Community organizations in water resource governance: Rural-urban interface of irrigation management in Thailand

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ABSTRACT

Diversification and input-led transformation in agriculture due to economic development and market pressure have created new dimensions in water resource management in Thailand. This paper analyzes how community organizations are mediating with local people in managing competing water use among various sectors, agricultural and non-agricultural sectors, across rural-urban areas in changing context. Empirical evidences from the sampled irrigation systems have shown that cultivation of high water demanding commercial cash crops have been growing overtime. The notable one is rapid increase in peri-urban vegetable productions resulting into increased competition for agricultural water use. The situation is further compounded by increased water demand from residential, tourism, and industrial sectors. Increased competition for water among various competitive users has caused various forms of conflicts. The extents of conflict in water use are higher in peri-urban areas compared to rural areas, having more competition with non-agricultural users. Moreover, presence of strong community organizations, water users' association (WUAs), in rural areas seemed to be more instrumental in successful management of conflicts and devising various coping strategies to deal with water scarcity situation. In peri-urban areas also, systems having relatively more autonomous WUAs appeared to have better capacity to negotiate for limiting resource in changed context. Our observation implies that lack of community organizations or relatively weaker WUAs were less successful in managing the situation.

Key words: Agricultural diversification, rural-urban, conflict, irrigation governance, community organizations, Thailand

1. Rural-urban dynamics in water resource management

Water resource demands arising from consumption and production activities in urban centers can have major impacts on surrounding rural regions (McGranahan et al., 2004). Conversely, agriculture-driven land use changes and water appropriation in upstream areas can have significant impacts on downstream and urban centers affecting water availability and flood issues (Cohen & Pearson, 1998; Delang, 2002). Water allocation and management goal conflicts between rural and urban interests are widespread (Steinberg & Clark, 1999; Solis, 2005). However, in case of conflicting interests in resource use, it has been documented that users come-up with different sort of collective action arrangements (Ostrom, 1990; 1992; Shivakoti & Bastakoti, 2006).

It is envisioned that by 2025 half of Asia's projected population will live in urban centers. Increasing urbanization and industrialization are likely to put severe pressure on water availability (ADB, 2000; 2001), and generate fierce competition among various water users (de Fraiture & Wichelns, 2007; and Rijsberman, 2006). To meet future demand the food production needs to be accompanied by increases in overall efficiency of irrigation water use. The 'Vision 2020' has focused on means and ways of overcoming water scarcity constraints (Meinzen-Dick & Rosegrant, 2001). It emphasized that future policy dialogue should focus on balancing urban-rural needs and capacity building at community level.

Rapid urbanization and industrialization process in Thailand has resulted into transformations in agricultural practices creating new dimensions for water resource management. Even though agriculture still contributes significantly in national economy (Koninck & Dery, 1997; Thaiprasert, 2004), water supply has constraints on limited expansion of irrigation and shifted the focus on improving efficiency of existing water use. Recent 'National Water Policy and Vision' formulated by Royal Irrigation Department (RID) emphasizes increasing irrigation water use efficiency in existing irrigation projects instead of new water resources development and extension of irrigable areas (Budhaka et al., 2002). The challenge of allocating water resources among competing uses is another critical issue. This paper explores water resource governance in a dynamic rural-urban interface. We examine how local institutions mediate water use conflicts among agricultural and non-agricultural users.

2. Analytical approach

The growth of urban centers due to rapid urbanization and industrialization has shrunk agricultural land. But, economic growth has also created opportunities for commercial farming which is more water demanding. In this context, the institutional analysis and development framework (IAD) provides basis for analyzing the role of governance in addressing conflict situation resulted due to water scarcity (Ostrom, 1990; Ostrom et al 1994; Ostrom, 1999). IAD framework has frequently been used to analyze common pool resource management problems (Blomquist, 1992; Tang, 1992; Lam 1998; Agrawal, 1999). In our modified framework, we added external influencing factors which have direct affect on action area (farming environment), patterns of interactions (water use competition) and resulting outcomes (conflict and coping strategies). Our analysis focused on the rural-urban interface. Figure 1 depicts proposed conceptual framework showing relationship between conflict in water management and role of governance structure.

