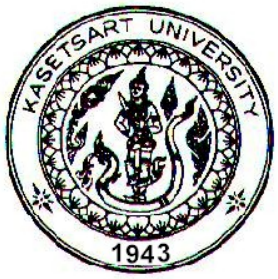

THESIS

MOBILIZING SOCIAL CAPITAL FOR COMMUNITY-BASED WATERSHED AND ENVIRONMENTAL MANAGEMENT

UNRUAN LEKNOI

GRADUATE SCHOOL, KASETSART UNIVERSITY

2008

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THESIS

MOBILIZING SOCIAL CAPITAL FOR COMMUNITY-BASED WATERSHED AND ENVIRONMENTAL MANAGEMENT

UNRUAN LEKNOI

A Thesis Submitted in Partial Fulfillment of
the Requirements for the Degree of
Doctor of Philosophy (Forestry)
Graduate School, Kasetsart University
2008

Unruan Leknoi 2008: Mobilizing Social Capital for Community-Based Watershed and Environmental Management. Doctor of Philosophy (Forestry), Major Field: Forestry, Interdisciplinary Graduate Program. Thesis Advisor: Associate Professor Wicha Niyom, Ph.D. 160 pages.

This thesis aims to investigate the characteristics and the dynamics of social capital for community-based watershed and environmental management; and to synthesize the findings to provide a system prototype of social capital for community-based watershed and environment management. The methodology of research is of ex-post facto research from 2 specific rural communities; those are 1) Romphothong Community, Thatakiab District, Chachoengsao Province; and 2) Khaopraputabatnoi Community, Kaengkhoi District, Saraburi Province through the concept of Social Capital.

The results found that the characteristics of social capital used to manage watershed and environment in the community level are; 1) cognitive social capital; those are trust, solidarity, norm, trust and adherence to norm, reciprocity. This category of social capital has beebrought to use in thinking system of the process of watershed and environment management 2) the structural social capital; those are engagement, participation, civil society, empowerment, community organization, group and network and information and communication, this category of social capital has been brought to use in practical method of the watershed and environment management. The dynamics of social capital found that at the beginning of community-based watershed and environment management, the cognitive social capital is a category of social capital to make the community to turn to realize and to give shared value to the natural resources in the watershed, making the community changing thinking method to natural resources in the watershed area in “destructive” to be “conservative-preservation”. Thereafter, the structural social capital enters to act as mechanism to make the community members to involve in the activities of watershed and environment management. While the structural social capital shall help to create the cooperation structure in the activities of the strong watershed and environment management.

The prototype model of dynamic social capital obtained from synthesis to the studying results found that the cognitive social capital is a origin mechanism to make community-based watershed and environment management; those are trust, solidarity, norm, trust and adherence to norm, which are the mechanism to cause engagement in the activity of watershed and environment management. Then the structural social capital which is norm, the mechanism to cause strong participation in the activity of watershed and environment management. Therefore, to promote to other communities to capable to manage on watershed and environment of the community sustainably.

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Student’s signature Thesis Advisor’s signature

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Unruan Leknoi

September 2008

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INTRODUCTION

Social capital has been considered critical potential for the community to be able to manage itself independently. Since the economic crisis, social capital has started to get on the public agenda and been greatly recognized in Thailand, which can be acknowledged by two factors. The first factor, the establishment of Social Investment Fund or SIF, is aimed at increasing social capital in communities under the purposes of fostering strength and learning process for self-independence. In addition, it is aimed to find solutions and protections for problems of the public including with establishing new society that possesses reciprocity, strength, stability, effectiveness, and quality. Moreover, the importance of social capital has been stated for its ability to aid grass-rooted communities and social residents. Secondly, social capital plays a critical role as a key strategy for the national development. This is determined by the National Economic & Social Development Board, which also pays attention to the development of strategies to promote social capital (The National Economic & Social Development Board, 2003). As having been previously mentioned, this can be regarded as “reproduction” which encourages the importance of social capital as effective equipment for the national development.

In Thailand, nevertheless, social capital is rather complicated for its relations to various aspects of development. The term “social capital” has been differently interpreted and defined by different groups of people. So far, there have not been any conclusions for this problem. However, those who are involved with the matter should, more concretely, provide better clarification as a healthy start to exploit social capital management towards watershed on community level.

From what having been mentioned previously, the researcher has strong intention to investigate the process of social capital management towards watershed and environmental management on community level, which lies under these three main issues as follow. (1) The Importance of Social Capital, (2) The Policy of the Government, (3) The Integrated Operation

1. The importance of social capital is being raised up as a national agenda by the National Economic & Social Development Board. The subcommittee, who has been set up to foster operational practice and responsible for Thailand social capital development, determines operational strategies and devises systematic evaluation. Being aware of the necessity of investigating social capital for better interpretation, the researcher, therefore, decided to study benefits of exploiting social capital management towards watershed and environmental management. Apart from its importance, there are several interesting qualifications that social capital occupies. This can be seen from a variety of existing definitions. Some look at social capital as a cause, and some as an effect. However, looking at social capital in a dimension of process, would help explain this thoroughly as a single unit. Consequently, both cause and effect can be contemporarily examined. The integration also helps reflect pictures and justifies social capital phenomenon in a more precise view.

2. To respond to the government policy, several public organizations have invited general people and community members to take part in managing the environment. This can be referred to Thai constitution B.E. (1997) section 44, 46, 48, 56, 60, 62, 70, 74, 76, 78, 79, 84, 282-284, and 290; Act of legislation for district council and district administration organizations B.E. (1994), and The enhancement and conservation of the national environmental quality B.E. (1992). Moreover, a trend to activate people’s cooperation has been very well accepted these days.

3. The integrated operations in local areas have now been considered effective and able to lead to capability and sustainability. The researcher has a purpose to integrate both principles of science and social sciences and apply to watershed management activities for effective and sustainable development.

New paradigm and trends for sustaining development of natural resources management have resulted in the adoption of local intelligence for handling social capital as well as motivating public participation of people in the communities. It is essential to support people with learning and understanding their capacity to manage their own social capital. With this form of practice, people can truly handle their resources by themselves. As mentioned by Prawet Wasri in the speech about good governance and public participation in environmental management, “eventhough there is a restructuring in the ministry, the problems will not be solved unless strong and self-help communities are being developed.”

OBJECTIVES

1. To investigate the characteristics of social capital for watershed and environmental management of Romphothong Community and Khaophraphutthabatnoi Community.

2. To investigate the management process (dynamic) of social capital for community-based watershed and environmental management of Romphothong Community and Khao Phra Buddha Bat Noi Community.

3. To synthesize the prototype of dynamics of social capital for community-based watershed and environmental management

Definitions of Terms

1. Social Capital

Social capital in this research is characterized by two key works.

Cognitive social capital comprise of 5 items i.e. Trust, Norms, Trust and Adherence to Norm, Reciprocity and Solidarity

Structural social capital comprise of 13 items i.e. Corporation, Collective Action, Social Cohesion and Inclusion, Engagement in Public Affairs, Civil Society, Participation, Empowerment and Political Action, Informal Sociability, Groups and Networks, Local Associations and Networks, Community Organization, Community Volunteerism and Information and Communication

2. Community-based watershed and environmental management means organizing community-based headwater forest management to reach for water supply.

LITERATURE REVIEW

1. Definitions of social capital

From the reviewed comments and opinions of social capital specialists, the researcher has found that the term is loosely defined. This is probably resulted from vague point of view that has been interpreted abstractly.

Social capital is not new for those who have been interested; there have been some studies as follow.

Samutawanicha (1998) suggested that culture can be defined as capital. It is the main principle of the society. Whenever the former culture declines and can recover at a later time, it, anyway, will lead to new social capital, particularly for people development.

Kaewhawong (1999) proposed his opinions relevant to social capital that it should be in accordance with social and cultural contexts that have retained some kinds of value. The first one is the prosperity of Thailand natural resources, which help sustain sufficient economics and well-being livelihood. Following that, the existence of sustainable economics, which turns out to be connecting the whole community together, motivates close relationship among family members and helps the group survive by passing on local wisdom to their next generations. Following that social capital is more concerned with communities' output than individuals'. Finally, there is not only Buddhism but also culture or beliefs that help sustain the awareness in the community.

Wasri (1999) defined social capital as collective people with collective goodness and intelligence. Besides it is the power for the society to solve social problems as well.

Seeluangsawat (2002) has analyzed social capital by reviewing relevant literature and interviews of academic and local intellectuals. Most of them consider social capital a device to build up an idealistic and peaceful society, and they also provide definitions lying on three grounds;

1. Healthy and spiritual consciousness.
2. Social standards such as norms, precepts, and etc.,
3. Social factors, solutions to community problems.

The Social Investment Fund (2002) claimed that the combination of social capital, cooperative learning, and social management can lead to new social capital. With its innovation, social capital can create social networks, value systems, principles, local wisdom, intellectual leaders, horizontal social relations, systems of right of ownership and cooperation, community institutes, cultural diversity, and organizations for social public.

The National Economic & Social Development Board (2003) has identified the three elements of social capital. The first one is human being capital, which refers to intellectual, skillful, knowledgeable, quality people who get together and set up networks for doing social work. The second is institutional capital; both natural and set up ones such as institutes of families, education, religions, politics, private development organizations, community organizations, and so on. The third is wisdom and cultural capital. It covers value systems such as beliefs, moral, principles, culture, and history.

Nakhabut referred social capital to spirit, mind, feelings, mercy, and self esteem. There are two levels of social capital; individual and community social capital for example devotion and cooperation in the community (The Social Investment Fund, 2002).

The following are concepts of social capital provided by international specialists.

The school of Alexis de Tocqueville focused on traditional relationship. In the past time, people were closely related to each other in the community. The people in this context contacted one another face to face. Therefore, they possessed trust, information flow, and strong ties from individual interactions and relationship in the group. Social capital is taken in the view of the community well being and its benefits (Cavaye, 2003).

Bourdieu (1989) studied social capital relevant with the class of people, three categories have been set up: economic capital, cultural capital, and social capital. The definition of social capital also consists of three important points: being the center of its members and networks, possessing symbolic capital attributes, being transformable to economic capital.

Caroll (2001) argued that social capital can be divided into two kinds: cognitive capital and structural capital. Both kinds of the social capital support one another and result to social members' behavior by the expectation mechanism. Cognitive social capital can hardly change because it has been accumulated through cultural norms for a long time, while structural capital changes easily depending upon organizations and their policies.

Coleman (1988) defined social capital is defined by its function. It is not a single entity, but a variety of different entities, having two characteristics in common: they all consist of some aspect of a social structure, and they facilitate certain actions of individuals who are within the structure

Fuguyama (1999) proposed that social capital means instantiated informal norm, which facilitates cooperation at least between two parties. The norm supporting social capital is initiated from reciprocity, which originality comes from religions and globalization.

Putnum (1994) provided meaning of social capital as trust, norms, networks, and collective value that belong to the public. These can influence various group activities such as civic group, bonds of family, informal community networks, kinship, friendship, reciprocity, volunteerism, altruism, and trust.

Woolcock and Narayan (1999) have found four aspects of social capital analysis from their literature review.

1. Community pros focus on local organizations.
2. Network pros concentrate on internal and external connections.
3. Institutional pros concern with political and legislative organizations.
4. Parties aim at social networks and relationship between the politics and the society.

The definitions defined by both international and local academics are that social capital is still abstractly defined and they are ambiguous to be applied for objective. In order to exploit the ideas of social capital, the application and combination of those definitions contributing to Thai social context are endorsed. Thus, this will reflect social capital in the forms of mind and spirit, ideal, beliefs, and value system; and consequently result in power for negotiation. Social capital is not only in the forms of relationship but also reproduction, and does not belong to any private persons, but to the public as a whole.

When considering the definition provided by The National Economic & Social Development Board along with the rest, it is found that the concepts are according with some overlapping. In conclusion, it is obvious that social capital has always been existing and attached in public members and communities. When needed, people ought to get together and bring up their social capital to solve the problems.

2. The attributes of social capital

The Attributes of social capital collected from the analysis of the academics in the pervious section can be generated below.

2.1 The diversity of social capital

The diversity of social capital is considered in the domain of human being Including public leaders, monks, local philosophers, and etc (The National Economic & Social Development Board, 2003) (The Social Investment Fund, 2002) (Wasri, 1999). Also, it can be looked at in the view of cultural aspect for example, tradition, customs, ways of life, beliefs, ideal, and so on (Pongsapicha, unpublished document) (The Social Investment Fund, 2002) (Bourdieu, 1989). Additionally, social capital can be viewed as the structure of community relationship such as kinship, patronage system, administrative system, network system, etc. (The National Economic & Social Development Board, 2003) (The Social Investment Fund, 2002) ((Carroll, 2001) (Coleman, 1988) (Krishna and Shrader, 1999) (Putnum, 1994). Finally, it can be studied in the manner of institutes such as law, regulations, norms, local administration, and so on (Putnum, 1994)

2.2 Specific characteristic of social capital in an individual community

Thai communities are dissimilar in ways of life, tradition, culture, value system, wisdom, philosophy, etc. These effect the intensification of social capital in different groups of people. Some communities care so much about tradition, while some do about beliefs leading to water source management. In contrast, eventhough some communities do not possess any beliefs about that, they do have efficient leaders who can promote cooperation, or connect with other communities to do so.

In comparison, social capital of communities in the rural area is dissimilar to those in the urban areas that are quite individual. Therefore, social capital in this area occupies human being capital with modern knowledge, technology, and numerous information channels; but in the rural area, social capital deals with series of traditional knowledge, value system, and naturally verified wisdom. Upcountry people have higher trust than those in the city; therefore, getting together is more likely for them. Consequently, social capital in each community can be similar or different depending on its uniqueness, and the degree of social capital accumulation.

2.3 The dynamics social capital

From the diversity of social capital can be referred to in the dimension of the structure and the value. Structural social capital involves with the relationship of the members both individually and collectively. As far as value social capital concerns, it is found that local wisdom should be modified accordingly with changes of ways of life closely related to the nature. It can be seen from the previous comments that social capital can be built up, collected, or damaged (Samutawanicha, 1998).

3. The origination of social capital

The theories, which are associated to social capital definitions in the scopes of cultural and local wisdom, reflect the origination of social capital as follow.

3.1 Social capital originated from lifestyles

Lifestyles and production patterns can perfectly reflect to the origination of social capital for the reason that communities do not stand alone by themselves. In fact, they have to confront with a great number of changes resulting from nature, interactions with other communities, or from political policies. Community members, therefore, are necessary to cooperatively search for appropriate actions essential for responding to certain activities. This turns out to be learning, verifying, accumulating, and extending value systems needed for taking actions. Additionally, reproduction has also been included and become existing accumulated social capital for the community (Fuguyama, 1999, Putnum, 1994)

3.2 Social capital originated from religious beliefs and moral system

Buddhism has long been closely attached to Thai society, and become the main principle for living. Moral and beliefs related to the religion have incubated the members to be reciprocal, generous, kind, harmonious, forgiving, respectful to nature,

and etc. All of these qualities have turned out to be the beliefs and norms of the society affecting the patterns of powerful and friendly relationship towards either fellow residents or surrounding environment. (Fuguyama, 1999)

3.3 Social capital originated from cooperative learning and information flow

Cooperative learning and information flow have been essential influence in originating social capital in both rural and urban areas as can be seen in a large numbers of examples of this in the present time. Cooperative learning and experience earning foster effective social capital (Cavaye, 2003)

4. Social capital capability in watershed and environment management and public participation

4.1 Social capital capability in watershed and environment management

When compared to the past, concepts related to social aspects for dealing with watershed and environment have been increasingly mentioned. However, most investigations associated with this were survey studies carried to find out knowledge, attitude, and local wisdom of the community in arranging watershed resources. Furthermore, attitudes toward the organizations, degrees and patterns of participation, and factors influencing participation for watershed and environment management have been investigated as well. In conclusion, the previous studies exclusively aimed at surveying studies that projected only the issues that did not clearly and dynamically mirror actual community phenomenon of social capital towards watershed resources management.

Consequently, three aspects are set up to investigate the process of social capital toward watershed management as follow.

4.1.1 Social capital for appropriate land use plan

4.1.2 Social capital for pollution control (particularly the landslide in water resource area which will lead to massive negative effect)

4.1.3 Social capital for resource management planning (according to conservative modes suitable for each kind of resource for a long term and careful use)

To summarize, principles of social capital are aimed at successfully achieving watershed and environment management. According to these principles, human should not be separated from natural resources, but a harmonious intervening combination. This relies upon social capital that lays out its roots as a mechanism encouraging anticipated results.

4.2 Public participation in watershed management

Originally, the philosophy of watershed management began from an arrangement of a natural reservoir. The concept of accomplishing this lies under the limitation of land for sustainable resource use by applying conservative principles into it. This does not view the existence separately (ecosystem). The principle of work starts from the first drop of the rain, it is also called operational concept.

Apart from this, setting human resources as the main focus of management concerns with the importance of the association between the residents in the community and its resources based in the area of watershed. The objective of this is to help people to live together and to be beneficial from the water resources harmoniously and nonviolently.

Additionally, public participation in effective resource management can as well rely on the complexity of rights.

The rights to access the resource have always been attached to the areas and types of the resource. This reflects the limitation of the understanding about the resource access right within linear concept of rights that connect with a governmental, private, or public organization. They are exclusive rights that obstruct participation from all sources. To successfully access the understanding of these rights, ones need to comprehend complexity concept of rights that various groups are able to live together according to the diversity admired by Thai tradition (Kanjanaphan, 2001). Hence applying complexity concept of rights to manage watershed should facilitate ways to raise up social capital broadly, and it can be effective mechanism for sustainable watershed management.

5. The studies related to social capital

From the literature reviewed with social capital, there have been a set up of a variety of social capital scopes and components. Measurement tools are developed for the studies in different aspects in accordance with the goals and applications. The literature reviews are shown below.

Putnum (1994) proposed that social capital measurement is to identify the intensity of voluntary organizations, particularly small-sized ones that allow close relationship among their members and sequentially, facilitate trust. He refers social capital to norms, networks, trust, and participants that accomplish the goals together effectively. He measures social capital from the degree of public participation of people in the north and the south of Italy, and compares the difference from the votes, number of newspaper readers, well-known residents, football clubs, and the trust towards governmental institutions

Table 1 Correlation with index of social capital

Component of comprehensive	Correlation with index
Measure of Community Organization Life	
Serves on committee of local organization in last year	0.88
Serves on office of some club or organization in last year	0.83
Civic and social organization per 1,000 population	0.78
Mean number of club meting attended in last year	0.78
Mean number of group memberships	0.74
Measure of engagement in public affairs	
Turnout president election, 1988 and 1992	0.84
Attended public meeting on town or school affaire in last year	0.77
Measure of Community volunteerism	
Number of non-profit organization per 1,000	0.82
Mean number of times worked on community project in last year	0.65
Mean number of times did volunteer work in last year	0.66
Measure of informal sociability	
Agree that " I spend a lot of time visiting friend"	0.73
Mean number of times entertained at home in last year	0.67
Measure of trust	
Agree that " Most people can be trusted"	0.92
Agree that " Most people are honest"	0.84

Source: Social Analysis and Report Division, Office for Nation Statistic (2001)

The World Bank explains social capital as institutes, relationship, and norms that limit the relations in both quality and quantity. It is impossible to consider social capital as a whole but as a glue linking those institutes together. The World Bank has exploited the result gained from the study of Grootaert and Van Bastelaer, who found that social capital evaluation should be performed both concretely (structural

institutins) and abstractly (association and norms). The three indicators are as follow (Grootaert and Van Bastelaer, 2002).

