastructure and	Impact on water harvest	Ineffective due to over-exploitation
resource dynamics	dynamics	by pumping
Resource users and	Co-production of water	No incentive/free riding
public infrastructure	infrastructure,	
	maintenance and	
	monitoring	
External forces on	Occurrence of land	Increasing frequency and mostly
resource	slides, soil erosion and	uncertain strength/severity
	flash floods	
External forces on	Major changes in	Conflict among early settlers,
resource users	economic prices, new	Lowlanders and migrants, Out
	roads, and infrastructure	migration of marginal farmers,
		High labor demand but labor
		scarcity.

Annex Table 2:	Entities involved	and linkages i	n irrigated socia	l ecological systems.
Annes Table 2.	Linuics involved	and minages i	n n ngawa socia	i ceological systems.

Source: Adapted from Ostrom, Anderies and Janssen (2003).

Prefered persons	Mae Sao (Head)	Mae Sao (Tail)	Thai Yai	Total
rieleieu persolis	(n = 22)	(n = 21)	(n = 18)	(n = 100)
Kae Muang	20 (91)	15 (71.4)	16 (88.9)	51 (83.5)
Irrigation Officer	1 (4.5)	3 (14.3)	0 (0)	4 (6.6)
Local Govt Officer	0 (0)	2 (9.5)	0 (0)	2 (3.3)
Others	1 (4.5)	1 (4.8)	2 (11.1)	4 (6.6)
Total	22 (100)	21 (100)	18 (100)	61 (100)

## Annex Table 3. Prefered persons to consult for the conflict management

Note: Figures in parentheses indicate percentage.

#### Annex Table 4. Most effective person for solving the conflict

Dargong	Mae Sao (Head)	Mae Sao (Tail)	Thai Yai	Total
r er sons	(n = 22)	(n = 21)	(n = 18)	(n = 61)
Kae Muang	21 (95.5)	18 (85.7)	16 (88.9)	55 (90.1)
Influential men in the village	0 (0)	0 (0)	2 (11.1)	2 (3.3)
Others	1 (4.5)	3 (14.3)	0 (0)	4 (6.6)
Total	22 (100)	21 (100)	18 (100)	61 (100)

Note: Figures in parentheses indicate percentage.

## Annex Table 5. Priority to the season for irrigation water

Seasons	Mae Sao (Head)	Mae Sao (Tail)	Thai Yai	Total
	(n = 17)	(n = 21)	(n = 13)	(n = 51)
Dry Season	12 (70.6)	17 (81)	9 (69.2)	38 (74.5)
Rainy Season	5 (29.4)	3 (14.3)	3 (23.1)	11 (21.6)
Cool season	0 (0)	1 (4.7)	1 (7.7)	2 (3.9)
Total	17 (100)	21 (100)	13 (100)	51 (100)

Note: Figures in parentheses indicate percentage and total number include only those responded.

# Annex Table 6. Use of Sanya Muang Fai and local customs after the completion of the new weir

Response	Mae Sao (Head) $(n = 21)$	Mae Sao (Tail) $(n = 21)$	Total $(n = 42)$
No	1 (4.8)	1 (4.8)	2 (4.8)
Yes	20 (95.2)	20 (95.2)	40 (95.2)
Total	21 (100)	21 (100)	42 (100)

Note: Figures in parentheses indicate percentage and total number include only those responded.

#### Annex Table 7. Effectiveness of rules and customs at present

Response	Mae Sao (Head) (n = 20)	Mae Sao (Tail) (n = 19)	Total $(n = 39)$
Yes, but less than before	1 (5)	2 (10.5)	3 (7.7)
Yes, very much	19 (95)	17 (89.5)	36 (92.3)
Total	20 (100)	19 (100)	39 (100)

Note: Figures in parentheses indicate percentage and total number include only those responded.