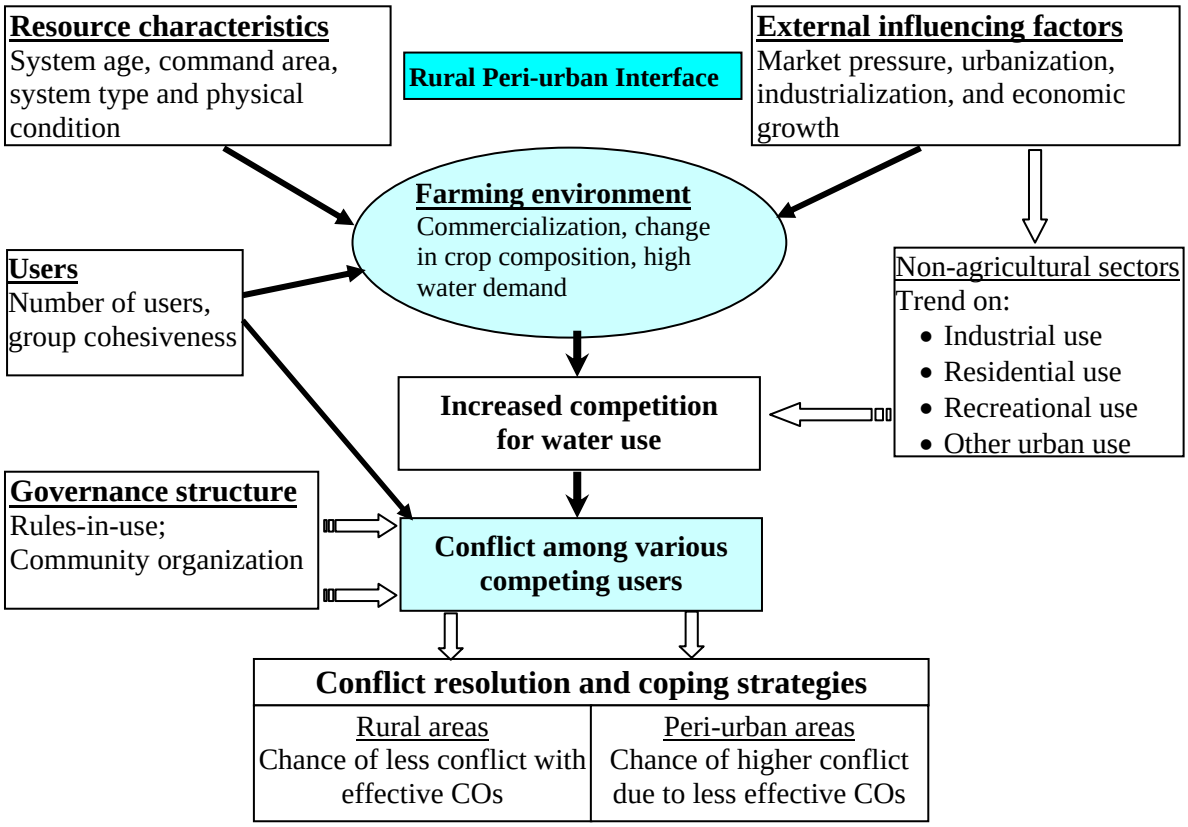


Figure 1 Conceptual framework showing relationship between conflict in water use and governance

We hypothesized that water use competition is governed by accessibility of system area. In some cases rural communities have shown strong cohesion and united against interfering elements of changing uses of natural resources (Solis, 2005). Specifically, we propose that in rural areas there is less conflict due to effective community organizations than in peri-urban areas because of their lack of effectiveness. Based on this conceptual framework, we look on differences between rural irrigation systems (mostly of hilly areas) and peri-urban systems of plain areas.

3. Overview of sampled irrigation systems

Information was collected from 50 irrigation systems in Thailand covering all regions of the country and seven major river basins (Table 1). The sampled systems represent different ecological domains, management regimes, and economic characteristics. The management domains include: farmer managed irrigation systems (FMIS), agency managed irrigation systems (AMIS), and jointly managed irrigation systems (JMIS). Similarly, economic characteristics represent accessibility of system area to market centers, thus peri-urban systems are those which cover at least some areas from municipalities, district towns, or adjoining villages to large cities.

Table 1 Distribution of sampled irrigation systems by management domain (mode of governance) and economic characteristics (rural and peri-urban) in Thailand

Mode of governance	Accessibility	
	Rural area (%)	Peri-Urban area (%)
FMIS	64.5	52.6
AMIS	3.2	10.5
JMIS	32.3	36.8

Irrigation systems in Thailand vary from old traditional systems to newly constructed systems with direct involvement and/or assistance from RID. Irrigation systems in northern region are older as compared to other regions. The size varied from very small systems in rural areas to large systems in plain areas providing water mainly to peri-urban production areas. The number of users also varied from few farmers in rural small systems to large number of farmers in large peri-urban systems.

In terms of provisioning water, irrigation systems included run-off-river, storage, and pumping (including ground water) type. Rural areas included more run-off-river type systems as compared to storage and pumping type which are relatively higher in peri-urban areas. It has implications on managing water use and dealing with conflict. In the context of growing competition in water use, storage and pumping systems provide opportunity for manipulating water supply and irrigation scheduling.

The storage-type systems in rural areas are small-sized reservoirs in foot-hills and tanks. There is possibility of controlling water supply from reservoir only based on existing water level, thus have limited capacity to manipulate water supply. In contrary, many storage-type irrigation systems supplying water to peri-urban production areas are large reservoir systems constructed on perennial rivers and some of them get water supply from big dams upstream in river systems. They have modern water supply and control structures including 'Tele-metering' facilities, thus systems providing water to peri-urban production areas possess capacity to manipulate water supply depending on demand from farmers and other uses.