1. An indicator for membership in local associations and networks (local administration, parental association, saving or cultural institutions, youth clubs, sport clubs, etc.)

2. An indicator for trust and adherence to norms (trust for loan granting, trust within the community, assistance and conflicts among community members, etc.)

3. An indicator for collective action (cooperation in solving community problems, public participation, donation, volunteerism, voting, etc.)

Table 2 Instruments of social capital analysis

Instrument	Data collection method	Unit of analysis	Type of analysis
Community profile Interview guild	Focus group, Community mapping, Institutional diagram	Community, Institution	Qualitative
Community characteristics and service questionnaire	Key respondent interviews, Focus group	Community	Quantitative
Household questionnaire	Household survey	Household, Individual	Quantitative
Organizational profile Interview guild	Interview with leader, Focus group with members and non-members	Institution	Qualitative
Organizational profile score sheet	Scoring by field team	Institution	Quantitative

Source: Grootaert *et al.* (2003)

In addition, (Grootaert, C., Narayan, D., Nyhan Jones, V., Woolcock, M., 2003) suggested the evaluation for social capital in six different aspects.

1. Groups and Networks Aspect: This sections looks at the attributes of either formal or informal organizations regarding with the intensity, the membership and roles, the degree of participation, the assistance gained and provided, the selection of the leader, the transfer of power, the perception of groups, organizations, or networks from the past time.

2. Trust and Solidarity Aspect: This part exclusively considers trust towards neighbors, strangers, and perception relating to trust from the past time.

3. Collective Action and Cooperation Aspect: This portion concerns with the degree of the public participation to cooperate or manage the crisis, the agreement disobeying, and the expectation regarding with public participation.

4. Information and Communication Aspect: This part focuses about the access to the information of the community members as well as basic facilitation such as communication and telecommunication.

5. Social Cohesion and Inclusion Aspect: This section is aimed at the natural existing differences in the community that may cause conflicts and management mechanism.

6. Empowerment and Political Action Aspect: This part concerns with political participation either local or national that effects the community's ways of life.

The instrument is the questionnaire that is divided for two levels: household and community. The questionnaire is constructed according to those six aspects to find out the feature, the basic structure, the migration of labor, health condition, agriculture, and support of the community. All of these aspects are explained in the combination with the household questionnaire.

Knack and Keefer (1997) used the questionnaire to measure trust and norms.

1. Trust measurement is used to investigate whether the respondents have trust towards people who they contact with. There are only two responses; yes or no. The percentage is computed from ‘yes’ answer.

2. Norm measurement by allocating 10 points for each five types of norm equally, totally 50 points. After discarding irrelevant information, the result from each place is compared. The five types of norm are awareness of rights, shame, attendance to social duties, fault, and honesty.

Callahan (1996) proposed that social capital cannot be measured directly. However, the definition identifies that it is an interpersonal factor that promotes trust and cooperation for the public benefits. The attributes are indirectly evaluated from public trust, for example, children or elder people can go out at night. Public gathering for public businesses can also an indicator. Finally, public properties are also measured as social capital under this aspect like safety traffic rules.

Haper (2002) investigated the Measurement of Social Capital in the United Kingdom explains preliminary problems in measuring social capital. Because social capital is diversity, the measurement is then various regarding with its concept and definition depending by time and response to the needs for different studies. The measurement of social capital, therefore, should be flexible in order to lead to conceptualization.

However, Haper clarified that the studies measuring social capital ought to follow these stages.

1. Definition determination: Problems involving with definition determination of social capital are critical. Haper states that the objective to provide a variety of definitions and concepts is mostly aimed at social networks, supportive structure,

public participation, public gathering in political activities, trust to individuals and norms, and reciprocity.

2. Limitations in social capital measurement: Haper suggests five features used for measuring social capital.

2.1 participation, social engagement, commitment associated with perception to control and influences effecting community work, health, and satisfaction in life

2.2 control and self-efficacy associated with perception to control and influences effecting community work, health, and satisfaction in life

2.3 the degree of perception to social structures and features associated with satisfaction in the residence, service, and local problems

2.4 social interaction, social networks, and social support associated with peers, family, neighbors, and social networks

2.5 trust, reciprocity, and social cohesion associated with other people, institutes, public services, cooperated value perception, and the length of stay

The features above have been led to the construction of questions investigating in four areas: participation, reciprocity, social engagement, and attitude towards the community.

1. Participation is investigated under the amount of culture, free time, social group that the answer provided by the respondent should come from true interests in respect to voluntary participation, the frequency of participation, the attention and support to religious or social activities, the frequency of socialization with friends or neighbors, and etc.

2. Reciprocity is investigated under the issue of trust the respondent possess regarding with the admiration that other people have toward him or her, and vice versa.

3. Social engagement is set to measure trust that the respondent has in relation to different levels of institutions, the perception for controlling situations, the provisional information for the community or public, the frequency of public contacts, the frequency of voting, and so on.

4. Attitudes concerning with the community regard with physical environment such as public facilitation, concrete environment as the desire and fear for residing in the community.

Kim, W. and Schweitzer J. (1996) studied “The Cause of, and Perception toward Social Capital in Neighborhood Community Context”, and suggests to measure social capital in neighborhood level within the same community. The topics for measuring should consist of the following.

1. Norms: investigating the sense of belonging to the same family and the residence, sharing the same values, and the influence toward people’s behavior

2. Connection: investigating the discussion about public problems, affinity, isolation

3. Trust: investigating the assistance in case of emergency, caring, and trusting

Rose, R. (1991) explained that it is difficult for the researcher to measure social networks quantitatively. Additionally, only measuring formal institutions is not enough to evaluate social capital accurately since informal social networks involving with a great deal of people are looked over in dealing with solutions to problems.

Onyx, J. and Bullen, P. (2000) have developed eight indicators to measure social capital. They are social engagement, ambition to public matters, trust and safety, relationship with neighborhood, relationship with the family members and friends, endurance toward turbulence, value, and work affiliation.

From having been reviewing the studies previously, there are several key works used for social capital study.

Table 3 Key works of social capital

Key works	Qualitative	Quantitative
Putnum		
Community organization life	-	- Serves on committee of local organization in last year - Serves on office of some club or organization in last year - Civic and social organization per 1,000 population - Mean number of club meting attended in last year - Mean number of group memberships
Engagement in public affairs	-	- Turnout president election, 1988 and 1992 - Attended public meeting on town or school affaire in last year
Community volunteerism	-	- Number of non-profit organization per 1,000 - Mean number of times worked on community project in last year - Mean number of times did volunteer work in last year
Informal sociability	-	- Agree that " I spend a lot of time visiting friend" - Mean number of times entertained at home in last year

Table 3 (Continued)

Key works	Qualitative	Quantitative
Trust	-	- Agree that " Most people can be trusted" - Agree that " Most people are honest"
<u>Grootaert & Van Bastelaer</u>		
Local associations and networks	-	- Memberships of organizations
Trust and adherence to norm	- Assistance in case of emergency - Conflicts in the community	- Trust in lending money - The comparison of trust with other communities
Collective action	-	- Cooperation for solving problems of the community - Participation to the community associations - Donation - Volunteerism Casting ballots

Table 3 (Continued)

Key works	Qualitative	Quantitative
Grootaert Groups and networks	- Group/Network attributes (both formal and informal) - Roles of members - Assistance (both providing /receiving) - Selection of leaders/ transition of power - Perception toward groups and organizations - Networks(from past to present)	- Density of groups/ organizations - Number of members - Degree of participation
Trust and solidarity	- Trust toward neighbors/ strangers - Solidarity from the past to the present	- Perception toward trust
Collective action / cooperation	- Cooperation/Action regarding crisis in the community - Expectation toward cooperation	- Participation to the community activities - Agreement violation in the community

Table 3 (Continued)

Key works	Qualitative	Quantitative
Information and Communication	- Access to Information	- Access to basic communication services
Social cohesion / Inclusion	- Natural differences/Conflict complexity/Mechanism for dealing with conflict complexity - Social interactions - Obstruction in the community	
Empowerment/Political action	-	- Political participation
<u>Knack & Keefer</u>		
Trust	-	- Trust to contact others
Norm	-	- Awareness of rights, - Shame - Respect to social responsibilities - Guilt - Honesty

Table 3 (Continued)

Key works	Qualitative	Quantitative
Harper		
Participation	-	- The amount of culture - Participation in community associations - Volunteerism / Frequency of participation - Frequency of interaction with relatives or friends - Participation in activity networks and frequency of contacts - Readiness for helping others - Desire / Self- Control
Reciprocity and trust	-	- Trust toward admired /despised people - Affection toward admired /despised people
Civil society	- Trust toward social institutions - Provision concerning with local / national activities - Perception of the ability for situational control	- Frequency of casting ballots - Frequency of institutional contacts

Table 3 (Continued)

Key works	Qualitative	Quantitative
Schweitzer		
Norms	-	- Sense of belonging to the same family - Shared value possession - Influence toward other behavior - Belonging to the residence
Connection	-	- Public problems discussion - Related feeling - Isolation
Trust	-	- Assistance for one another in case of emergency - Caring / Trust

Source: Adjusted from

(1) Putnum (1993)

(2) The National Economic and Social Development Board (2003)

Moreover there are two researches that aimed to find definition of social capital from the Thai researcher according with Thai society. Firstly, a study of social capital from Thai perspective. This research aimed to explore social capital concept, to compare international and Thai social capital, and to examine the social capital building process. The result showed that social capital building processes can be viewed into 2 types: in rural areas and in urban areas. There are internal and external factors. Internal factors are social organizations, shared history, and mutual benefits. External factors are social streams, political system, and government policy. This study found that social capital concept has been rooted in western ideas since the 1980s and were expanded to Thai society in 1997 after the economic crisis to strategy to revive and strengthen community. This study found that the definitions of social capital given by Thai Thinkers were different from those given by international thinker because of different paradigms, experience and culture. Among Thai thinker, the definitions were similar but different in detail according to personal interests. (Seeluangsawat, 2002) Secondly, the discourse on social capital: conceptualization and practice in Thai development context (1997-2003). The objectives of the research are 1) to describe and explain the discourse of "social capital" in Thai society from a sociological of knowledge perspective 2) to assess critically the concept as a new Thai development concept 3) to analyze some case-study in Thai development context. The results show that, firstly, the diversity of social capital concept in Thailand stemmed from different conceptual bases. The concept is about the social relations that highlight social cohesion and adaptively, both on group and institution level. The concept is in Thai development discourse broadened to mean the "capital of society". The last includes other concepts - cultural capital, natural capital, local wisdom capital - to be elements of social capital. Consequently, it is believed that developing social capital will bring about sustainable development. Secondly, from inter-disciplinary perspective, the concept of "social capital" is integrating both economic and sociological perspectives. This integration is a direct response to the mainstream development discourse that overly emphasis on economic growth. And thirdly, from the case-studies of Community Fund, One Tambon One Product (OTOP), and conflict management on resource problems show the ideological conflicts between government, academics, local intellectual, and NGOs. The government agencies tend

to give the meaning of social capital with reference to economic growth while the others tend to give stronger support for sustainable development. The contestations of social capital discourse are related to interests and power; the differences between "values" and "pricing" thus becomes evident (Srisuphun, 2004)

From having been reviewing the studies about social capital, its definitions provided have covered the main features as norms, trust, groups and networks, participation, collective action and cooperation.

According to key works of social capital, there are definitions of key works used for social capital study.

1. Norm

Cambridge University (2003) defined that norm meant an accepted standard or a way of behaving or doing things that most people agree with: Europe's varied cultural, political and ethical norms accepted social norms, the norm a situation or type of behavior that is expected and considered to be typical: One child per family is fast becoming the norm in some countries.

Oxford University (2005) defined that norm meant a situation or a pattern of behave that is usual or expect, standard of behavior that are typical of or accepted within a particular group or society, social/cultural norm is a require or agree standard, etc.

So, norm is a pattern of behavior expected within a particular society in a given situation.

2. Trust

Oxford University (2005) defined that trust that meant to believe that somebody is good, honest, sincere, etc.

Jack (1978) claimed that rust is a relationship between people. It involves the suspension of disbelief that one person will have towards another person or idea. It especially involves having one person thinking that the other person or idea is benevolent, competent/good, or honest / true. Trust can be said to be the basis of all social institutions. It is also integral to the idea of social influence, as it is easier to influence or persuade someone who is trusting. In social psychology the notion of trust is being increasingly adopted to predict acceptance of behaviors by others, institutions (e.g. government agencies) and objects such as machines.

3. Group and network

A social unit consisting of a number of individual interacting with each other with respect to:

3.1 Common motives and goals:

3.2 An accepted division of labor, i.e. roles

3.3 Established status (social rank, dominance) relationships;

3.4 Accepted norms and values with reference to matter relevant to the group;

3.5 Development of accepted sanctions (praise and punishment) if and when norms were respected or violated.

Social network is a social structure made of nodes which are generally individuals or organizations. It indicates the ways in which they are connected through various social familiarities ranging from casual acquaintance to close familial bonds. The term was first coined in 1954 by J. A. Barnes (in: Class and Committees in a Norwegian Island Parish, "Human Relations"). The maximum size of social

networks tends to be around 150 people and the average size around 124 (Hill and Dunbar, 2002).

4. Participation

Arnstein (1969) discusses types of participation and "nonparticipation" in A Ladder of Citizen Participation She grades levels of participation from Manipulation (least citizen participation) to Citizen Control (most citizen participation). The three categories used are:

4.1 Degrees of citizen power in 3 levels i.e. Citizen Control, Delegated Power and Partnership

4.2 Degrees of tokenism in 3 parts i.e. Placation, Consultation and Informing

4.3 Nonparticipation in 2 parts i.e. Therapy and Manipulation

Arnstein continues to define citizen participation as “the redistribution of power that enables the have not citizens, presently excluded from the political and economic processes, to be deliberately included in the future”

5. Collective action and cooperation

Sandler (1992) explained that collective action as an explanation of social movements, an inquiry into collective action involves examining those factors that cause the setting of standards of social integration, as well as those factors which lead to standards of deviance and conflict. An explanation of a collective action in sociology will involve the explanation of those things which are similar or dissimilar to collective actions at different times and in different places. Theories of collective action emphasize how group behavior can, in some sense, be linked to social institutions.

Robert (1984) explained that cooperation refers to the practice of people or greater entities working in common with commonly agreed-upon goals and possibly methods, instead of working separately in competition. Cooperation is the antithesis of competition, however, the need or desire to compete with others is a very common impetus that motivates individuals to organize into a group and cooperate with each other in order to form a stronger competitive force. Cooperation in many areas such as, farming and housing may be in the form of a co-operative or, alternately, in the form of a conventional business. Many people support cooperation as the ideal form of management of human affairs. In terms of individuals obtaining goods and services, rather than resorting to theft or confiscation, they may cooperate by trading with each other or by altruistic sharing.

6. Relationship

Oxford University (2005) defined that relationship refer to the way in which two people, groups or counties behave toward each other or deal with each other

So that, interpersonal relationships are social associations, connections, or affiliations between two or more people. They vary in differing levels of intimacy and sharing, implying the discovery or establishment of common ground, and may be centered around something(s) shared in common.

7. Reciprocity

Fehr, E. and Simon, G. (200) refers to in-kind positive or negative responses of individuals towards the actions of others. Thus positively interpreted actions elicit positive responses and vice versa. Positive reciprocal actions differ from altruistic actions as they only follow from other positive actions and they differ from social gift giving in that they are not actions taken with the hope or expectation of future positive responses. Reciprocal actions are important to social psychology as they can help explain the maintenance of social norms. If a sufficient proportion of

the population interprets the breaking a social norm by another as a hostile action and if these people are willing to take (potentially costly) action to punish the rule-breaker then this can maintain the norm in the absence of formal sanctions. The punishing action may range from negative words to complete social ostracism.

In public good experiments, behavioral economists have demonstrated that the potential for reciprocal actions by players increases the rate of contribution to the public good, providing evidence for the importance of reciprocity in social situations.

6. Systems Thinking

Systems thinking has its foundation in the field of system dynamics, founded in 1956 by MIT professor Jay Forrester. Professor Forrester recognized the need for a better way of testing new ideas about social systems, in the same way we can test ideas in engineering. Systems thinking allows people to make their understanding of social systems explicit and improve them in the same way that people can use engineering principles to make explicit and improve their understanding of mechanical systems.

6.1 The Systems Thinking Approach

The approach of systems thinking is fundamentally different from that of traditional forms of analysis. Traditional analysis focuses on the separating the individual pieces of what is being studied; in fact, the word “analysis” actually comes from the root meaning “to break into constituent parts.” Systems thinking, in contrast, focuses on how the thing being studied interacts with the other constituents of the system—a set of elements that interact to produce behavior—of which it is a part. This means that instead of isolating smaller and smaller parts of the system being studied, systems thinking works by expanding its view to take into account larger and larger numbers of interactions as an issue is being studied. This results in sometimes strikingly different conclusions than those generated by traditional forms of analysis,

especially when what is being studied is dynamically complex or has a great deal of feedback from other sources, internal or external.

The character of systems thinking makes it extremely effective on the most difficult types of problems to solve: those involving complex issues, those that depend a great deal dependence on the past or on the actions of others, and those stemming from ineffective coordination among those involved. Examples of areas in which systems thinking has proven its value include:

6.1.1 Complex problems that involve helping many actors see the “big picture” and not just their part of it.

6.1.2 Recurring problems or those that have been made worse by past attempts to fix them.

6.1.3 Issues where an action affects (or is affected by) the environment surrounding the issue, either the natural environment or the competitive environment.

6.1.4 Problems whose solutions are not obvious.

6.2 Use of Systems Thinking

So many important problems that plague us today are complex, involve multiple actors, and are at least partly the result of past actions that were taken to alleviate them. Dealing with such problems is notoriously difficult and the results of conventional solutions are often poor enough to create discouragement about the prospects of ever effectively addressing them. One of the key benefits of systems thinking is its ability to deal effectively with just these types of problems and to raise our thinking to the level at which we create the results we want as individuals and organizations even in those difficult situations marked by complexity, great numbers of interactions, and the absence or ineffectiveness of immediately apparent solutions. (Aronson, 1996)

MATERIALS AND METHODS

Materials

1. Watershed classification maps of Klongtakrao watershed and Pasak watershed

2. Topographic maps scale 1: 50,000 of Romphothong community and Khaophraphutthabatnoi community.

3. Land used maps: maps were prepared officially by Department of Land Development (DLD).

4. Office supplies: pencils, erasers, color pens, flipchart papers, sound recorder, microcomputer.

5. Focus group discussion guides

6. In-depth interview guides

7. Questionnaires

Methods

This study is Ex-post Facto Research in combination with qualitative research and quantitative research. The expected result is to provide explanations of social capital dynamism through the whole process starting from: 1) thinking system, 2) practice, 3) outputs and including with external factors of the process.