In general, sampled systems have permanent headwork with at least partial canal lining. The system types and their overall physical condition have ultimate effect on the water availability at different parts of the system. We observed some differences in water availability; with limited availability in many systems in rural areas compared to relatively adequate situation in systems of peri-urban areas.

3.1 Resource and users characteristics: Implications on water use conflict

The rural resource characteristics with differences across rural-urban irrigation systems and their implication on water use conflict are presented in Table 2. Irrigation systems existing since long duration depict diverse nature of governance dynamics overtime. The relatively older systems, mainly in rural areas, have capacity to provide alternative management options based on adaptive learning, with less chance for conflict, and if conflicts arise these are resolved in an effective manner.

The institutional responses on changing contexts are influenced to large extent by size of systems and user characteristics. In irrigation systems with relatively larger command area, it is not easy to monitor water allocation. Large sized irrigation systems with large number of appropriators show less group cohesiveness. Larger command area and more appropriators mean various competing interests and more chance of being conflict. It is also difficult to bring users together for collective action and negotiation process. However, overall physical condition of irrigation systems was more or less similar in both rural and peri-urban areas without any implications in water use competition.

Table 2 Resource and users' characteristics and implications on water use conflict

Characteristics	Related issues	Differences across rural-urban systems	Implication on water use conflict
Appropriators	Group cohesiveness, collective action	Low level of cohesiveness in peri-urban systems due to large number of users	More chance of conflict in large peri-urban systems
System age	Management experience, adaptive learning	Rural old systems provide alternative management options	Less chance of conflict in old rural systems
Command area	Monitoring process, collective action	Large sized peri-urban system means difficult monitoring	More chance of conflict in large peri-urban systems
Type of system	Water availability, allocation	Peri-urban systems with storage facility manipulate water supply effectively	Less chance of conflict in peri-urban systems
Overall physical condition	Water availability, repair & maintenance	No difference in overall physical condition	Less chance of conflict in both areas

This discussion on supply side factors and emerging issues in water management provides insight on likely chances of being conflict situation due to differences in resource characteristics. But it does not ensure that the situation comes as we expected, we need to look on demand side of water use to have a clear picture of existing situation of water use competition.

4. Agricultural diversification and water use conflict

The changes in farming practices have ultimate impact on water use and conflict management which can be attributed to demand side of water use. In recent decades, Thai agriculture has experienced significant transformations in cropping pattern due to the influence of economic growth and rapid urbanization process. The predominantly cereal based farming practices in the past has gone through several changes with changing market pressures. It has influenced the cropping intensities, crop composition and thus creating conflicting situation due to various competing use of water.

4.1 Cropping intensity and crop production

In Thailand, farmers grow crops mainly in three seasons; cool season (November to February), hot season (March to May), and rainy season (June to October) allowing to grow many crops around the year. But actual cultivation depends on extent of water availability, and existing cultivation practices of the farmers. Thus cropping intensity varies across rural-urban systems, and head-tail end within the system (Table 3).

Table 3 Cropping intensity at head and tail end of the irrigation system across rural and peri-urban areas of Thailand

Cropping Intensity	Accessibility	Minimum	Maximum	Mean	Std. Deviation
At head end					
	Rural area (%)	80	265	169.4	53.6
	Peri-urban area (%)	80	250	179.5	49.6
At tail end					
	Rural area (%)	50	240	163.9	51.3
	Peri-urban area (%)	100	250	183.7	44.2

The major crop grown is rice which is staple food and one of the major commercial crops in Thailand since long period. Besides rice, major cash crops grown include vegetables (mainly Asparagus, Beans, Cabbage, Cauliflower, Chilli, Cucumber, Egg-plant, Garlic, Gourds, Leafy vegetables, Melons, Onion, Potato, Pumpkin, and Tomato), fruits (Mainly Guava, Jackfruit, Litchi, Longan, Mango, Orange, and Pineapple), corn (Sweet corn, baby corn and normal corn), sugarcane, rubber and other cash crops such as soybean, peanut, and cassava (Table 4). Due to presence of large sized irrigation systems in peri-urban areas, area under cash crops was higher than rural areas.

Table 4 Cultivation of different crops in the command areas of irrigation systems across rural and peri-urban areas of Thailand*

Crops	Rural area (%)	Peri-Urban area (%)
Rice	93.5	100.00
Vegetables	74.2	78.9
Fruits	61.3	52.6
Corn	51.6	21.1
Sugarcane	16.1	21.1
Rubber	9.7	15.8
Others	51.6	68.4

Note: *Percentage in this table represents those systems which include some areas under the concerned cash crops for commercial purpose. As irrigation systems can have various possible combinations of crops, total % in each column does not become 100, rather each row represent information for different crops as fraction of total systems in each column categories, that is, rural and peri-urban areas.

4.2 Emergence of peri-urban commercial farming

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). Mostly the

changes have inclined towards high water demanding crops from other cereals to fruit orchards and commercial vegetable farming (Table 5). The trend of cultivation for majority of the cash crops is increasing. Vegetables, baby corn, sweet corn and rubber production area are increasing in both rural and peri-urban areas.

Among cash crops, the trend for vegetables and corn was higher in peri-urban areas as compared to rural areas. In Thailand, growth in peri-urban vegetable production has been higher as compared to rural areas. This is mainly due to increasing urban demand for vegetables (Chunnasit et al., 2000). The peri-urban vegetable production has a number of advantages as compared to rural areas (Midmore and Jansen, 2003). Being near to market centers, peri-urban production of commercial crops requires less marketing costs thus resulting into relatively higher producer's share.

Table 5 Changing composition of different cash crops in the command areas of irrigation systems across rural and peri-urban areas of Thailand**

Crops	Rural area (%)			Peri-Urban area (%)		
	Constant	Increasing	Decreasing	Constant	Increasing	Decreasing
Vegetables	4.3	87.0	8.7	-	93.3	6.7
Fruits	15.8	84.2	-	20.0	70.0	10.0
Corn	18.8	68.8	12.5	-	100.0	-
Sugarcane	-	100.0	-	25.0	50.0	25.0
Rubber	-	100.0	-	-	100.0	-
Others	31.3	31.3	37.5	21.4	57.4	21.4

Note: **The percentage in this table represents only for those systems which showed the production of these crops during this period as presented in Table 5 earlier. In this case, the changing trend for each crops in each category, rural and peri-urban, totals to 100%.

4.3 Change in water use and conflict situation

The demand for water in non-agricultural sector increases with urbanization and that will intensify competition for water resource (de Fraiture and Wichelns, 2007). Conflicts in water use among agricultural and other non-agricultural uses are prominent phenomenon during recent period (Ruet et al, 2007). Midmore and Jansen (2003) also noted that demand for water by peri-urban vegetable production along with existing competition from residential and industrial users in limited supply environment, where marginal value product of water is high, has substantially amplified potential conflict.

The overwhelming majority of irrigation systems in both rural and peri-urban areas reported some forms of conflict in their system. The situation was more pronounced in peri-urban areas as it was reported that all systems have some form of conflict situation. The most common forms of conflict in study area are presented in Table 6. The conflict among farmers of head-end areas and tail-end areas is more common. Another prominent form of conflict was observed with urban uses including residential and industrial sectors. More than half of sampled systems in peri-urban areas reported conflict among residential or industrial uses. The nature of conflict in peri-urban area, involvement of various users, makes it relatively difficult to manage than rural areas where the main conflict was only among agricultural users.

Table 6 Nature of water use conflict across rural and peri-urban areas of Thailand

Nature of conflict	Rural areas (%)	Peri-Urban areas (%)
Among farmers	77.4	89.5
Among systems	-	5.3
Urban, residential, and industrial uses	9.7	52.6
Others	3.2	5.3

These conflicting situations were due to changing land use pattern in Thailand. The increase in commercial vegetable farming and other high water demanding crops have ultimately changed water use equation. The direct impact is that there is more competition for water use among farmers. The competition for water becomes severe in dry season as compared to other seasons (Shivakoti and Bastakoti, 2006).

There is increasing demand for water in non-agricultural sectors also. Residential pattern is changing in peri-urban areas with higher water demand. Similarly, growing tourism sector and other recreational activities also have higher demand for water. In addition, the process of industrialization has increased demand for water significantly.

5. Governance structure and institutional response to water scarcity

It is important to understand how farmers are coping with adverse situation and how governance structure has mediated such instances. Earlier study has reported that local people with the help of local leader have managed conflict effectively (Shivakoti and Bastakoti, 2006). But at the same point, it was also noted that users do not feel the need of any intervention from related irrigation agency.

5.1 Mode of governance and changes in rules in water management

Majority of irrigation systems in both rural and peri-urban areas are under farmers' management, with relatively higher in rural areas. In rural areas most FMIS were initiated and are being managed by user themselves for long period. Among FMIS in peri-urban areas, majority of them were earlier AMIS and management authority was given to users when Thailand adopted participatory irrigation management (PIM) policy. Generally, older FMIS were found to be more effective than newly transferred systems in terms of group cohesiveness. Users in such FMIS have strong sense of ownership feeling which has resulted in their increased participation in systems management including water allocation, operation and maintenance, and conflict management. Other systems were JMIS and AMIS with limited success in management.

Almost all sampled systems have either formal or informal rules related to water allocation, cleaning and repair of canal, and monitoring and sanctioning. The devised rules were effectively followed in rural areas as compared peri-urban areas. Rules have become part of institutions in their community. Another characteristic of rural irrigation systems is that they are more autonomous compared to peri-urban systems in terms of developing their own rules and bringing on necessary changes in management.

Even in rural system where there are no predetermined rules, local leaders sit together when they need to decide any conflict or operation and maintenance issue which became

ad-hoc rule. Farmers followed ad-hoc arrangements as rule. But in case of peri-urban system which are under agency management and no any predetermined rules; users are not active and the system is ultimately becoming dysfunctional due to lack of community organizations, including other reasons.