1. Research scope

1.1 Content scope

The framework of this process is sectioned into two parts.

1.1.1 Part 1: The process consists of three parts.

a) Thinking system, Thinking process will be investigate the process of social capital that is highly abstract such as traditional beliefs, values, customs, tradition, culture, or wisdom. In addition, there is a part of thinking derived from modern learning, which includes new ways of beliefs, values, faith, or tradition.

b) Practice, This is to study practical process of social capital in relation with thinking system for the reason that the way they think would result in outcomes of that thinking.

c) Outputs, This part deals with the process of social capital resulted from the thinking system and its practice.

1.1.2 Part 2: External factors of the process

External factors of the process refer to the study of concrete actions (the capital, instrument, personnel, internal and external academic bodies); and abstract actions (academic assistance, news, information from external sources). Results caused by political, economic, and technological matters also effect the way people think and practice. (Romrattanapun, 2005)

1.2 Area scope

The researcher has identified the area for the study under these following criteria.

1.2.1 The area should be transition zone or buffer zone. People residing in this community usually adjoining to the forest area live their lives on agriculture and tend to damage the area of watershed and its environment. Paying attention to this zone is believed to create better understanding and encourage participation for the protection of forestry invasion. Particularly the people are urged to maintain the environment that exposes to high risks of being damaged.

1.2.2 The area should house the community that still relies on natural resources essential to their living. This area still occupies the characteristics of rural areas considered to possess much higher social capital than urban areas.

1.2.3 The area has been experienced best practices in managing their own watershed and environment. Since the features of this kind of community accords with the conditions of Ex Post Facto Research for dynamism study of social capital management towards watershed and environmental management, it should, therefore, be appropriate to reflect the experiences regarding with this process in the study accordingly.

Consequently, the researcher has selected the following communities for this investigation.

1.2.4 Romphothong community, Klongtakrao sub-district, Thatakiab district, Chachoengsao province. This community won the 7th Green Globe Award from the Green World Foundation in 2005.

1.2.5 Khaophraphutthabatnoi community, Songklong sub-district, Kaengkhoi district, Saraburi province. This community won the 5th Green Globe Award from the Green World Foundation in 2003.

2. Research framework

The framework respectively of research and methodology are shown in figure 1 and 2

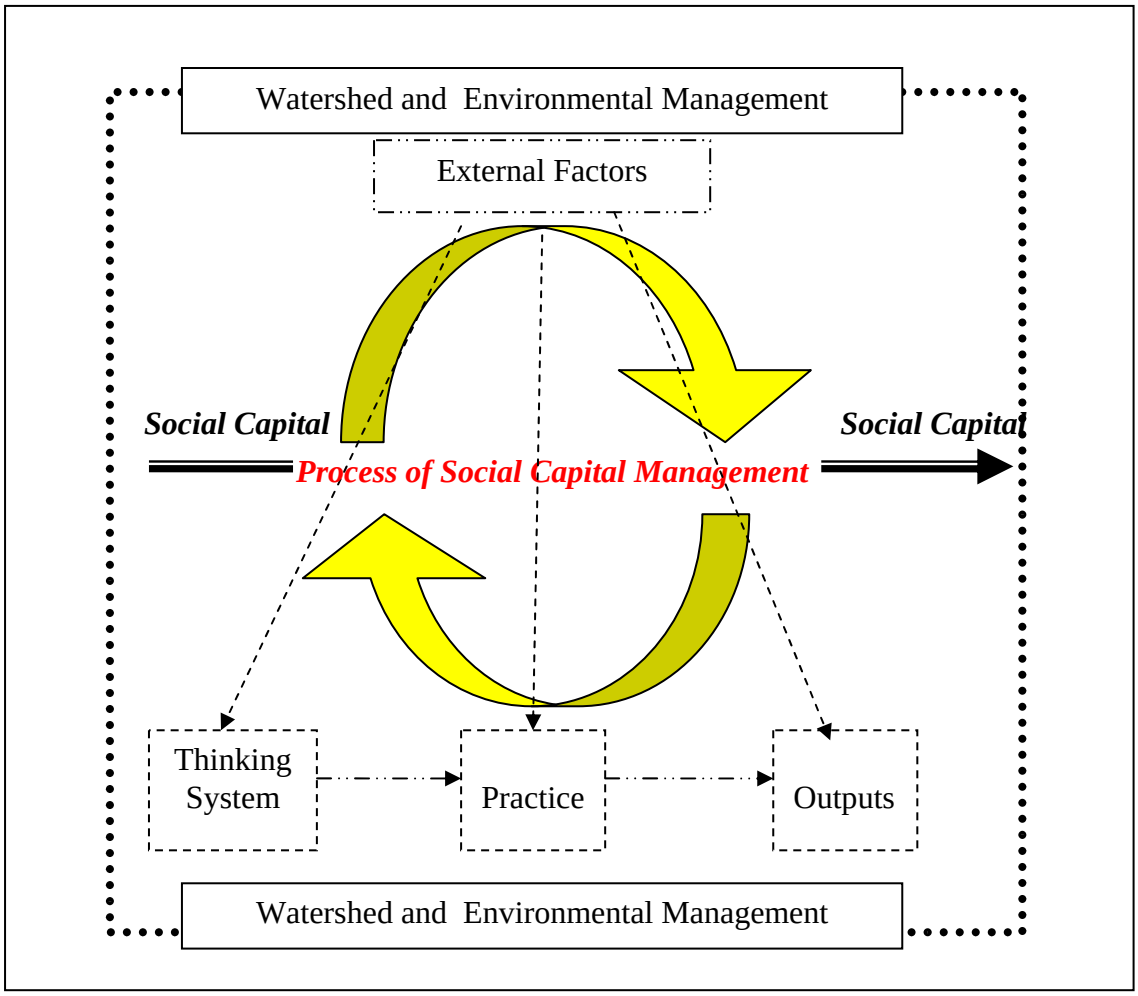

Figure 1 Framework of research

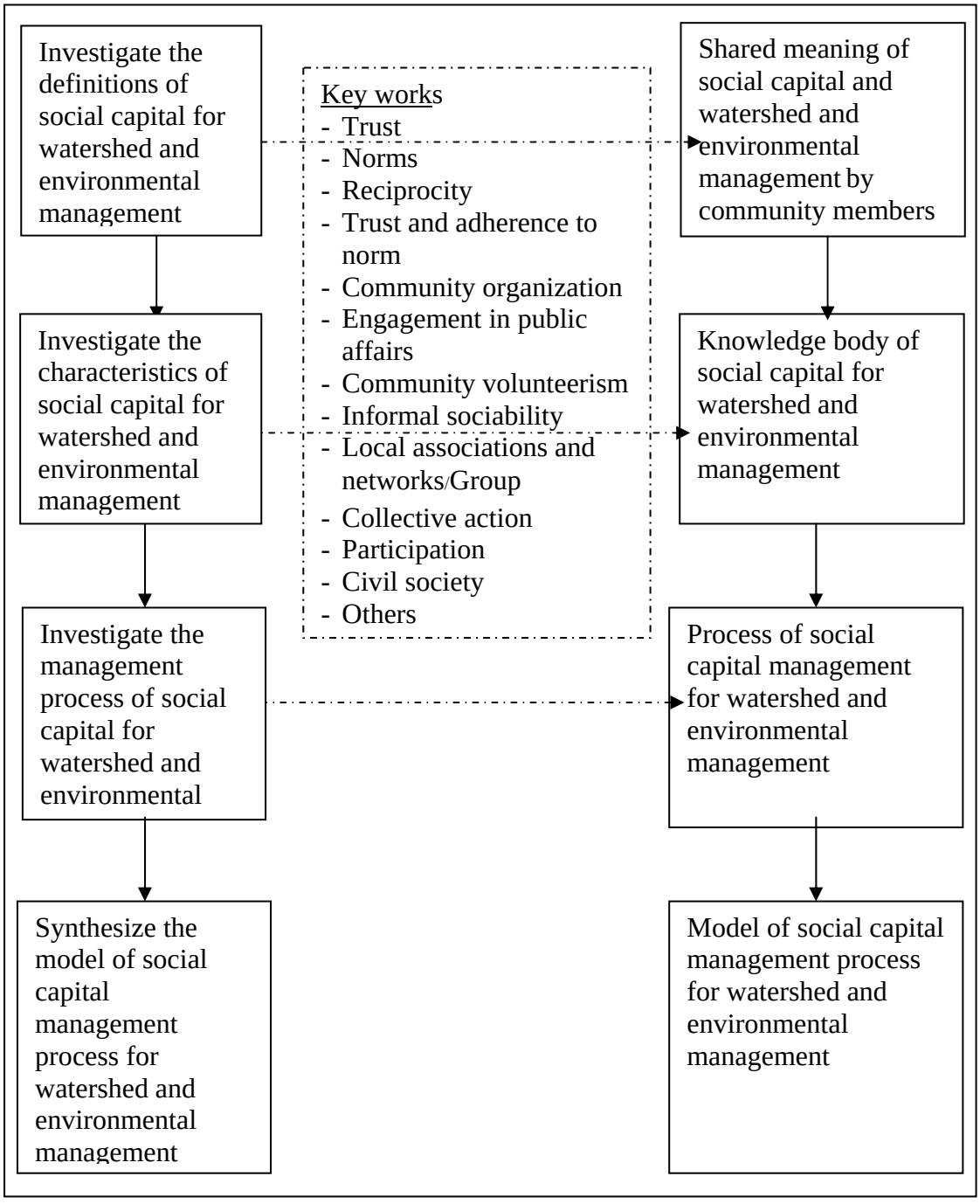

Figure 2 Framework of methodology research

3. Sampling

Sampling in this research is divided into two parts.

3.1 Part 1 In section of qualitative research use snowball sampling.

Snowball sampling is a special non-probability method. Beginning by identifying someone who meets the criteria for inclusion in this study. Then ask them to recommend others who they may know who also meet the criteria.

3.2 Part 2 In section of quantitative research use stratified sampling.

Stratified sampling is commonly used probability method that is superior to random sampling because it reduces sampling error. A stratum is a subset of the population that share at least one common characteristic. The researcher first identifies the relevant stratums and their actual representation in the population. Random sampling is then used to select a *sufficient* number of subjects from each stratum. "Sufficient" refers to a sample size large enough for us to be reasonably confident that the stratum represents the population. Stratified sampling is often used when one or more of the stratums in the population have a low incidence relative to the other stratums. Khajornslip(1996) suggested sampling of small population as shown below.

Population size less than 1,000 sampling minimum 25%
Population size 1,000 – 9,000 sampling minimum 10%

In this research stratums and sampling are:

3.2.1 Stratum 1: Key informants, sampling minimum 25%
3.2.2 Stratum 2: Community member, sampling minimum 10%

4 Research Procedures

4.1 Preparation phase

This phase regards with literature review, instrumental preparation for data collecting in the field study.

4.1.1 Literature review

This stage was to study data about principle of watershed and environmental management, concept of social capital, research techniques to prepare the data collecting phase.

4.1.2 Investigation of social capital key works

This stage was to investigate the key works of social capital by documentary technique.

4.1.3 Preparation of data collecting instrument

Data collecting instrument in the field study such as focus group discussion guide in-depth interview guide and questionnaire, the steps of preparation of data collecting instrument are shown fallows.

a) Set draft questions according to the research framework,
b) 1st Revise the questions by researcher and thesis advisor
c) Final review.

4.2 Data collecting phase

This phase was time consuming due to the embedding to closely observe the characteristics of social capital and the environmental management process of the

community, particularly in the watershed and environment. The stages were stated below.

4.2.1 The stage of the study of context of the community

a) Investigation the socio-economic data of the community. This stage used the documentary technique, the participatory mapping; a physical map indicating landscapes and resources produced by the member of the community, and in-dept interview of the key informants.

b) Topography with Geographic Information System (GIS)

(1) To determine the scope of studying area by using position indicator of Geo-referenced Coordinate with GPS Receiver, then taking into Geographic Information System with the Program of Geographic Information System (ArcGIS 9.1).

(2) To collect data layer of Geographic Information System in studying area using in the studying (As shown in Table 1), then the data layer shall be adjusted and revised into the map projection. This study, the researcher shall select the map projection of UTM (Universal Transverse Mercator) Datum WGS84 (World Geodetic System) Zone 47N which is the same system to the topographic map, ratio of 1:50,000, Serial No. L7018

(3) Making map showing data layer with the he Program of Geographic Information System (ArcGIS 9.1)

(4) Data Layer used in studying and topography; 1) Topographic map, Serial No.L7018, year 1998, by Military Map Department, 2) Scope of studying area, 2007 by using GPS Receiver, 3) Village Position, year 2007 by using GPS Receiver, 4) Land utilization year for 2000, year 2000 by National Park, Wildlife and Plant Conservation Department, 5) Land utilization year for 2001, year

2001 by Land Development Department, 6) Watershed Class Layer, year 1995 by Office of Policy and Natural Resources and Environment Plans, 7) Land use zoning of forest, year 1992 by National Park, Wildlife and Plant Conservation Department, 8) Stream Layer, year 1978 by Topographic Map, Serial No. L7017, 9) Model Terrain Model (DEM), year 2007 analyze from height layer line of distance of 20 meter, Topographic Map, Serial No. L7017, 10) Height layer of distance of 100 meter interval, year 2007 analyze from Model Terrain Model (DEM)

4.2.2 The stage of watershed and environmental management investigation

This stage was arranged to find out the procedures of watershed and environmental management process and the result of the watershed and environmental management. This stage used the focus group discussion technique, in-depth interview of the key informants to study the watershed and environmental management process.

4.2.3 The stage to study the result of the watershed and environmental management used conduce the on-site forest survey to study the characteristic of ecological system of the headwater forest.

a) Plotting to collect data, plotting sample of sampling random plot by random plotting in the area scattering to the studying areas.

b) Plot size, use 3 sample plots temporally with the studying objectives as follows:

(1) The circle plot with radius of 17.85 meter (area 1,000 square meter or 1.1 hector) for studying and collecting trees data, which are perennial plants with diameter at breast height: DBH from 10 centimeter as well as to study on bamboo, palm, rattan and other ground plants.

(2) The square plot of 5x5 meter (area 25 square meter or 0.0025 hector) overlaying on the center of the circle plot for studying and collecting data of saplings which are perennial plants with height more than 1.30 meter up and the with diameter at breast height (DBH) only 4-10 centimeter.

(3) The square plot of 2x2 meter (area 4 square meter or 0.0004 hector) overlaying within square plot of 5x5 meter for studying and collecting data of seedlings which are trees with height less than 1.30 meter.

(4) Collection data, recording to studying data to forestry resources in survey form (Tally Sheet) by showing the details of forestry areas to be surveyed such as position of site, species.

(5) Data analyzing: 1) to classify type of forest and species of tree found in the forest showing common name, and sciencetific name and 2) to analyze tree society in sample plot by calculating average wood volume, density of trees, saplings and seedlings as well as average density to bamboo, frequency, dominance, Important Value Index (IVI) and to analyze value of forestry ecological system.

4.2.4 The stage of the characteristics of social capital for watershed and environmental management investigation

a) Definition searching stage: This stage was to find out the definition of the term “Social Capital” and “Watershed and Environmental Management by the Community” to set a shared meaning of those terms from the community. This stage used the focus group discussion technique.

b) Characteristics searching stage: This stage concerns with the characteristic of social capital underpinning the watershed and environmental management in the community. This stage used the focus group discussion technique and in-depth interview of the key informants.

c) Social capital organization: This part was resulted from the previous stage, which the researcher has identified the preliminary key works according to figure 2 as the framework to investigate two characters of social capital: cognitive social capital and structural social capital.

4.2.5 The stage of social capital management process investigation

This stage studied social capital management for watershed and environmental management by analyzing the content according to these following steps.

a) In-dept interview of the key informants about the community history was administered to investigate the thinking system concerning social capital management process from traditional and modern thinking.

b) In-dept interview of the key informants about the watershed and environmental management process of the community was administered to investigate the practice concerning social capital management process. The secondary data is collected through activities, practices, plans and projects in relations to watershed and environmental management.

c) In-dept interview of the key informants about the outputs of watershed and environmental management process comparing the past time activities with the present.

4.2.6 The stage of the study of External factors

The study was related to external factors effecting thinking system and practices in watershed and environmental management of the community. This stage used the focus group discussion technique and in-depth interview of the key informants.

4.2.7 Verifying stage

This stage contributed to the multiple revisions, which considered to be an imitation of the study between the researcher and the community. This stage used the questionnaire.

4.3 Data Analyzing Phase

The qualitative data collected through the field study was analyzed and verified accordingly with shared meaning and interpretation of the community. This was to prevent the researcher's bias. This research was analyzed by using content analysis technique, and concluded inductively. The data collected from field studies was not considered as empirical data, therefore, the analysis was interpreted and related to the meaning of the existing behavior. (Chuntarwanich, 1993) Data analysis operated in five steps: 1) Theoretical framework 2) Verification 3) Note taking and indexing 4) Working hypothesis and reduction 5) Conclusion and verification.

The quantitative data was analyzed with descriptive statistic.

4.4 Synthesis: model and verification

4.4.1 After the data has been analyzed with related reports and document, the model of the process of social capital management for watershed and environmental management was synthesized.

4.4.2 The model derived from the preliminary session was verified and modified to be the most complete one using the workshop with the community.

The research procedures are shown in figure 3

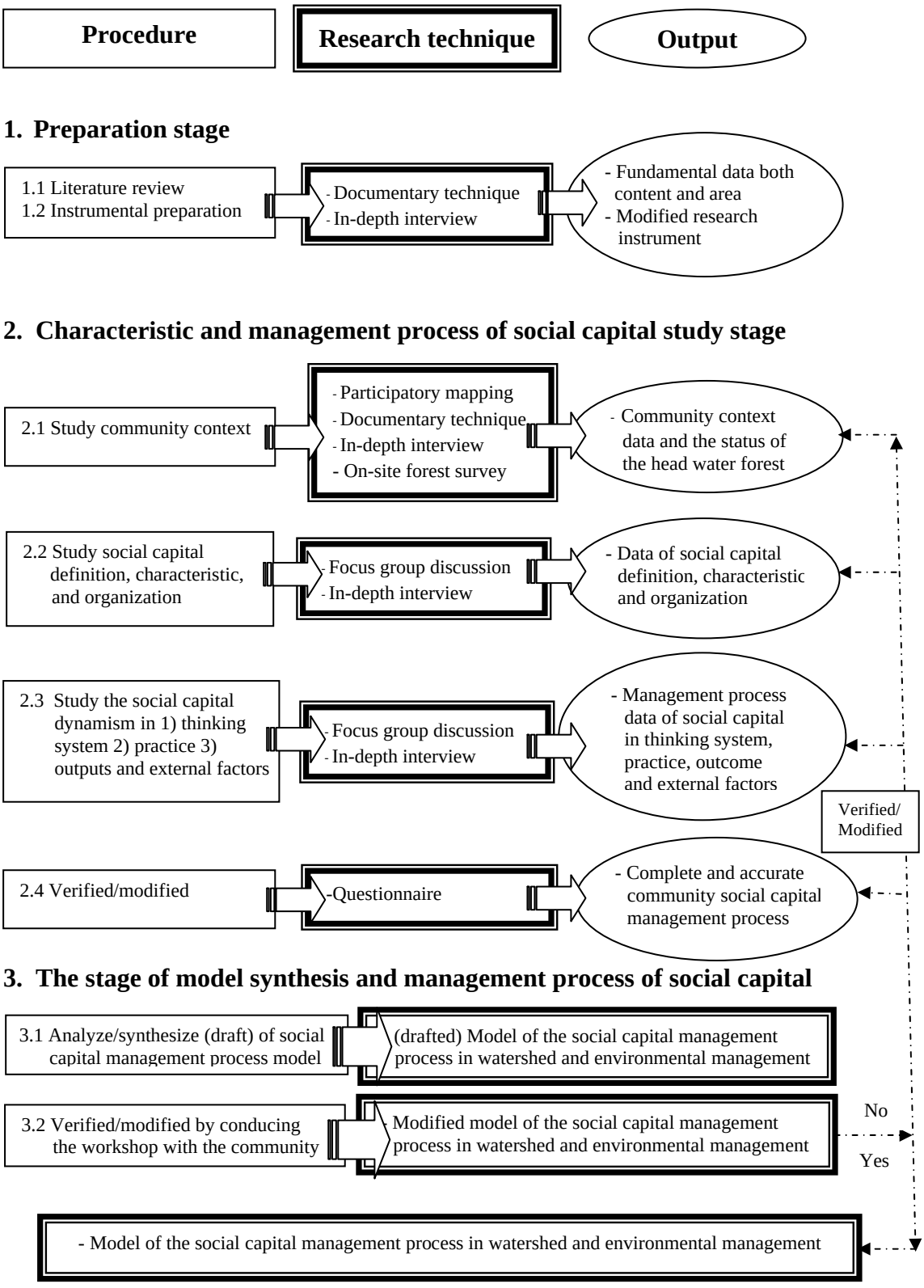

Figure 3 Research procedures

5. Data collecting instrument

Data collecting instrument in the field study such as focus group discussion guideline, in-depth interview guideline and questionnaire were used for inquiring data from key informants.

5.1 Focus group discussion guides

5.1.1 The focus group discussion guide was used for inquiring data about community context can be divided into 3 parts as follows; general information of community, community socio-economically, status of environment in the community.

5.1.2 The focus group discussion guide was used for inquiring data about definition of social capital and watershed and environmental management by community members can be divided into 2 parts as follows; definition of social capital, definition of watershed and environmental management by community members

5.1.3 The focus group discussion guide was used for inquiring data about watershed and environmental management process can be divided into 3 parts as follows; thinking system of watershed and environmental management, practice in watershed and environmental management, outputs and external factors of watershed and environmental management

5.1.4 The focus group discussion guide was used for inquiring data about social capital for watershed and environmental management can be divided into 2 parts as follows; the characteristics of social capital for watershed and environmental management, the dynamism of social capital through the whole process of watershed and environmental management.

5.2 In-depth interview guides

5.2.1 The in-depth interview guide was used for inquiring data about community context can be divided into 3 parts as follows; history of the community, community socio-economically, status of status of environment in the community.

5.2.2 The in-depth interview guide was used for inquiring data about watershed and environmental management process can be divided into 3 parts as follows; thinking system of watershed and environmental management, practice in watershed and environmental management, outputs and external factors of watershed and environmental management

5.2.3 The in-depth interview guide was used for inquiring data about watershed and environmental management process can be divided into 3 parts as follows; thinking system of watershed and environmental management, practice in watershed and environmental management, outputs and external factors of watershed and environmental management

5.2.4 The in-depth interview guide was used for inquiring data about social capital for watershed and environmental management can be divided into 2 parts as follows; the characteristics of social capital for watershed and environmental management, the dynamism of social capital through the whole

5.3 Questionnaire

Questionnaire was used for inquiring data from key informants and community member to study about the characteristics of social capital for watershed and environmental management. Questionnaire can be divided into 2 parts as follows; general information of answerer, the characteristics of social capital for watershed and environmental management.

6. Place

The study areas of this research are shown below.

6.1 Romphothong community, Klongtakrao sub-district, Thatakiab district, Chachoengsao province.

6.2 Khaophraphutthabatnoi community, Songklong sub-district, Kaengkhoi district, Saraburi province.

RESULTS AND DISCUSSION

Results

1. The characteristics of social capitals for community-based watershed and environment management

1.1 The case study 1: Romphothong community

1.1.1 The general conditions of the community

Romphothong community, Klongtakrao sub-district, Thatakiab district, Chachoengsao province located at the South of Pracheenburi watershed. (shown in Figure 4). The community was allocated as a forest villages in 1991 under the project to restore the national reserved forest Kaewrabgom-Seeyad. The community was allocated with the area of 4,375 hectares (1 rai = 0.625 hectare) (7,000 rai), in which 250 hectares (400 rai) are allocated for residency, 62.5 hectares (100 rai) for government-use, and 4,062.5 hectares (6500 rai) for agricultural land. The community consist of the local people who immigrated from the Wildlife sanctuary of Khaoangruanai to live in the border line of wildlife sanctuary in lowland area. Therefore, settlement plan was organized by the Royal Forestry Department (at that time). The area of 9.375 hectares (15 rai) was allocated to each household; by which 0.625 hectares (1 rai) was for residency and 8.75 hectares (14 rai) was for agricultural lands. The residency areas were located in the middle, separated from the farms by a small road. The farms were located on the circumference.

Geographical characteristics of Klongtakrao watershed cover 201.72 km^2 with UTM section at the standard WGS 84, horizontal standard No. 789500 E to 808500 E and vertical standard No. 1458500 N to 1477500 N. The watershed represented as polygonal shape. The elevation is between 65 to 750 meters above sea level with the mean slope of 14.63%. Most areas slope towards the North.

The water flow path starts from the South to the North having one major water flow e.g. Klongtakrao (shown in Table 4 and Figure 5)

Most of Klongtakrao Watershed is dry evergreen forest of 167.53 km^2 (or 83.05% of total area), located in the South of watershed area. Agricultural area is 22.32 km^2 (or 11.06% of total area), located in the north of watershed area. (shown in Table 5 and Figure 6). The National Park, Wildlife and Plant Conservation Department has reported that most of Klongtakrao Watershed area is conserved forest of 179.15 km^2 (or 88.81% of total area). In addition, there is economic forest area. (shown in Table 6 and Figure 7). The quality of watershed is appointed by the Office of Natural Resources and Environmental Policy and Planning (ONEP), reported that most of Klongtakrao Watershed having 13.88 km^2 (or 61.41 % of total area), is classified as watershed class 4 suitable for agricultural convention. However, it is necessary for the area to establish the policy on soil and water conservation. (shown in Table 7 and Figure 8)

At present, the community consisted of 324 households and 1,269 of population; 655 of which were males and the rest (614) were females. Most of the people here came from the Northeast of Thailand. Thus, most of the traditions still had heredity from the Northeast of Thailand such as the Rocket festival. For occupations, 90% of the population did agriculture as their major occupations as well as some employment as a minor (Rural development Information Center, 2005)

Table 4 The geographical characteristics of Klongtakrao watershed, Chachoengsao

Geographical characteristics	Unit	Value
Watershed area	Square kilometer	201.72
Perimeter	Kilometers	68.01
Max. elevation	Meters above mean sea level	750
Min. elevation	Meters above mean sea level	65
Mean elevation	Meters above mean sea level	191
Mean slope	Percent	14.63
Aspect	-	North
Shape	-	Polygonal shape
Stream pattern	-	Dendritic pattern
Drainage density: Dd	Kilometer/ Square kilometer	0.69

Table 5 The land utilizations of Klongtakrao Watershed, Chachoengsao

Land Utilizations	Square kilometers	Percent
Dry evergreen forest	167.53	83.05
Secondary growth forest	1.21	0.60
Mixed deciduous forest	10.54	5.23
Agricultural area	22.32	11.06
Water bodies	0.12	0.06
Total	**201.72**	**100**

Table 6 The land use zoning of the forest in Klongtakrao Watershed, Chachoengsao

Land use zoning of the forest	Square kilometers	Percent
Forest zone E (Economic)	22.57	11.19
Forest zone C (Conservation)	179.15	88.81
Total	**201.72**	**100**

Table 7 The watershed classification of Klongtakrao Watershed, Chachoengsao

Watershed classification	Square kilometers	Percent	Cumulative Percent
class 1A	24.16	11.98	11.98
class 1B	0	0	11.98
class 2	24.52	12.15	24.13
class 3	29.16	14.46	38.59
class 4	123.88	61.41	100.00
class 5	0	0	100.00