5.2 Institutional response: Community organizations and their role

In general, water users' association (WUAs) is responsible community organization for management of irrigation systems. The various features of WUAs and their role in water management across rural and peri-urban systems in Thailand are presented in Table 7.

In rural FMIS, WUAs were formed long ago, in the beginning as informal arrangement and later users made same arrangement more formal with organized structure. Due to relatively small-sized irrigation systems, WUA members are well aware with their system infrastructure, and well known among users. These systems have strong group cohesion and people have trust on their community organization. These WUAs were found more effective in terms of devising water allocation mechanism during water scarce period. Those functionaries in WUAs are people serving for a long period and also these leaders are themselves experienced farmers. The adaptive learning for long period has increased their efficiency in conflict management.

Table 7 WUA and role in water management across rural and peri-urban systems

Characteristics	Rural areas	Peri-urban areas
Presence of WUA	Almost all	Almost all
Formation process	Users themselves, since long during start of system	External assistance, mostly during management transfer
Number of WUA and area coverage	Mostly one WUA; relatively small area	Generally more than one WUA; relatively large area
Leadership and external interference	Old people with long farming experience; Low	Young active people, but with less experience; High
Group cohesiveness and collective action	High; more	Low; less
Rule formation and breaking	Mostly need based informal rules; followed by majority of the users	Mostly formal rules; many rule breaking due to ineffective enforcement mechanism
Effectiveness in conflict management; adoption of coping strategies	More Effective; alternative coping mechanisms	Less effective; inadequate coping strategy

In peri-urban FMIS, WUA are relatively new mostly formed after PIM, which has provision of vital role for community organizations in management. Generally there are many sub-groups within WUA, each being responsible for looking branch canal or tertiary canal, and are federated at system level. Selection of WUAs in many peri-urban systems are influenced by irrigation officials, as they are responsible for management at headwork and main canal level. Though systems with autonomous WUAs were effective in managing conflict, effectiveness of WUA in was limited by lack of experience, relatively larger area and size of users including competition with other sectors.

Among sampled AMIS, some of them are doing well with inclusion of local users in management at tertiary level. Many systems have joint management arrangement where WUA manage water distribution at tertiary level. In these systems, there is higher level of agency involvement in water allocation and drafting rules. In JMIS, water regulation gates are operated by irrigation staffs. WUA members are allowed to manage at tertiary level, with limited scope for manipulating water allocation considering water scarcity situation.

The institutional structures are important in shaping social adaptive capacity, and with sufficient social adaptive capacity conflicts originated due to water scarcity is solved effectively (Appelgren and Klohn, 1999). We observed that adaptive learning of FMIS for long period resulted into better management situation. But if there is more external interference, community based initiatives may not function effectively (Cleaver and Toner, 2006); as noted in some peri-urban systems where management was not effective with more agency interference.

6. Case studies: Inter-sectoral water allocation and management

In this section we discuss findings from two most dynamic basins in Thailand; Ping and East coast basin; in terms of changes in farming practices, competing uses of water among various sectors and governance mechanism adopted by users.

6.1 Community organizations and governance mechanism for water use in Chiang Mai valley

Chiang Mai valley in Ping river basin of Northern Thailand provides significant case for interaction among various competing users of water, brought by influence of rapid urbanization and economic growth. It is home to large number of traditional irrigation systems in surrounding hills and foot-hill areas. There are some agency-built medium and large irrigation systems providing water mostly to peri-urban areas. We have based our discussion on selected irrigation systems from tributaries of Ping River.

The valley has gone through transformations in farming practices in the tune of changed world market (Cohen and Pearson, 1998). We observed changes from cereals (rice) to high water demanding crops like vegetables, fruits and corn (sweet corn and baby corn), and flowers also. In surrounding mountainous areas, where swidden agriculture was common in past, people are shifting towards intensified production of cash-crops, mostly vegetables and orchards.

Similarly, there is increasing demand for water in non-agricultural sectors. Chiang Mai's commercial and urban areas have grown strongly covering large areas of agricultural land with new housing estates. The growth of tourism and increased demand for recreational services has also increased competition for water resources. Due to these transformations competing uses for water are coming up fast. The most common forms of conflict were between upland and lowland users, and agricultural and urban uses.

In such scenario, users in this valley have come up with various alternative ways to deal with competing uses. Re-working of water allocation based on the demand from farmers, revising production areas during dry season based on water supply, and area sharing for production of commercial cash crops during water scarcity, are various strategies adopted by farmers. The instrumental force behind offsetting the difficult situation was involvement

of community organizations in management and negotiation. In this area, management of water resources through community organizations is century old phenomenon. Most irrigation systems have WUA actively involved in management. They can influence effectively and bring people together for collective arrangements, so that conflict situation does not go beyond control.

6.2 Competing water use and viability of irrigation systems in Rayong basin

Rayong basin in the Eastern coast is another dynamic basin which provides insight on competing uses of water by agricultural and industrial sectors. In case study we included two medium scale irrigation systems in Rayong River and another from tributary of Rayong River. Among these systems; one from Rayong River covers rural production areas where rice, rubber and orchard are common crops; another system covers rural and peri-urban production areas where rice, vegetable and orchard are common crops; third system in tributary of Rayong covers peri-urban areas where some farmers grow rice and few use water for shrimp farming.