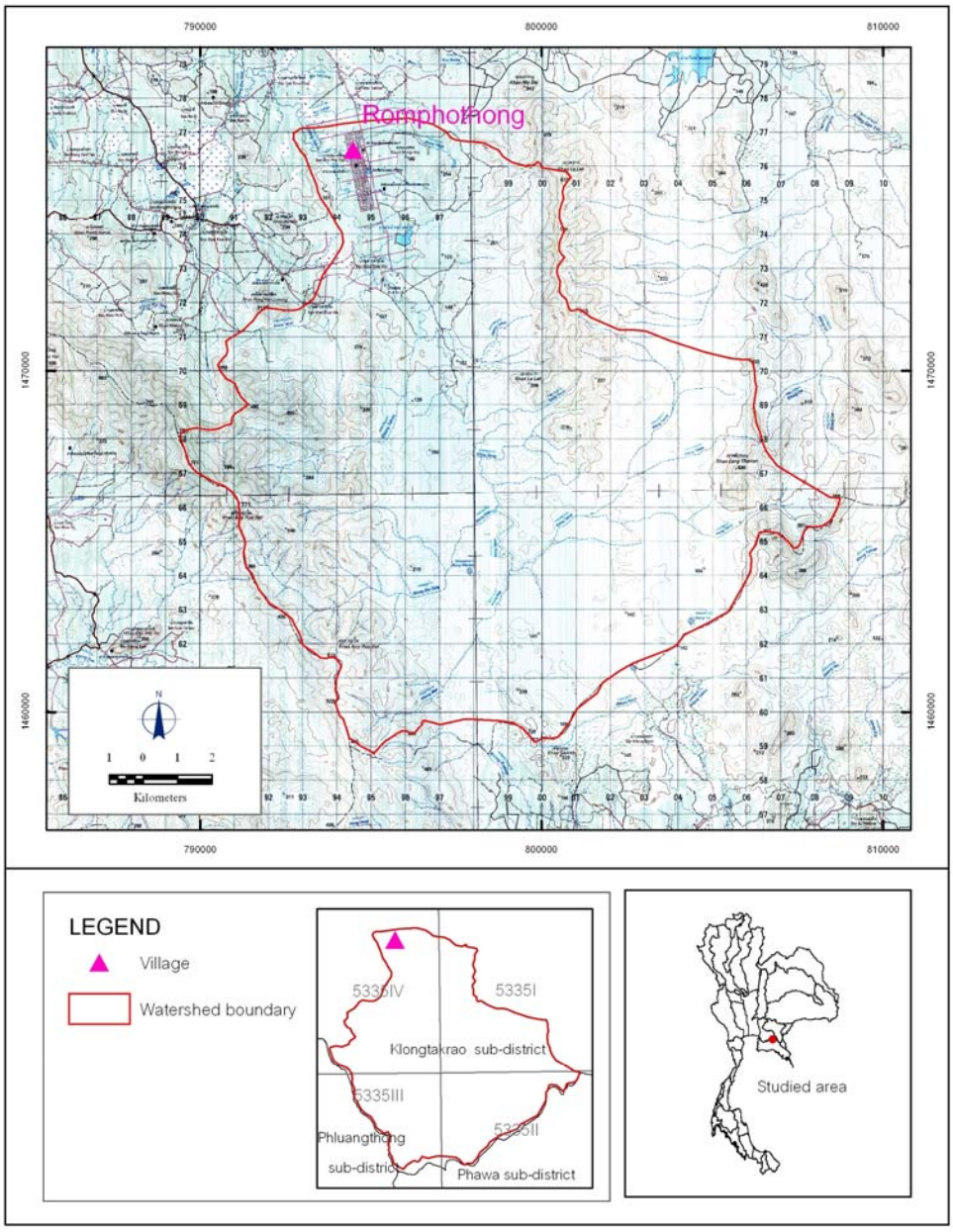

Figure 4 Boundary of Klongtakrao watershed, Chachoengsao

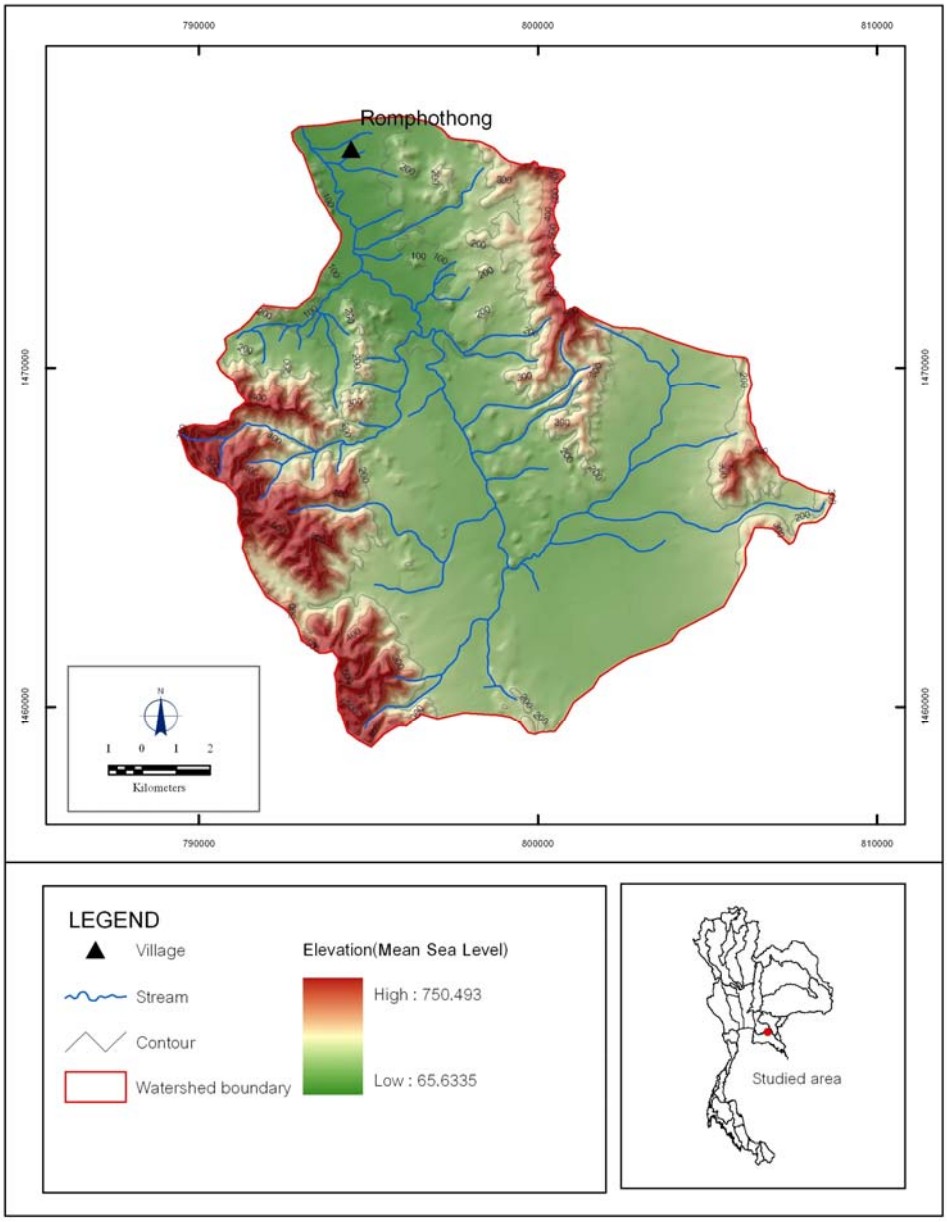

Figure 5 Geographical map of Klongtakrao watershed, Chachoengsao

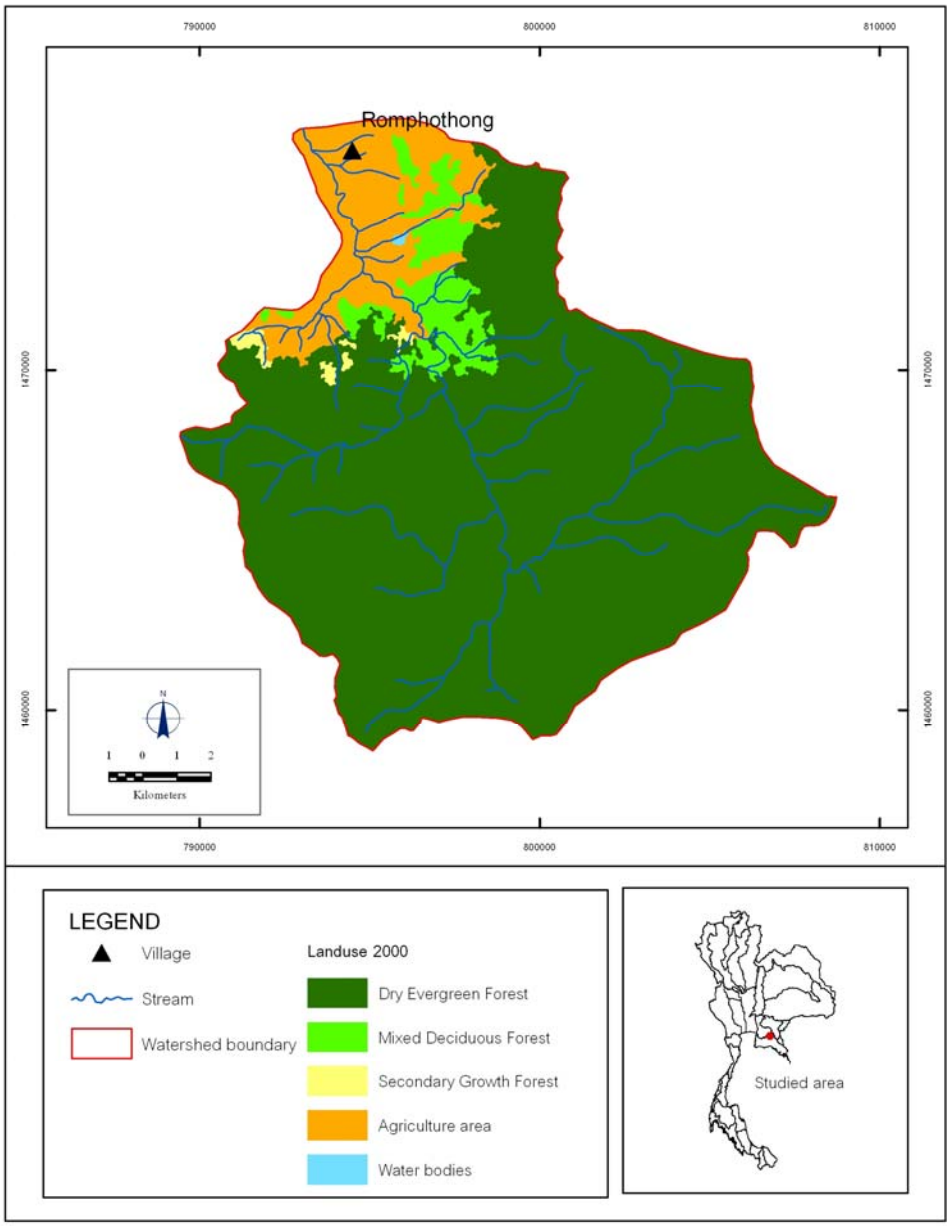

Figure 6 Land use map in 2000 of Klongtakrao watershed, Chachoengsao

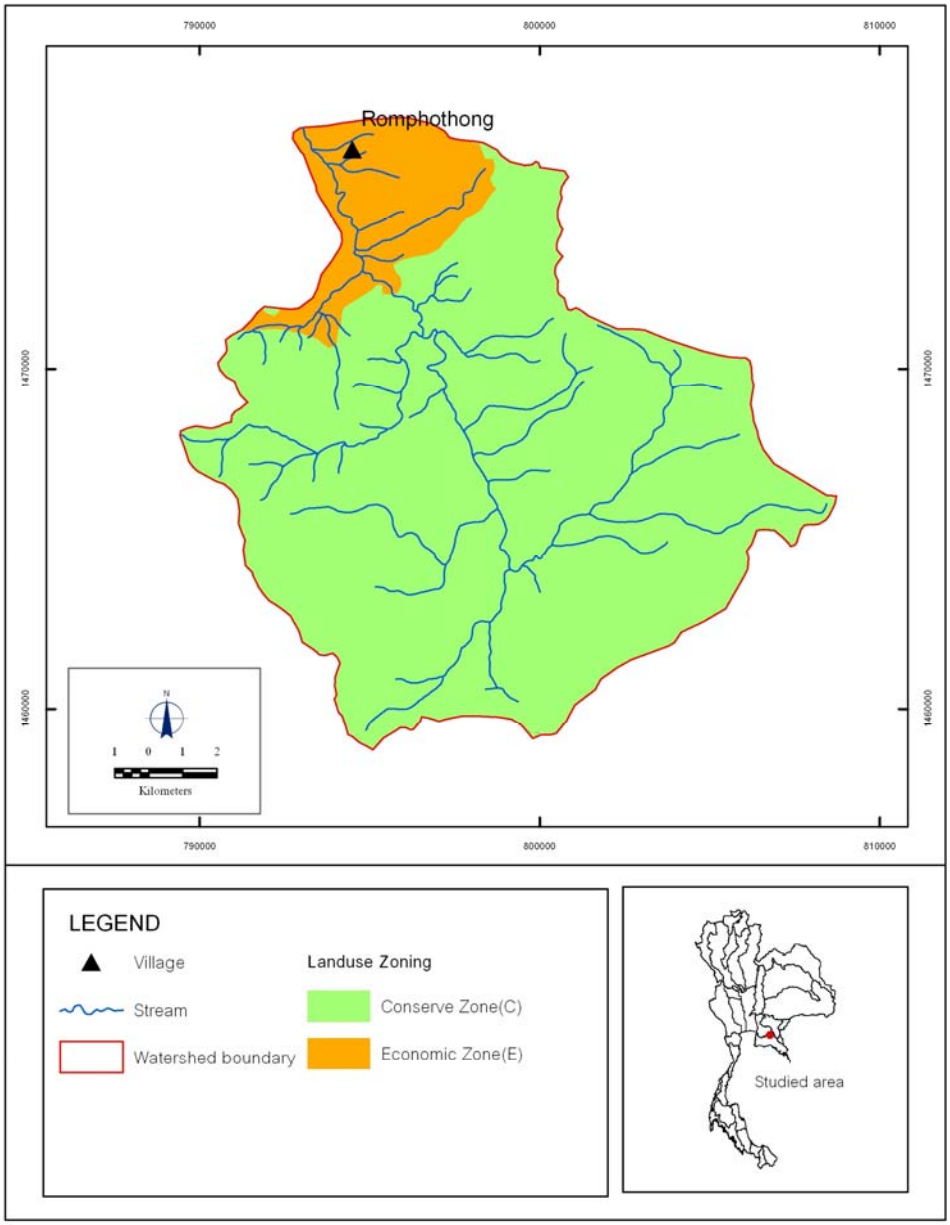

Figure 7 Land use zoning of the forest map of Klongtakrao watershed, Chachoengsao

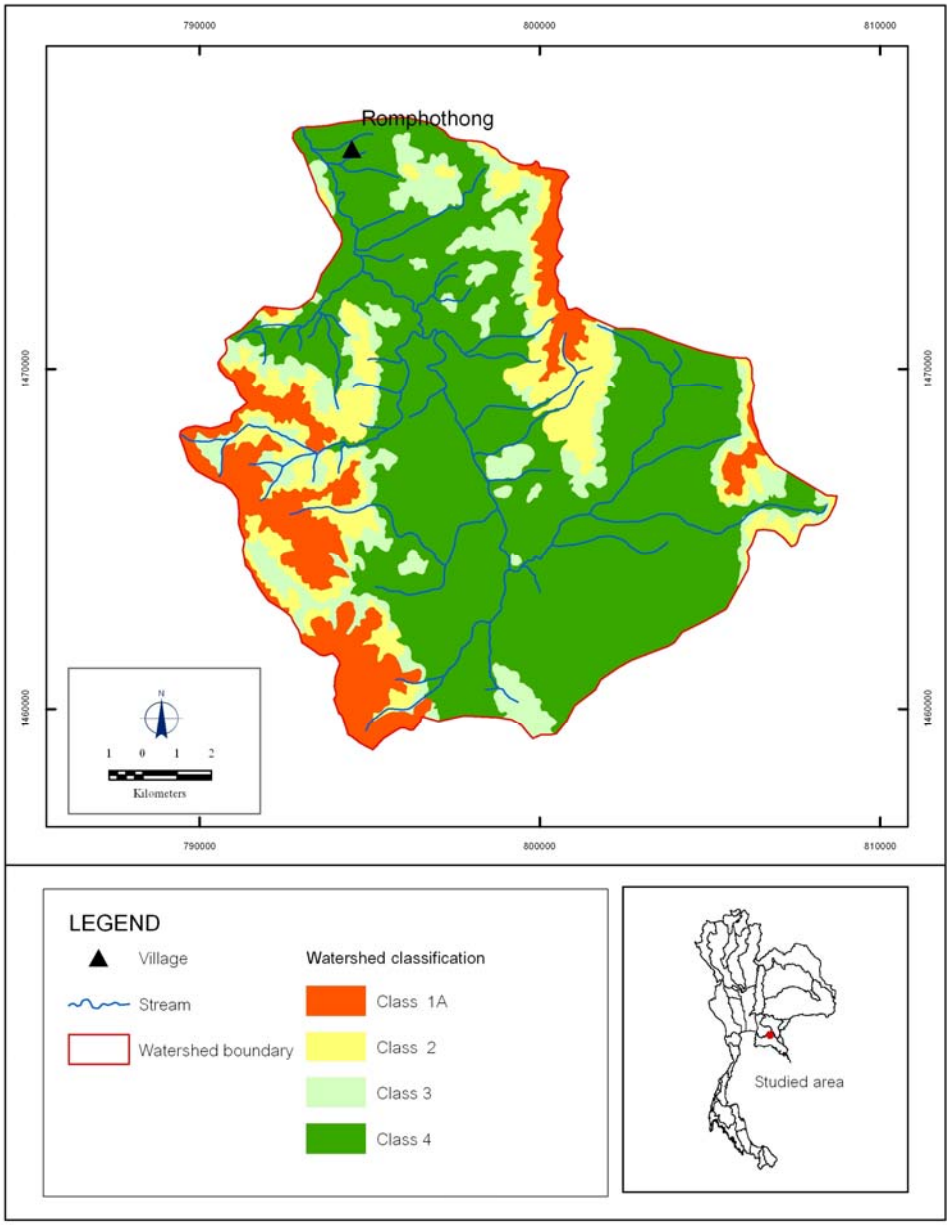

Figure 8 Watershed classification map of Klongtakrao watershed, Chachoengsao

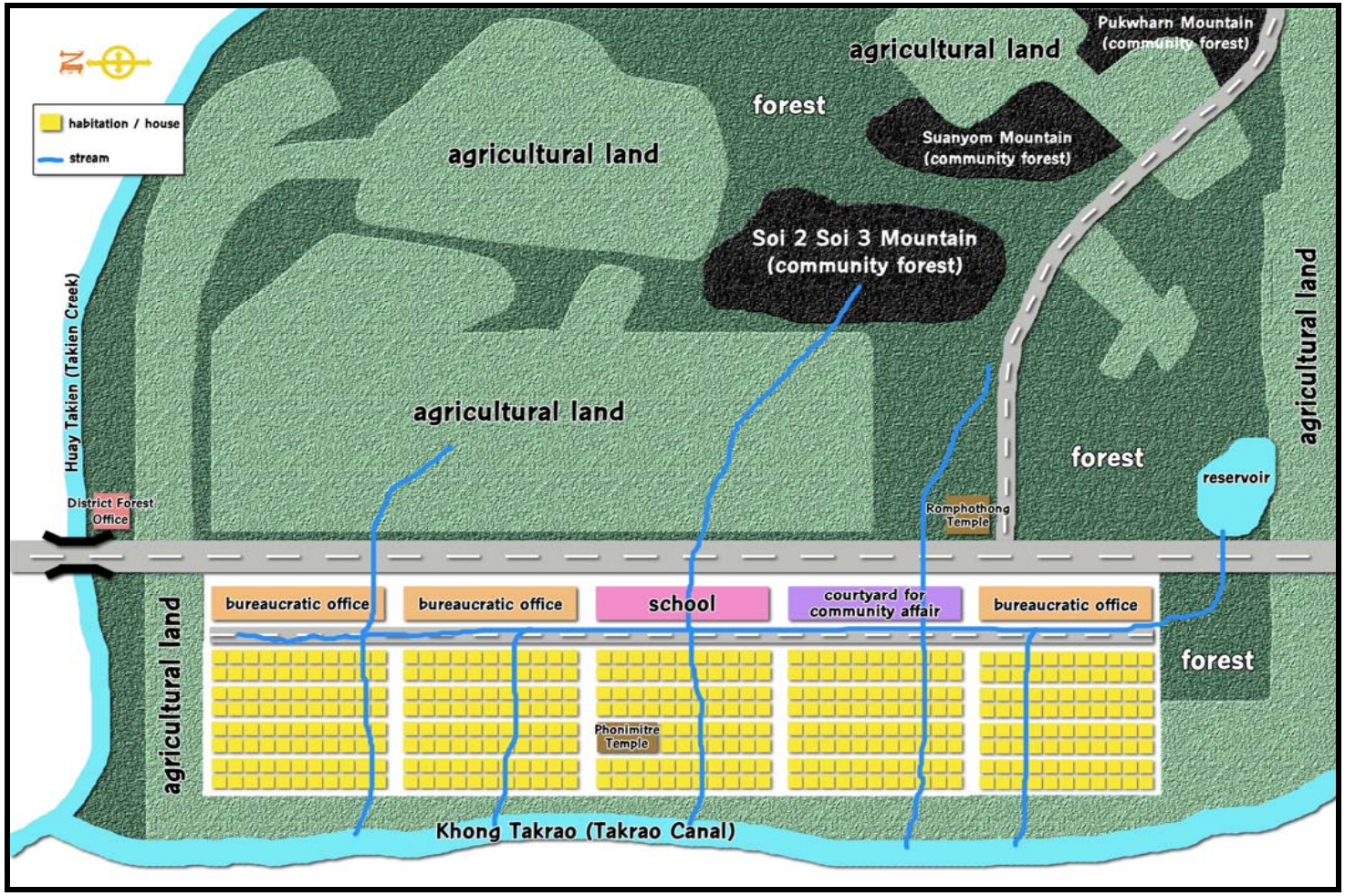

Figure 9 Perspective of Romphothong community, Chachoengsao

Figure 10 General condition of Romphothong community, Chachoengsao

1.1.2 The history of Romphothong community

The study on the social capitals used for managing the watershed and environment was focusing on its history, context, the management process of watershed and environment. The history of this community is divided into three periods. Firstly, before forest village allocation taken place (1973-1986). Secondly, the forest village allocation (1982-1992). Lastly, the community development and resource restoration period.

a) Period 1: before forest village allocation taken place (1973-986)

In 1973, after the logging concession, there were about 4 households settling in the area. They immigrated by traveling along the wood-dragged trail. During that time, the land lay covered primarily by forest and completely shut in from the outside world. The wood-dragged trail was the only path that could be used for foot journey. Besides, area was plagued by malaria. Originally there were some former residents living in Korkae village and doing rubber plantations for their livings. After the logging concession was over, they moved in to claim the land for their rubber farms. Later, they sold the land, which was still the forest, to the newcomers. The locals said, at that time, the land-selling agreements were made roughly upon the width of the land alongside with the road. Which means the buyer or new-owner could claim for their lands as long as they could clear the path deep from the road's edge into the forest. Houses were usually built around Klongtakrao Canal (to the west of the village), in which they were called "Ban Soi 4" according to the wood-dragged path. At that time there was no public utility at all.

Most of the resident here emigrated from the Northeastern area of Thailand. The major reason they came here because they seek for employments, and farming in Chanthaburi and Rayong. Meanwhile, they tried to claim for their own lands into the forest in order to settle down. At the beginning of the period, the crop plantations were for consumptions, i.e., rice, corn, and vegetables from backyard. Most foods were brought from brooks, swamps. In additions, wild vegetables, wild

fruit, fish, wild animals were also primary sources of food. The only things people need to spend money to buy were medicine or condiments (salt and sugar). People made their primary earning by selling forest's resources. They also hunted wild animals for foods and sell them for money, i.e., wild boars, forest deer, barking deer, porcupines, chevrotains,

Later, until 1975-1981, the logging concession was over. The government tried to promote plantations of industrial corps like cassava, sugarcane, and corn in order to export. As a result, the land had been extensively taken over by people who tried to expand their agricultural lands, and also the more parts of the forest had been cleared by them.

In this period, people in the community had been benefited significantly by the natural resources and from the resourceful environment of the watershed. The watershed served as an important factor for productions and human well being.

b) Period 2: during the forest village allocation (1987-1994)"

In 1982, the 1st Army Area had proclaimed the forest to be the operation and gathering points for the communism terrorists, and thus put the forest as the restricted area. In 1987, the Ministry of Agriculture and Cooperation had established the forest protection committee to protect the adjacent boundaries of five provinces; Chachengsao , Sa Kaew, Chon Buri, Rayong, Chanthaburi. Finally the government had approved and established the Forest and Animal Conservation Project in the adjacent boundaries of the five provinces. According to the conversation-project's regulations, the local residents had to be evacuated from the area which the government would proclaimed as the wildlife sanctuary. The government had assigned the 1st Army Area to assist the evacuation, to develop the area as the forest-village in 1991, and then the government proclaimed it as the animal preservation area, called Khao Ang Ruenai Wildlife Sanctuary later in 1992.

After the evacuation, the Royal Forest Department had provided 8.75 hectares (14 rai) for agricultural land and 0.625 hectares (1 rai) for residency for each household. The residents were given the owner' rights of the lands as workplaces, and they could inherit the lands but had no right not sell them. The Royal Forest Department had also provided them with the title deeds. However, during when government proceeded, there were so many problems. For examples, the errors of census due to the misconceptions between the officers and the residents; the conflicts with the former landowner in the land-sharing agreements; problems with the outsiders who stealthily claimed for their lands; as well as the protest done by the residents that the officers did do as promise by giving another land to the married child who still lived with their parents.

Romphothong community was established and put as a part of the National Forest in the form of forest village Kaew-Seeyad (1). Total of 94 households were evacuated due to the National Forest Reforming Project; 33 households of Phutai Village, 12 households of NhongKaYong Village, 13 households of Morsai-TorTaBak-SoiHok Villages, and 36 households of TonMaPring Village, Soi pad Villages, SoiSibHa Villages, SoiSibHog Villages and SamroiRai Villages). However, there were so many problems again. For examples; the rainy season made the road more bumpy and difficult for the evacuation.; Some new residents could not make their living on the allocated lands, because they were threaten by the former landowners; also the resettling time was after the cultivating season; No road to support the agricultural transportations; conflict among the families since the new residents had come from different backgrounds.

During this time, people feared with the threats of their life-security, and they could not live as they normally did before. On the other hand, the community had lost its factors for productions. The changes in the life-courses due to the emigration from the old places had lead people in the community to the feeling of "Insecurity in their lives"

c) Period 3: during community development and resource restoration (1995-2006)

During the period, the Government assembled the public utility which was more convenience than the past. Unfortunately, the standard of living of many families was not so good as most of them were on debt. Some of them had to sell all their lands and migrated to other settlements. Most people who still had their lands in this community recognized that it was too risky to move to the new habitat. Fortunately, the Government had the policies to develop communities that settled near the forest border especially the Project of Natural Resources and Wildlife Conservation in 1994 under the Royal-initiated project of Queen Sirikit, that strongly emphasized on mixing plantation method, building local pond and supporting on soya bean cropping.

Until the year of 1996, the community received many sustainable development policies from various studies. The Regional Community Forestry Training Center of Asia and the Pacific (RECOFTC) had help the local residents by proving them with the educational workshops on how to develop and improve the community. RECOFTC gave the agro-forestry and community forest at Tawaungtrai temple NakhonRatchasima province as the case study to inspire people of Romphotong village. And in the later time, the project to manage the headwater forest had been established.

1.1.3 The characteristics of social capitals for watershed and environment management

At the beginning of the headwater forest community-based management project, people of the community had to face with so many crises. For examples, people were from the different backgrounds and thus they lived independently and separately as groups without trust in each others; the conflict aroused between the former landowners and the legal landowner; the forest had been devastated by annual forest fires, thus the area was covered primarily by dried grasses

with no standing-trees, or (on the other hand) the forest had been in the most decadent condition

The very first thing that the they had to do was to build trusts and understandings between the leaders of each group, in order for the leaders to convince their followers to believe that this project will be for the community and everyone can profit from it as a whole, just like one said in the interview that "*When the group leaders understand and trust each other, no one will seek profit for their own or their groups. Everything will be sincere and explicit*" (source: the field interview, 2006) Thus the social capital which was the key to manage the watershed and environment of this community at this time, just as all leaders of the management project agreed, was the trusts.

In addition to the community's leaders strongly organizing the headwater forest community-based management project without hidden agenda. Objective to reforest. The resident understood that the development project was for the community's benefit to establish its vital source for food and other necessities ("green supermarket").The determination is another key to archive and make this project more tangible, and all the group leaders agreed that the social capital is "Engagement in public affairs" to make them succeed.

Since all of the residents came from different backgrounds, religion played an important role in uniting and establishing the harmony in the community. This conformity is one factor to push the society forward, and all the leaders agreed that the social capitals is "Solidarity" that enable them to work successfully as a team.

In addition to building trust and conformity, the community had set up the forums in order to share and discuss about the headwater forest community-based management project. The forums didn't limit to only members, but the official staffs from the ranger division, the district forest officer and the school representatives can join them. Usually the formal forums had been held at the school's meeting-room on the 5th of each month. Also informal small forums had been held from time to

time. Therefore this led to the constant learning in the community. As a result, all the group leaders proposed that “Civil society” should be another social capital that enable them to succeed in the headwater forest community-based management project.

According to the people had faced with non-resolved problems such as the conflicts with former landowners, liabilities, forest decadence, depletion of water, the limitation of geophysical properties. They started to realize they cannot run away from the problem, but have to improve their livings by the existing resources. Having with that time, the group leader were trying to promote the concept of community forest by implanting the people with the idea that “they belong to the forest” As a result, the concept to recover and improve the forest resources had become the social capital as the norm of society or proposed by the group leaders as “Norm of conservation” The concept of “Norm of Conservation” had reflect that the community had changed their perspectives on nature as their living tools to be “Human-and-nature live together”. This rising concept is to promote the “Reciprocity” between the community and the forest. All of the group leaders had proposed “Reciprocity” as another social capital to develop the headwater forest community-based management project.

As a result, the headwater forest community-based management project had begun. The very first activity of the project was the forest fire control. It turned out that this activity with a good participation can decrease the areas of forest fire down to 40% of the total area. Consequently the forest’s resources had begun to grow up (Thaworn and Kumpila, 2001). Therefore “Participation” was another social capital for this community to succeed in the headwater forest community-based management project, as agreed by all the group leaders. The participations among the people in community can be seen by the following examples. 1) organized “A Pa Pha” ceremony (local Buddhist) to raised fund for the headwater forest community-based management project, 2) the annul activity to build fire-break to prevent forest fires.

For the plan to recover and improve the watershed and environment, the community approached it by improving the forest's water sources for their uses, since water sources were considered to be forest's resources and play a vital role for providing foods and necessities for life. The community had established an outlines for approaching this plan; 1) not cutting the trees/prevent the deforestation 2) planting the trees, to replace the lost trees 3) guard / protect/ and preserve the forest 4) to built awareness of the forest management to the next generation.

The headwater forest community-based management project had created the communication in the community in many dimensions such as; the forest-community network had been established. The community received supports and cooperation in many ways including academic knowledge, budgets as well as other administration supports from many outer organization networks. The organizations that provided supports to the community forest were such as RECOFTS, the department of the Royal Forest, Agro-Forestry network by Vibul Kemjarearn (the village headman), Conservation network, schools, and the researchers from many institutes who went to do the research. The community had proceeded timely to the plan and enforced its conformity. As a result, it had broadened its communications greatly. Thus the group leaders all agreed to put the Information and communication as well as Group and network to be another social capital that made them succeed in their plan.

Another social capital that made the headwater forest community-based management project success was the "Empowerment". The community received the cooperation as well as the authority to establish or to turn such a normal community to be the community forest.

Community organization was another social capital as a tool to succeed. When the residents of the community were given the authority to monitor and manage the forest area and resources on their own, they had established an organization called "the community forest committees". The purposes of the organization were to precede the plan, and turn the community demands or requests

into the tangible forms under the concept “Preserve for the future use”. Furthermore, 88.9 % of the leaders of the headwater forest community-based management project agreed to put “community organization**”** as a social capital.

According to the above, it can be concluded that the characteristics of social capitals were used in both “Thinking System” and “Practicing System” for watershed and environmental management of Romphothong Community as shown in the Figure 11.

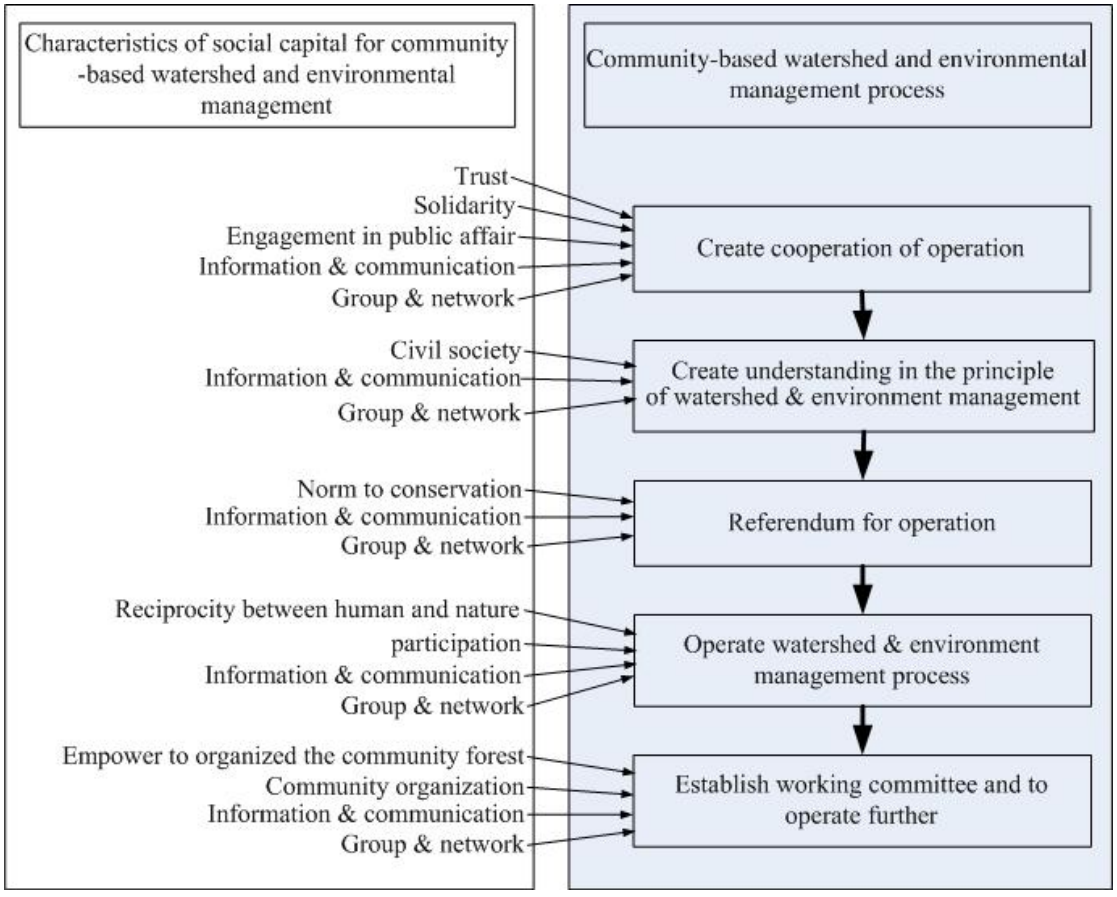

Figure 11 Characteristics of social capital used to manage the headwater forest of Romphothong community, Chachoengsao

1.1.4 The results obtained by using social capital to manage the watershed and environment

The obtained results had reflected upon the characteristic of ecological system of the headwater forest of community as well as other direct or indirect benefits of the forest's fertility that the community received. The results can be described in the followings

a) The characteristic of ecological system of "the headwater forest"

Before 1996, the community didn't established plan to manage and restore the headwater forest. Thus the overall condition was that the forest was primarily covered by dried grasses with no standing-trees. Or in the other hand, the forest was significantly decadent

In 1996 until now, after the plan, to restore the headwater forest to be sources of water, foods and necessities, had begun, the forest's resources had become more abundant, and become productive source for living.

According to the data analysis, by conducting on-site survey of 0.5% of total area (12 sample plots), it was found that there were 73 species of trees. The forest was characterized as "Mixed Deciduous Forest". There were the other important ecological aspects in the followings;

(1) The wood volume; the wood volume of level 1 (TQ1.1 and 1.2) was equal to 41.1344 m^3/hectare. The wood volume of level 2 was equal to 7.5395 m^3/hectare. The wood volume of level 3 was equal to 7.5186 m^3/hectare. Thus the total wood volume was equal to 56.1925 m^3/hectare (shown in Table 8) If comparing the total wood volume to forest's resources, it can be seen that Most of wood found in Romphothong community forest considered to have medium to low quality as most were used for fuel only. None of them were used for construction purpose.

(2) The relative density; It was found that there were 73 species of trees. The trees (DBH: 10-30 cm.) had the density equal to 225 trees/hectare. The trees (DBH: 30-60 cm.) had the density equal to 23 trees /hectare. The trees (DBH: >60 cm.) had the density equal to 4 trees /hectare. The sapling had the density equal to 5,067 trees /hectare. The seedlings had the density equal to 45,625 trees /hectare and Bamboos had the density 20 trunk/hectare. (shown in Table 9) The sapling and seedling showed higher tree density than large tree. It was indicated that there were small amount of large trees as in the past, this area was denuded forest creating environmental degradation. In addition to the species that had maximum density was *Streblus asper* Lour., which was equal to 9.06 %. The next 4 succeeding species were Thonglang pa (*Erythrina subumbrans* (Hassk.) Merr) with 5.47% of density, Trabag grai *(Terminalia dafeuillana* Pierre ex Laness) had 5.31% of density, Pradoo (*Pterocarpus macrocarpus* Kurz) had 4.53% of density, Intrarachit (*Lagerstroemia loudonii* Teijsm. & Binn.) had 4.22% of density, respectively . (shown in Table 10)

(3) The relative frequency; the more frequency value indicated the more consistent distribution over the area. The species that had highest frequency was Khoi (*Streblus asper* Lour.), Thonglang pa (*Erythrina subumbrans* (Hassk.) Merr), Pradoo (*Pterocarpus macrocarpus* Kurz), Khleng (*Dialium cochinchinense* Pierre), which had 4.07% of frequency. (shown in figure 10)

(4) The relative dominance; this value is obtained from the cross-sectional area of the trees. And it turned out to be that the species that had the highest dominance value was Thonglang pa (*Erythrina subumbrans* (Hassk.) Merr) with 16.23%. The next succeeding 4 speicies were Khoi (*Streblus asper* Lour.) with 13.08%. Intrarachit (*Lagerstroemia loudonii* Teijsm. & Binn.) with 7.49%, Pradoo (*Pterocarpus macrocarpus* Kurz) with 7.00% and Trabag grai *(Terminalia dafeuillana* Pierre ex Laness) with 5.72 % (shown in table 10)

(5) The importance value index (IVI); The species that had the highest importance value index (IVI) was Thonglang pa (*Erythrina subumbrans*

(Hassk.) Merr) with 26.22%. The next succeeding 4 species were Khoi (*Streblus asper* Lour.) with 25.77%, Intrarachit (*Lagerstroemia loudonii* Teijsm. & Binn.) with 14.37 Pradoo (*Pterocarpus macrocarpus* Kurz) with 13.98 % and Trabag grai *(Terminalia dafeuillana* Pierre ex Laness) with 13.55% (shown in table 10)

Table 8 Average wood volume classified by saw timber quality of Romphothong community forest, Chachoengsao

Forest	average wood volume(m^3/ hectare)			
	Level 1: saw timber quality 1.1 and 1.2	**Level 2: saw timber quality 2**	**Level 3: saw timber quality 1.3 and 3**	**Total**
The forest of Romphothong community	41.1344	7.5395	7.5186	56.1925

Table 9 Tree density of trees, sapling, seedling and bamboo of Romphothong community forest, Chachoengsao

Forest	Tree density (trees/hectare)						
	classified of trees: DBH (cm)				sapling	seedling	Bamboo (trunk/hectare)
	10-30	30-60	60	Total			
The forest of Romphothong community	225	23	4	252	5,067	45,625	20

Table 10 Relative density, relative frequency, relative dominance, importance value index and utilization of trees of Romphothong community forest, Chachoengsao

NO.	Common name	Sciencetific name	Relative density (%)	Relative Frequency (%)	Relative Dominance (%)	IVI (%)	Utilization
1	Thonglang pa	*Erythrina subumbrans* (Hassk.) Merr	5.47	4.07	16.23	26.22	-
2	Khoi	*Streblus asper* Lour.	9.06	4.07	13.08	25.77	Fd., Hb.
3	Intrarachit	*Lagerstroemia loudonii* Teijsm. & Binn.	4.22	3.62	7.49	14.37	-
4	Pradoo	*Pterocarpus macrocarpus* Kurz	4.53	4.07	7.00	13.98	Cons.
5	Trabag grai	*Terminalia dafeuillana* Pierre ex Laness	5.31	3.62	5.72	13.55	-
6	Trabag deang	*Lagerstroemia calyculata* Kurz	2.50	3.62	5.14	13.38	Cons., Hb.
7	Khleng	*Dialium cochinchinense* Pierre	3.44	4.07	4.59	10.21	-
8	Plong bai lek	*Memecylon geddesianum* Craib	2.97	2.71	4.42	9.93	-
9	Ma kok klean	*Canarium subulatum* Guill.	2.97	3.17	3.92	9.88	-
10	Edum	*Diospyros variegata* Kurz	2.50	3.62	3.79	9.73	Hb.
11	Seaw yai	*Bauhinia malabarica* Roxb.	2.66	3.62	3.48	9.22	Hb
12	Khem pa	*Greenia wightiana* Wall. ex Wight & Arn.	1.56	2.26	2.80	7.98	Hb.
13	Po gen thao	*Grewia elatostemoides* Coll. et Hemsl.	2.34	0.90	1.81	6.64	-

Table 10 (Continued)

NO.	Common name	Sciencetific name	Relative density (%)	Relative Frequency (%)	Relative Dominance (%)	IVI (%)	Utilization
14	Ma huad	*Lepisanthes rubiginosa* Leenh.	2.19	1.81	1.74	6.13	Cons.,Hb.
15	Sab sua	*Eupatorium odoratum* Linn	2.50	2.71	1.70	5.57	Hb.
16	Somkob	*Hymenodictyon excelsum* (Roxb.)Wall.	1.41	2.26	1.51	5.12	Hb.
17	Luad Gwang	*Knema linifolia* Warb.	0.63	0.90	1.54	5.11	-
18	Satao, lumpang	*Pterospermum diversifolium* Bl.	0.63	1.36	1.47	4.73	Hb.
19	Deung sa ngae	*Schoutenia hypoleuca* Pierre	2.34	2.26	1.11	4.48	-
20	Ma glom ton	*Adenanthera pavonina* Linn.	2.34	2.71	0.95	4.41	Hb.
21	Ma kha mong	*Afzelia xylocarpa* Craib	0.94	0.90	0.93	4.37	Fd.
22	Teaw khon	*Cratoxylum formosum* Byer subsp. pruniflorum Gogel.	0.47	0.90	0.87	4.31	Fd.
23	Pha sean	*Vitex canescens* Kurz	0.94	0.45	0.80	4.16	Cons.
24	Pootoodoowae	*Nauclea orientalis* Linn.	0.78	0.90	0.73	3.87	-
25	Khae hua moo	*Markhamia stipulata* Seem.	0.94	0.90	0.67	3.82	Fd.
26	Mok mun	*Wrightia tomentosa* Roem. & Schult.	0.47	0.90	0.58	3.67	Hb.
27	Song pha	*Clausena guillauminii* Tanaka	0.47	0.45	0.52	3.37	-

Table 10 (Continued)

NO.	Common name	Sciencetific name	Relative density (%)	Relative Frequency (%)	Relative Dominance (%)	IVI (%)	Utilization
28	Ta ko na	*Diospyros castanea* Fletch.	0.47	0.45	0.52	3.37	Fd.
29	Kra bao glug	*Hydnocarpus ilicifolius* King	2.03	2.26	0.51	3.29	Hb.
30	Po khao	*Sterculia pexa* Pierre	2.19	1.81	0.43	3.19	Hb.
31	Teen nok	*Vitex pinnata* Linn	3.75	1.36	0.41	3.09	-
32	Keaw	*Murraya paniculata* Jack	1.56	2.26	0.36	2.80	Hb.
33	Ngew pa	*Bombax anceps* Pierre	1.41	1.81	0.34	2.77	Fd.
34	Gang kee mod	*Albizia odoratissima* Benth.	0.47	0.45	0.31	2.51	-
35	Pla kwang	*Pterospermum jackianum* Wall.	0.63	0.45	0.27	2.45	-
36	Plubpla	*Microcos tomentosa* Smith	0.31	0.45	0.25	2.42	Fd.
37	Poegeang	*Pterocymbium javanicum* R. Br.	0.47	0.45	0.22	2.31	-
38	Plao yai	*Croton oblongifolius* Roxb.	1.72	1.81	0.21	1.98	Hb.
39	Ta khlo	*Schleichera oleosa* Merr.	0.78	0.45	0.21	1.95	Fd.
40	Kha nang	*Homalium tomentosum* Benth.	0.47	0.90	0.19	1.94	-
41	Nom kway	*Uvaria hahnii* Sincl.	0.31	0.45	0.18	1.88	-
42	Khem khao	*Tarenna collinsae* Craib	0.31	0.45	0.16	1.73	-

Table 10 (Continued)

NO.	Common name	Sciencetific name	Relative density (%)	Relative Frequency (%)	Relative Dominance (%)	IVI (%)	Utilization
43	Tra bag pleakbang	*Lagerstroemia duperreana* Pierre	2.66	1.36	0.16	1.58	-
44	Teawkhao	*Cratoxylum formosum* Byer	1.25	1.36	0.16	1.51	Fd.
45	Kra dai ling	*Bauhinia scandens* Linn. var. horsfieldii K. & S. Larsen	0.47	0.45	0.16	1.44	Hb.
46	Khaw	*Haldina cordifolia* Ridsd	0.31	0.45	0.16	1.39	Hb.
47	Krajae	*Hesperethusa crenulata* Roem	0.31	0.45	0.16	1.37	Hb.
48	Kook	*Lannea coromandelica* Merr.	1.41	1.81	0.05	1.30	Fd.
49	Madook	*Siphonodon celastrineus* Griff.	1.56	1.81	0.00	1.29	Fd.
50	Seaw klua	*Bauhinia glauca* Wall. ex Benth. subsp. tenuiflora K. & S. Larsen	0.78	1.36	0.00	1.22	Hb.
51	Sathorn	*Millettia leucantha* Kurz	1.41	0.90	0.00	1.08	Cons.
52	Kontha	*Harrisonia perforata* Merr.	1.09	0.90	0.00	1.08	Hb
53	Kluaynoi	*Xylopia vielana* Pierre	0.94	0.90	0.00	1.08	-
54	Deangnoi	*Dalbergia cochinchinensis* Pierre	0.63	0.90	0.00	0.92	-
55	Makokpa	*Spondias pinnata* Kurz	0.47	0.45	0.00	0.92	Fd.