The selected irrigation systems showed that area under rubber and orchard is increasing fast. Similarly, vegetable production is also on the rise. Water competition among different crops is common, and notable one was competition with upland fruit orchards. They pump water from canal affecting supply on other parts of command area. In one system, shrimp farming was in boom few years ago. But due to extreme market competition, it reduced drastically and now only few farmers are doing shrimp farming.

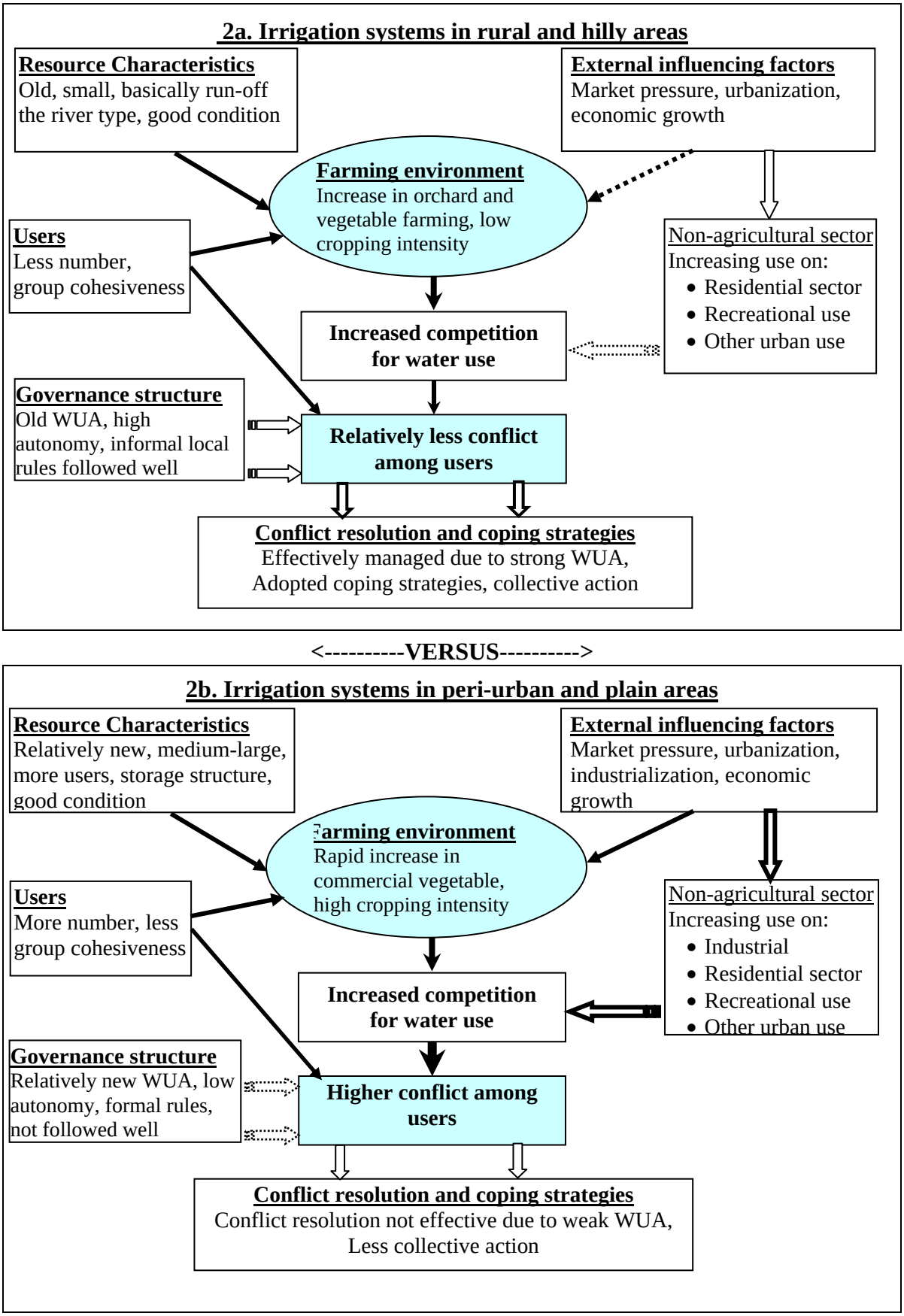
The competition among different agricultural use was not that much severe and WUAs was playing very important role in managing the situation. Due to active role of WUA they are negotiating the conflict successfully. But, the system where people used to practice shrimp farming there was not any WUA and after market shock people stopped shrimp farming, and it is operating only partially (for agricultural use).