Table 10 (Continued)

NO.	Common name	Sciencetific name	Relative density (%)	Relative Frequency (%)	Relative Dominance (%)	IVI (%)	Utilization
56	Plongbaiyai	*Memecylon ovatum* J.E. Smith	0.47	0.45	0.00	0.92	Fd.
57	Kheawmeunpee	*Pterocarpus indicus* Willd.	0.47	0.45	0.00	0.86	Cons.
58	Arang	*Peltophorum dasyrachis* Kurz	0.31	0.45	0.00	0.79	Hb.
59	Sakaesang	*Cananga latifolia* Finet & Gagnep.	0.31	0.45	0.00	0.77	Hb.
60	Mamaodong	*Antidesma bunius* Spreng.	0.31	0.45	0.00	0.77	Hb.
61	Magaykud	*Mallotus philippensis* Muell. Arg	0.31	0.45	0.00	0.77	Hb.
62	Mheemhen	*Litsea glutinosa* C.B. Robinson	0.16	0.45	0.00	0.76	Hb.
63	Mhanmakled	*Canthium parvifolium* Roxb.	0.16	0.45	0.00	0.76	-
64	Mhamthang	*Catunaregam spathulifolia* Tirveng.	0.16	0.45	0.00	0.76	Hb.
65	Yopa	*Morinda coreia* Ham.	0.16	0.45	0.00	0.76	Fd.
66	Mamoungpa	*Mangifera caloneura* Kurz	0.16	0.45	0.00	0.76	Fd.
67	Paeka	*Oroxylum indicum* Vent.	0.16	0.45	0.00	0.61	Fd., Hb.
68	Phukkwanpa	*Phyllanthus elegans* Wall. ex Muell. Arg.	0.16	0.45	0.00	0.61	Fd.
69	Samudyai	*Micromelum glanduliferum* B. Hansen	0.00	0.45	0.00	0.45	Hb.
70	Makratuablong	*Ficus pubigera* Wall.	0.00	0.45	0.00	0.45	Hb.

Table 10 (Continued)

NO.	Common name	Sciencetific name	Relative density (%)	Relative Frequency (%)	Relative Dominance (%)	IVI (%)	Utilization
71	Makhamkrua	*Solanum seaforthianum* Andr.	0.00	0.45	0.00	0.45	Fd., Hb.
72	Plaonumngen	*Croton cascarilloides* Raeusch.	0.00	0.45	0.00	0.45	Hb.
73	kruaplasongdeang	*Ichnocarpus frutescens* R. Br.	0.00	0.45	0.00	0.45	Hb.
		Total	**100.00**	**100.00**	**100.00**	**300.00**	

Note: Fd. = Food, Fu. = Fuel (From dead tree), Cons. = Construction (From dead tree), Hb. = Herb

According to the tables, it can be concluded that Romphothong forest community is characterized as “Mixed Deciduous Forest” which found 73 species of plants, which considered to be diversified of natural forest resources. As a result, most trees were the same species and having similar or ecological characteristic, which was a positive sign for good emission. Trees that had the highest uniqueness value considered to have low quality with less benefit such as Thonglang pa (*Erythrina subumbrans* (Hassk.) Merr), Khoi (*Streblus asper* Lour).

Ecological index to show that the forest’s ecosystem has become more plentiful compared to the time before project came. The details are shown in the following paragraphs

(1) The species diversity; there are 73 species of tree which indicate the large diversity of the species, and it was a significant change since before the community-based watershed and environmental management project took place.

(2) The numbers; the numbers of trees are quite low. In contrast, the volumes of sapling and seedling are quite high, which indicates the higher activities of reforestation or tree-plantings to compensate the woods lost by the logging concession.

(3) The proportions and distributions; It is found that the species of trees are quite similar, throughout the area. Furthermore, it is found that the most dominant species are the most non-productive trees such as Thonglang pa (*Erythrina subumbrans* (Hassk.) Merr) and Khoi (*Streblus asper* Lour). This implies that the reforestation in the Romphothong community forest did not aim for productivity of the woods.

By the previous information, it shows that the Romphotong community forest has quite a better ecosystem compared to before, in which land was covered merely by dried grasses. Furthermore, the ecosystem could be even better in the future, if all the negative factors are controlled.

b) The benefits that can be obtained from the watershed service

Since the headwater forest of the community has become more abundant, as a result, the watershed shall have the valuable impact. The watershed has become a vital source for human well being in the following ways

(1) Direct benefits

(a) The community has perennially enough water for drink and consumptions. It was found that 100% of all households had enough of quality water for drink and consumptions throughout the years (Rural development Information Center, 2005) This outcome is accordance with the article proposed by Murakami (1991). Murakami had proposed the way to increase the water-absorption rate in the soil. He said if increasing the forest area, grassland, and organic matter more, it will help increasing the absorption rate and water-retention in the soil. This will prevent the land from dehydration and promote water retention as well.

(b) The community can benefit more foods from the forest such as wild vegetables, mushrooms, etc. In addition, the people in community can make extra incoming by making brooms out of grasses and sell them for money.

(c) People can benefit from medical herbs. For example, Mr. Sombut Kanlabanjong has become the herbal medic for the village. He had helped others with their sickness by using herbal remedy. Furthermore, he is a herbal-specialist and lecturer for the community school.

(d) People in community can make firewood from dead trees

(e) People in the community can use dead trees to restore buildings such as temples and schools

(f) The community forest can be a nice place for recreational activities, since it has a beautiful waterfall and is abundant with wild animals such as bison, barking deer, wild boar, elephant, jungle fowl and birds. (Romphothong community forest committee. 2005)

As describe above, the benefits described previously can ensure the stability of foods, good health as well as constant access to the natural resources. Also these benefits can reflect upon human well being of the people in community as well.

(2) Indirect benefits

From the study on the important factors and the positive relationship that men have with the ecosystem of the watershed, it can be concluded that the watershed with stable ecosystem will yield benefits to mankind like in the following ways (Millennium Ecosystem Assessment Panel, 2005);

(a) It controls and regulates the important factors that can affect human's quality of life. The factors are controlled for examples; water's quantity, quality, and timing , climate regulation, disease regulation, soil erosion control. In additions, it was found that the forest's area was being washed away by as much 0.04 tons/acres/year, whereas the agricultural was being washed away by as much 20 tons/acres/year (Murakami, 1991)

(b) It gives the supports especially to the nutrient cycling, energy cycling, soil formation and primary production so that these natural processes occur regularly.

As previously stated, the headwater forest restoration has yield back to benefits to the community in both direct ways (which ensure the stability of foods and natural resources accessibility, for productivity of the community) and indirect ways (which constantly enable the balance of ecosystem).

Lastly, it can be summarized as a whole picture of community-based watershed and environment management and the social capitals utilizations as the followings:

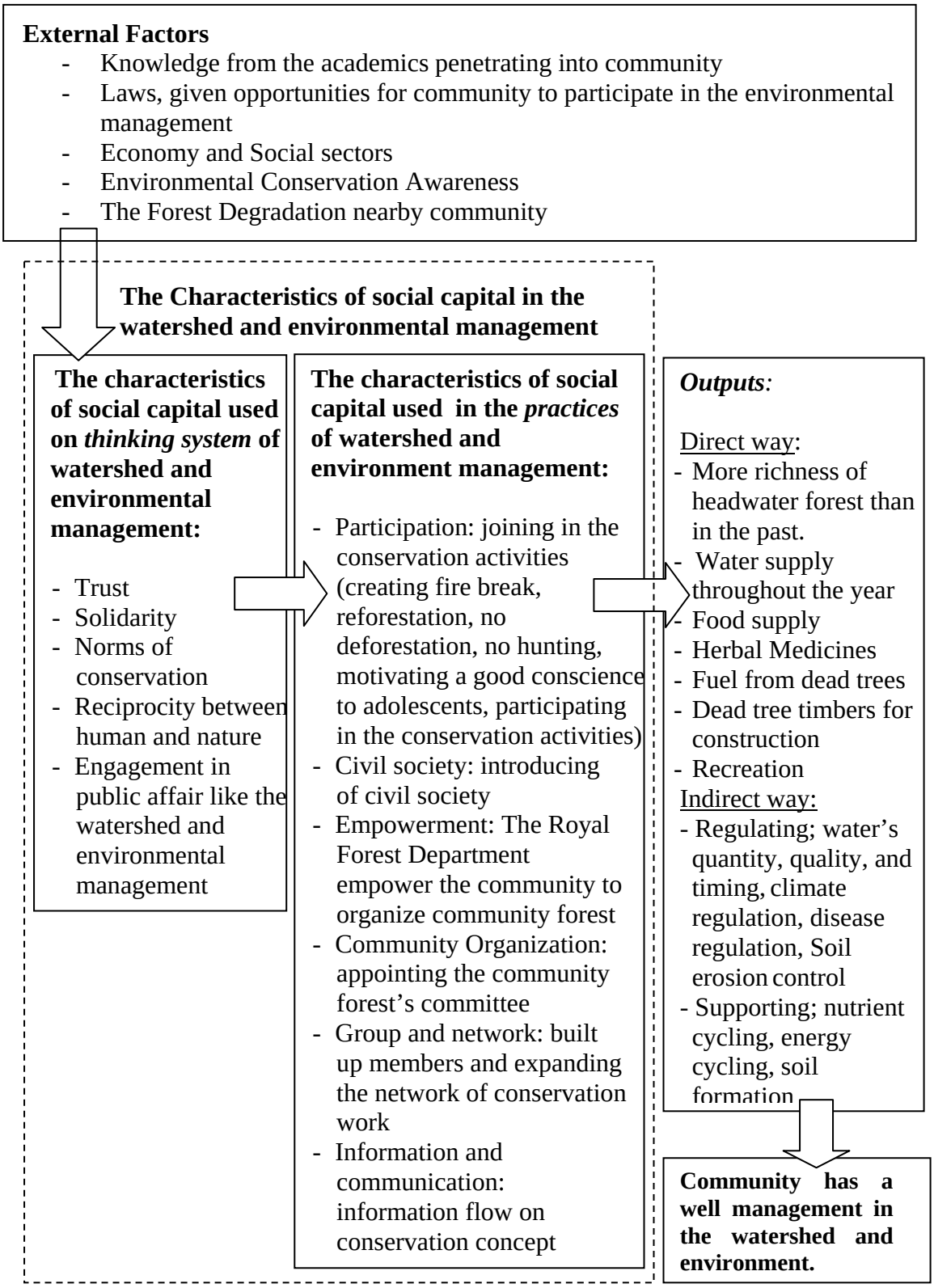

Figure 12 Characteristics of social capital for community-based watershed and environmental management of Romphothong Community, Chachoengsao

From the characteristics of social capitals used to manage the watershed and environment, it is able to be classified the category of social papitals as follows:

Table 11 Social capitals for watershed and environmental management classified by category of Romphothong Community, Chachoengsao

Cognitive Social Capitals	Structural Social Capitals
Trust	Engagement in public affairs
Solidarity	Information and communication
Norms	Empowerment
Reciprocity	Civil society
	Community organization
	Participation
	Groups and networks

1.2 The case study 2: Khaophraphutthabatnoi community

1.2.1 The general conditions of the community

Khaophraphutthabatnoi community is located in two sub-districts which are Tartoom sub-district and SongKon sub-district, Kaengkoi district, Saraburi province. It is considered to be a part of the National Forest and the Buddha's footprint Colony. The area is proclaimed as a forest by Forest Act 1941 and located in sub-watershed of Khaophraphutthabatnoi which in the South of Pasak watershed (Shown in Figure 13)

The land primarily consists of the lower land alternating with mountain ranges. Adjacent to the mountain borders locates farming areas for planting corn, cassavas, green grams, and the sunflowers. Next to it, locate the mango-garden and residential area for the community. The community consists of 4 villages that are surrounding the mountain. The villages are 1) Thungsaeng village, Thatum sub-

district, which has 80 households and 307 residents, 2) Pongkhapamaidaeng village, Thatum sub-district, which has 144 households and 536 residents, 3) Phraphutthabatnoi Village Songkorn sub-district, which has 242 households and 994 residents, and 4) Bosok Village, Songkorn sub-district, which has 64 households and 221 residents. The resident in both 2 sub-district mostly are agriculturists, and they do farming and grow short-live crops. The rest of them are industrial and agricultural employees (Rural development Information Center, 2005)

The part of the land which is in Phraphutthabatnoi mountain, has 2,000 hectare (3,200 rai) with very steep limestone mountain aging around 270 – 290 million years. The mountain consists mostly of very beautiful but complex limestone–peaks but also there exist in the stone's crack paths, some soils for plant's livings. Below at the mountain's base, there are about 15 caves in which mashes and also various species of plants survive.

Geographical characteristics of Phraphutthabatnoi sub-watershed cover 11.14 km^2 with UTM section at the standard WGS 84, horizontal standard No. 711000 E to 715000 E and vertical standard No. 1620000 N to 1624000 N. The watershed represented as polygonal shape. The elevation is between 19 to 261 meters above sea level with the mean slope of 17.76 %. The mountain is inselberg, and most of the area slope towards to the East. The water flow path starts from the West to the East. There are rivers on the north of the watershed. The rivers converge at Pasak river (shown in Table 12 and Figure 14). The rocks are from middle-age of Permian era, and mostly are limestone. Some of the rocks are transformed to marble or dolomite. The rocks age around 270-265 million years. The adjacent area to Phraphutthabatnoi mountain is a plain-land which consisted mostly of clay and stones. Most people live here in the plain-land, and make their living by agriculture.

The Khaophraphutthabatnoi sub-watershed are used largely for rice farming, which is about 7.18 km^2 (or 64.47% of the total area). The areas for rice farming are surrounding the Phraphutthabatnoi mountain. The next area is the mixed deciduous forest, which is about 3.62 km^2(or 32.48% of the total area). The mixed

deciduous forest area is located about the middle of the watershed (shown in Table 13 and Figure 15) The National Park, Wildlife and Plant Conservation Department has reported that most of Klongtakrao watershed area is doesn't have a conservation zone (C) and economic-forest zone (E). The quality of watershed is appointed by the Office of Natural Resources and Environmental Policy and Planning (ONEP), reported that most of Khaophraphutthabatnoi sub-watershed having 7.71 km^2 (or 69.18% of total area) is classified as watershed class 5, which indicates that the area is suitable for rice farming. Furthermore, 2.76 km^2 (or 24.73%of total area) is classified as watershed class 1A which indicates that such area is more suitable for riverhead preservation area (shown in Table 14 and Figure 16)

Table 12 The geographical characteristics of Khaophraphutthabatnoi sub-watershed, Saraburi

Geographical characteristics	**Unit**	**Value**
Watershed area	Square kilometers	11.14
Perimeter	kilometers	13.39
Max. elevation	Meters above mean sea level	261
Min. elevation	Meters above mean sea level	39
Mean elevation	Meters above mean sea level	64
Mean slope	Percent	17.76
Aspect	-	East
Shape	-	Polygonal shape
Stream pattern	-	-
Drainage density: Dd	Kilometer/ Square kilometer	0.40

Table 13 The land utilizations of Khaophraphutthabatnoi sub-watershed, Saraburi

Land Utilizations	Square kilometer	Percent
Rice farm	7.18	64.47
Mixed deciduous forest	3.62	32.48
Poultry farm	0.23	2.02
Industrial area	0.11	1.01
Crop plantations	0.001	0.01
Total	**11.14**	**100**

Table 14 The watershed classification of Khaophraphutthabatnoi sub-watershed, Saraburi

Watershed classification	Square kilometer	Percent	Cumulative Percent
class 1A	2.76	24.73	24.73
class 1B	0.30	2.73	27.46
class 2	0.16	1.40	28.86
class 3	0.00	0.00	28.86
class 4	0.22	1.97	30.83
class 5	7.71	69.17	100.00