Many industrial estates are growing rapidly in eastern coast area which was originally fishing and agricultural community. At present it is a large industrial estate and has huge requirement of water for its industrial operation, which comes in direct competition with agricultural users. The interconnected reservoirs in Rayong basin mostly supply water to those industrial estates, leaving farmers compelled to use water in their orchards and fields by pumping from local streams. In terms of negotiating with those urban and industrial uses, WUAs are not able to play any effective role.

7. Conflict resolution and coping mechanism

In case of competing water uses and conflicts, users in many cases have successfully managed it, and but in some cases have failed to do so. The ability to cope with scarcity was largely influenced by how well community organizations can coordinate in such scenario. Earlier, in conceptual framework, we hypothesized that resource and user characteristics differ in rural and peri-urban systems providing various implications for water use and conflict. Resource characteristics provided supply side situation, which in combination with demand side of water use brought up different scenario. Figure 2 presents comparative scenario on resulting conflict and its management along with coping strategies in irrigation systems of rural hilly areas and peri-urban plain areas.

Figure 2 Comparative scenario on resulting conflict due to competing water uses and its management in two types of systems



Despite relatively better situation in terms of their capacity to manipulate water supply, we observed that water use related conflict was higher in peri-urban systems due to rapid increase in high water demanding crops and demand from non-agricultural sectors. Relatively weaker WUAs and lack of collective action among users due to large command area and number of users, conflict resolution was not effective as compared to rural areas. Due to this factor, it was found that irrigation systems in rural areas are more capable of adopting various coping strategies compared to peri-urban systems.

Water scarcity situation demands use of irrigation modernization and optimization measures which ultimately increase water productivity requiring less water in crop production (Playan and Mateos, 2006). Some argue about using non-conventional water sources for irrigation like desalinized sea water, rain water harvesting, wastewater and agricultural drainage water, as a means of tackling water scarcity (Capra and Scicolone, 2007; Qadir et al., 2007).

Besides such measures, in many circumstances farmers follow alternative management strategies to cope with scarcity situation. The coping strategies followed by people to deal with water scarcity situation were dependent on local context and changing situation. The common strategy adopted by users was re-working of water allocation mechanisms depending on situation. Farmers submit application mentioning water required for their crops and area to head of WUA. After collection of application from all interested users, WUA allocate the turn to individual farmers or in groups based on their demand. Mostly it was found effective in rural small sized systems.

In modified form of the previous strategy, people apply for water showing their willingness to grow certain crops in specified areas during dry season. After collection of all interested farmers' application, WUA makes estimate for water allocation. But if in case they feel that water may not be sufficient for the amount they demanded, they suggest farmers for growing in reduced area, or growing in a cluster or group. Further modification of this second strategy, in the form of 'area sharing', was also observed in some systems in Chiang Mai valley. In area sharing arrangements, during dry season, irrigation office used to supply water only to the head end area of the canal. After that, farmers of that area provided certain area of land to farmers from tail end.

But in some cases, users were not able to cope with changed scenario brought by changes in economic pressure created by global market fluctuation. In a system in eastern coast basin, people changed their farming practices from rice to shrimp farming due to booming market, but with market failure, they could not continue shrimp farming. And they could not return to rice farming also as it needed more investment to reclaim back the land for rice production. Farmers were operating at individual basis, so they could not come up with any collective arrangements and gave up farming.

8. Conclusion and policy implications

The shifts from traditional cereal based farming to commercialized intensive cash cropping has brought fierce competition in water use within the agricultural sector. Rapid industrialization and urbanization; growth of housing estates in peri-urban fringes, expansion of modern residential estates and growth of tourism and recreational services have also increased the competition for water resources. In these changed circumstances, it

was found that irrigation systems are struggling with adopting various coping strategies and negotiating with various competing users.

Increased competition for water among various competitive users has caused various forms of conflicts. The extent of conflict in water use was higher in peri-urban areas compared to rural areas, having more competition with non-agricultural users. In such scenario, the presence of strong community organizations (WUAs) in rural areas has resulted into successful management of the conflict and they have adopted various coping strategies. In peri-urban areas also systems which have relatively more autonomous WUAs are becoming successful in negotiation with the changed context. But we also noted that lack of community organizations or relatively weaker WUAs (with more external influence) are not successful in managing the situation.

A national policy is needed to provide a statement to the people the priorities in that society for effective water management taking into consideration all aspects and demands of domestic, agriculture and industrial sectors. There is a need for discussion and consensus development at all levels of the civil society for effective water resource management. The commitment of entire nation to the development of any policy can best be achieved through fullest people's participation representing diverse physical and social attributes. Further in-depth research considering various factors of rural-urban water use dynamics and specific roles of concerned stakeholders including community level organizations can be effective tools for the policy feed back mechanism.

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References

ADB. (2000) *Water in the 21st Century*. Theme Paper No. 8 (Manila: Asian Development Bank).

ADB. (2001) *Water for All: The Water Policy of the Asian Development Bank* (Manila: Asian Development Bank).

Agrawal, A. (1999) *Greener Pastures: Politics, Markets, and Community among a Migrant Pastoral People* (Durham: Duke University Press).

Appelgren, B., & Klohn, W. (1999) Management of water scarcity: A focus on social capacities and options, *Physics and Chemistry of the Earth (B)*, 24(4), pp.361-373.

Blomquist, W. (1992) *Dividing the Waters: Governing Groundwater in Southern California* (Oakland, California: ICS Press).

Budhaka, B., Srikajorn, M., & Boonkird, V. (2002) Thailand country report on investment in water. In '*Investment in Land and Water*', Proceedings of the Regional Consultation Bangkok, Thailand, 3-5 October 2001 (Bangkok: FAO).

Capra, A., & Scicolone, B. (2007) Recycling of poor quality urban wastewater by drip irrigation systems, *Journal of Cleaner Production*, 15(2007), pp. 1529-1534.

Chunnasit, B., Pages, J., & Duangnam, O. (2000) Incidence of Bangkok city development on peri-urban agricultural patterns and cropping systems evolution. Proceedings of the International Conference "*The Chao Phraya Delta: Historical Development, Dynamics and Challenges of Thailand's Rice Bowl*", 12-15 December 2000, (Bangkok: Kasetsart University).

Cleaver, F., & Toner, A. (2006) The evolution of community water governance in Uchira, Tanzania: The implications for equality of access, sustainability and effectiveness, *Natural Resources Forum*, 30 (2006), pp. 207-218.

Cohen, P. T., & Pearson, R. E. (1998) Communal irrigation, state, and capital in the Chiang Mai Valley (Northern Thailand): Twentieth-Century transformations, *Journal of Southeast Asian Studies*, 29(1), pp. 86-110.

de Fraiture C., & Wichelns, D. (2007) Looking ahead to 2050: Scenarios of alternative investment approaches. In D. Molden (Ed.) *Water for food, water for life: A comprehensive assessment of water management in agriculture* (London: Earthscan, and Colombo: International Water Management Institute).

Delang, C. O. (2002) Deforestation in northern Thailand: The result of Hmong farming practices or Thai development strategies? *Society and Natural Resources*, 15, pp. 483-501.

Koninck, R. D., & Dery, S. (1997) Agricultural Expansion as a Tool of Population Redistribution in Southeast Asia, *Journal of Southeast Asian Studies*, 28(1), pp. 1-26.

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

McGranahan, G., Satterthwaite, D., & Tacoli, C. (2004) *Rural–urban Change, Boundary Problems and Environmental Burdens*. Working Paper 10. Working Paper Series on Rural-Urban Interactions and Livelihood Strategies, IIED.

Meinzen-Dick, R. S., & Rosegrant, M. W. (2001). *Overcoming Water Scarcity and Quality Constraints*, Focus 9 Vision 2020. (Washington DC: IFPRI).

Midmore, D. J., & Jansen, G. P. (2003) Supplying vegetables to Asian cities: Is there a case for peri-urban production? *Food Policy*, 28(1), pp. 13-27.

Ostrom, E. (1990) *Governing the Commons: The Evolution of Institutions for Collective Action* (New York: Cambridge University Press).

Ostrom, E. (1992) *Crafting Institutions for Self Governing Irrigation Systems* (San Francisco, CA: ICS Press).

Ostrom, E. (1999) Institutional rational choice: An assessment of the institutional analysis and development framework. In P. A. Sabatier (Ed.) *Theories of the Policy Process* (Boulder, CO: Westview Press).

Ostrom, E., Gardner, R., & Walker, J. (1994) *Rules, Games and Common Pool Resources* (Ann Arbor: University of Michigan Press).

Playan, E., & Mateos, L. (2006) Modernization and optimization of irrigation systems to increase water productivity, *Agricultural Water Management*, 80 (2006), pp. 100-116.

Qadir, M., Sharma, B. R., Bruggeman, A., Choukr-Allah, R., & Karajeh, F. (2007) Non-conventional water resources and opportunities for water augmentation to achieve food security in water scarce countries, *Agricultural Water Management*, 87 (2007), pp. 2-22.

Rijsberman, F. R. (2006) Water scarcity: Fact or fiction? *Agricultural Water Management*, 80 (2006), pp. 5-22.

Ruet, J., Gambiez, M., & Lacour, E. (2007) Private appropriation of resource: Impact of peri-urban farmers selling water to Chennai Metropolitan Water Board, *Cities*, 24 (2), pp. 110–121.

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.

Solis, P. (2005) Water as rural heritage: Reworking modernity through resource conflict in Edwards County, Kansas, *Journal of Rural Studies*, 21 (2005), pp. 55–66.

Steinberg, P. E., & Clark, G. E. (1999) Troubled water? Acquiescence, conflict, and the politics of place in watershed management, *Political Geography*, 18 (1999), pp. 477–508.

Tang, S. Y. (1992) *Institutions and Collective Action: Self-Governance in Irrigation* (San Francisco, CA: ICS Press).

Thaiprasert, N. (2004) Rethinking the Role of the Agricultural Sector in the Thai Economy and Its Income Distribution: A SAM Analysis, *Forum of International Development Studies*, 27 (8), pp. 187-212.