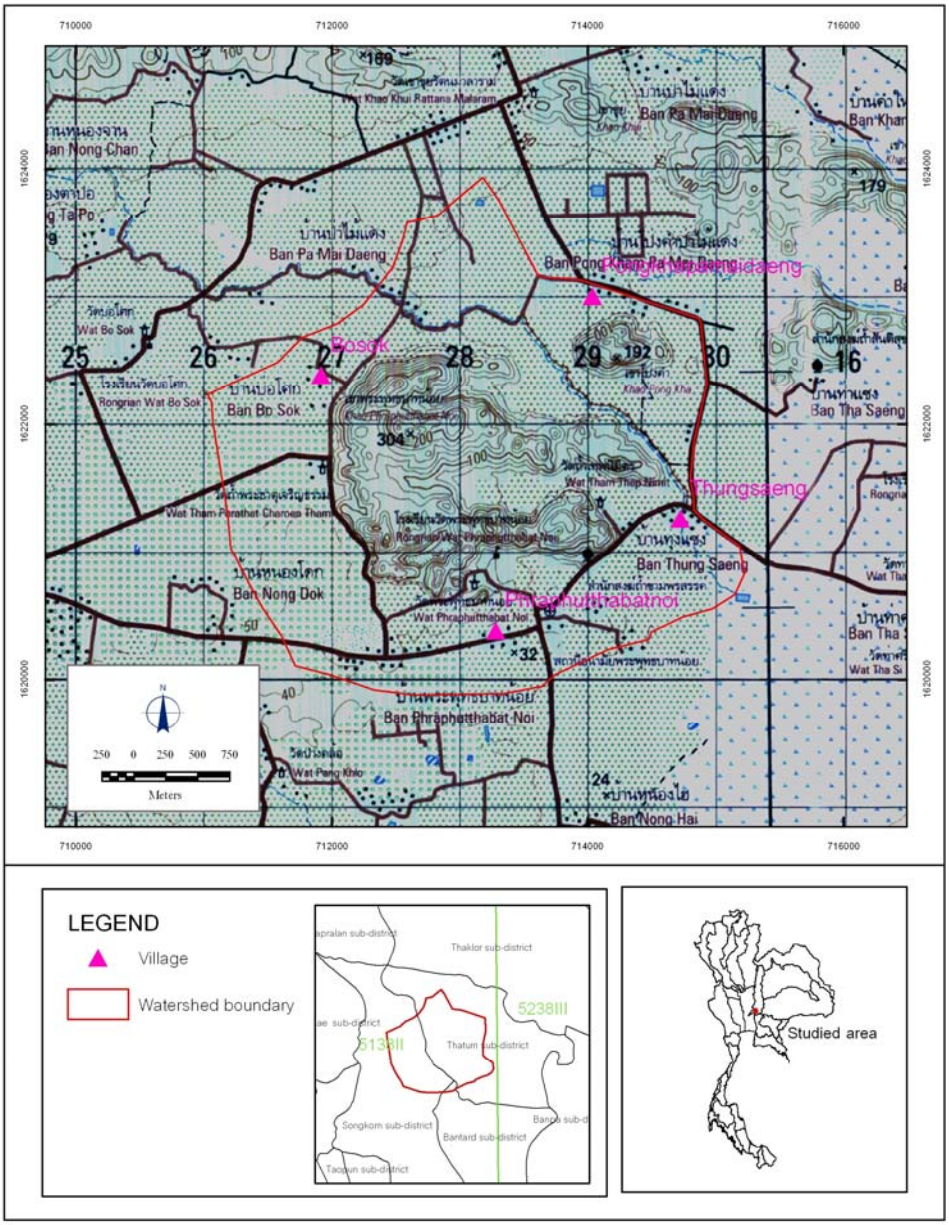

Figure 13 Boundary of Khaophraphutthabatnoi sub-watershed, Saraburi

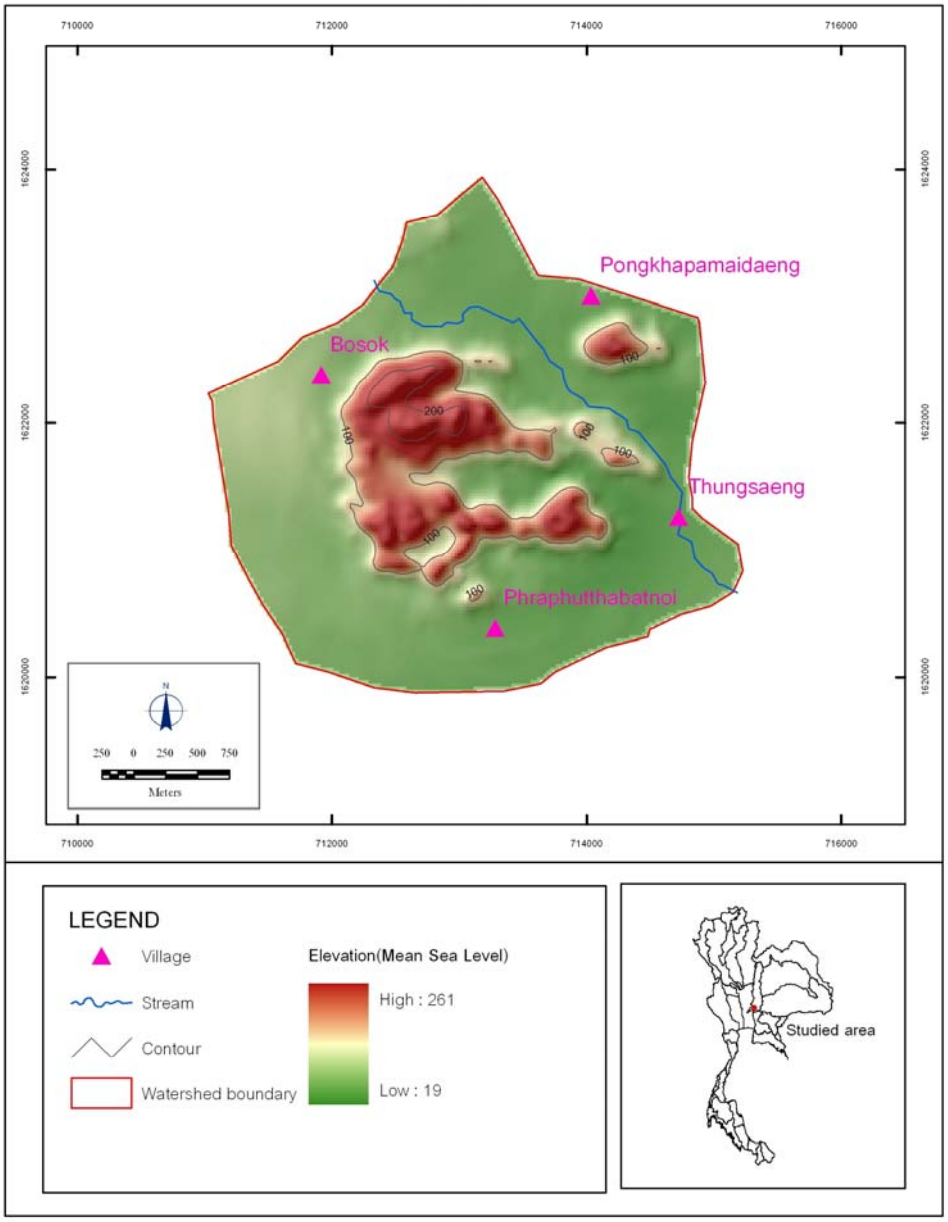

Figure 14 Geographical map of Khaophraphutthabatnoi sub-watershed, Saraburi

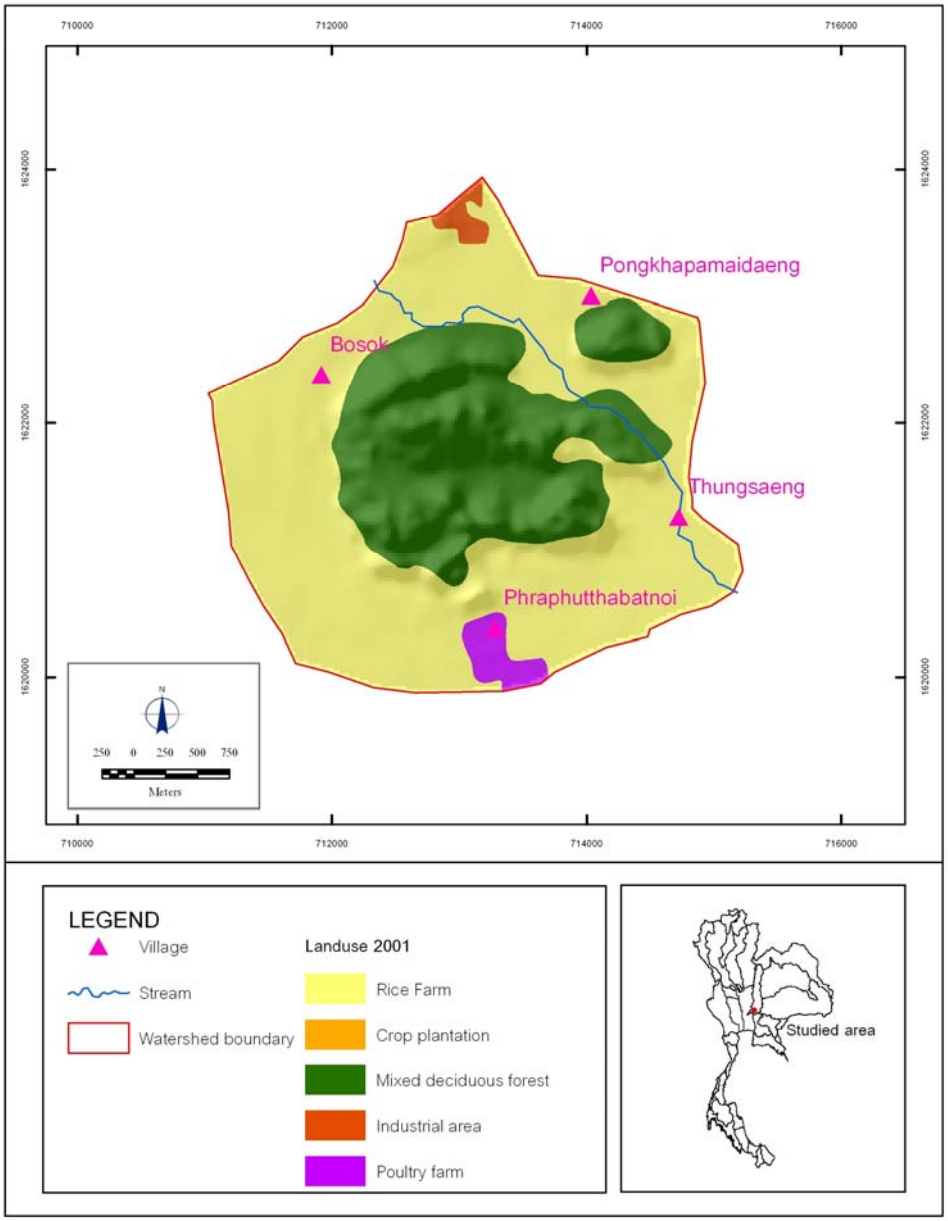

Figure 15 Land use map in 2001 of Khaophraphutthabatnoi sub-watershed, Saraburi

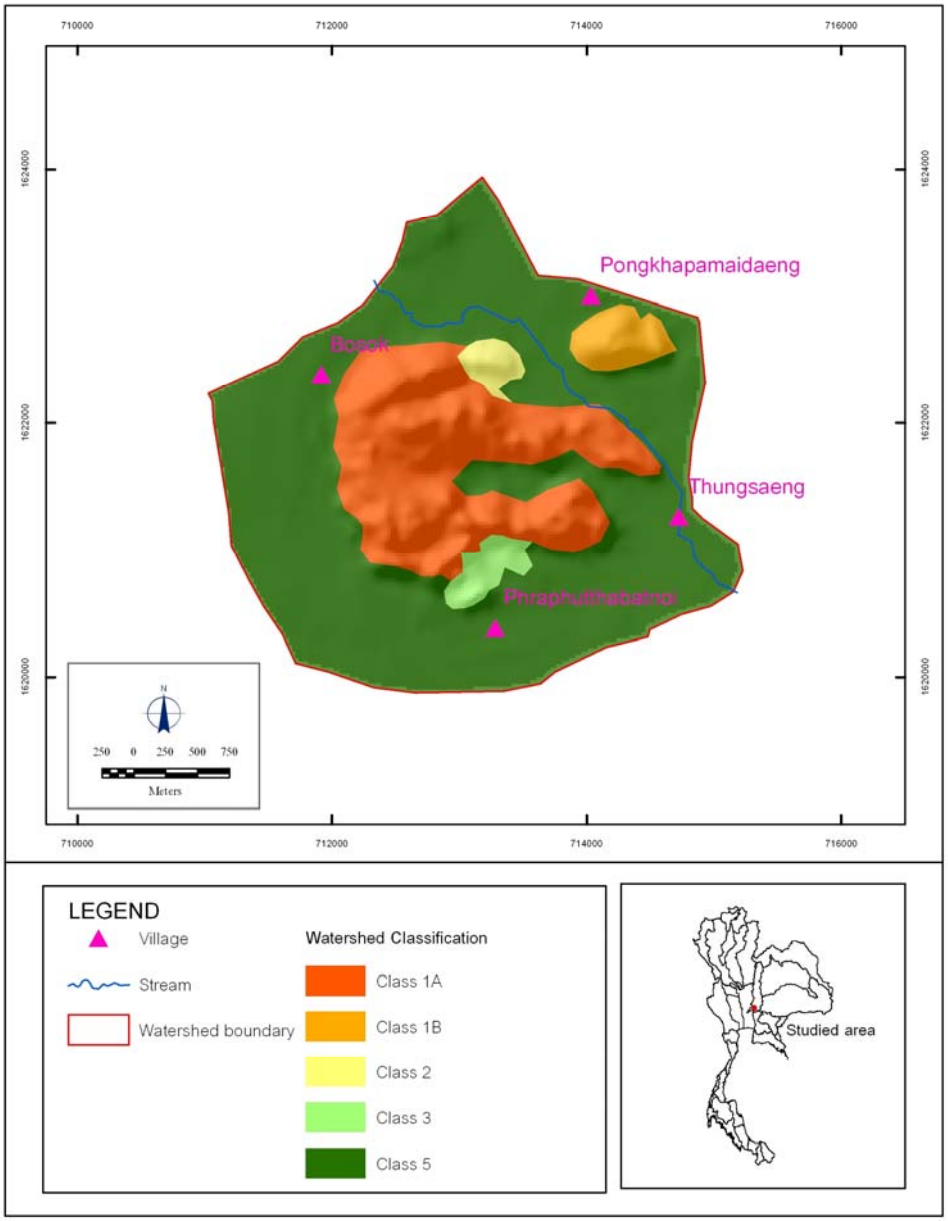

Figure 16 Watershed classification map of Khaophraphutthabatnoi sub-watershed, Saraburi

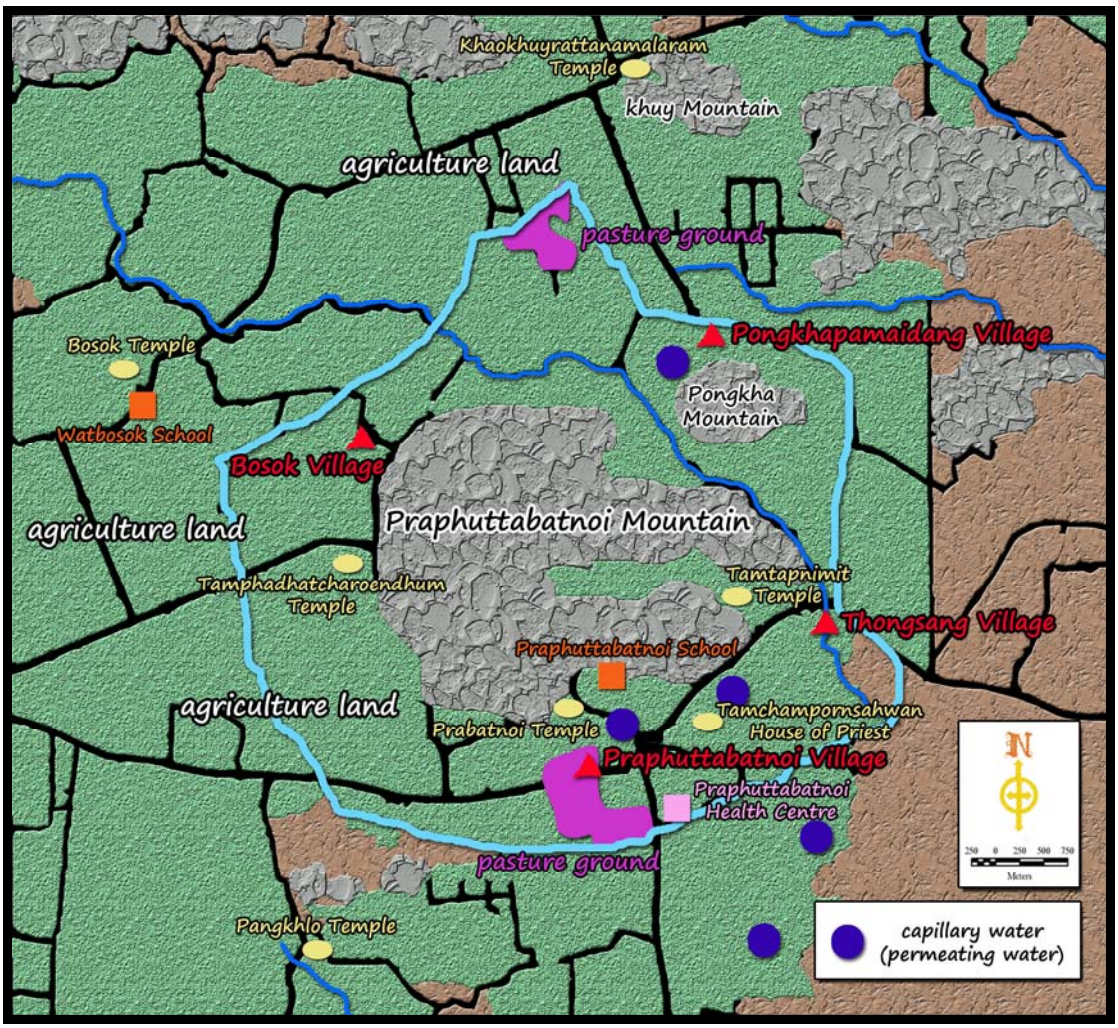

Figure 17 Perspective of Khaophraphutthabatnoi sub-watershed, Saraburi

Figure 18 General condition of Khaophraphutthabatnoi sub-watershed, Saraburi

1.2.2 The history of Khaophraphutthabatnoi community

The study on the social capitals used for managing the watershed and environment was focusing on its history, context, the management process of watershed and environment. The history of this community is divided into three periods. Firstly, the struggle with the mountain concession (Before 1983). Secondly, the struggle of the community to use forest's resources (1984-2001) Lastly, the headwater forest development period (2002 -2006). Each period has details described in the followings;

a) Period 1: The struggle with the mountain concession (Before 1983)

In 1983, the company of cement manufacture had sent a request to the district council for making a concession of Phraphutthabatnoi mountain. At that time Mr. Somkuan Mongnatee (Nhu, the sub-district headman) was the chairperson of the Songkorn district council. Mr. Somkuan called for a meeting 1-day earlier in order to decide whether or not The company of cement manufacture should have the concession. The answer of the meeting turned out to be "No", and the council's opinion was reported to the provincial governor of Saraburi province.

However the company of cement manufacture had offered 10 - 12 million baths (money value at that time) to Mr. Somkuan in order to allow it for the right for concession. But the negotiation failed. Mr. Somkuan believed that if the concession was allowed, the school and temple (which had the Buddha's footprint at the front and had Buddha from Ayutthaya period) would have an adverse effect as well as other villages around this mountain would receive an impact on environmental pollutions. Thus the decision made by Mr.Somkuan was the first attempt and an inspiration for the community to protect this limestone mountain.

b) Period 2: The struggle with the community to use forest's resources (1984-2001)

In addition to preventing private companies from having the concession, the community had also struggled with its own people who tried to grab the resources for their own. This was due to the fact that those people, who lived around the mountain border still made their livings by collecting from the forest, especially bringing down the gorgeous trees and sell them for money, for example, Prongsaraburi *(Cycas tansachana),* ChunPha *(Dracaena loureiri* Gagnep.), Chundeang *(Dracaena sp.)* They also disturbed the ecosystem of limestone. Furthermore, people had destructive relationship with the natural resources such as; chopping down trees for the fruits, burning the whole forest just for the honey, etc.

The case example of Mr. Saart Janpraphom who used to be a forest collector, had become an important turning-point for community to protect this mountain. Before, he would begin his daily work by digging out the trees (Prongsaraburi *(Cycas tansachana),* ChunPha *(Dracaena loureiri* Gagnep.), Chundeang *(Dracaena sp.))* and sold them at the goft-course or hotels. He told about the day when he had to decide to give up this job. It was when he was planning to bring down the giant Prongsaraburi *(Cycas tansachana)* and sell it at 1 million baths. But the buyer had beaten the selling price down to 800,000 baths. Finally the buyer still did not setup for the deal until he could come to see the tree by himself. However, an unexpected thing happened. The accident had coursed to selling deal to be over. And people still baffled about the sacred power of “Lhuang Phor-Yai” (the Buddha image in the cave under the Phraphutthabatnoi mountain) that caused this accident. Therefore that was a big step in turning the people to caring and protecting the natural resources.

c) Period 2: The headwater forest development period (2002 - 2006)

Until the year of 2002, the community received many sustainable development policies from various studies. The forest officers and teachers had helped the community by proving them on how to protect and manage

the forest. And in the later time, the project to manage the headwater forest had been established.

1.2.3 The characteristics of social capitals for watershed and environment management

Due to the fact that Phraphutthabatnoi mountain is located at the middle of the 4 villages of 2 sub-districts of Kaengkoi district, in general, it is hard to have all the people in each village to participate in the same public activity. However, people for these villages were eager to help or participate in the development activity. This was due to the fact that the four villages had been established very long before, and people from each village are close relatives to each others. Thus the social capital which was the key to manage the watershed and environment of this community at this time, just as all leaders of the management project agreed, was the solidarity

The very first thing of the headwater forest management project was to seek for cooperation. In case of Mr. Saard Janphom, he finally turned himself to be the group leader for the project. Therefore another social capital for this community is engagement in public affaire as all agreed the group leaders to be a tool to make the community succeed.

In additions, the group leaders had proceeded to widely teach and educate the community's members. In doing so, they had setup meetings for among the group leaders and between the group leaders and people in the 4 villages in order to share opinions and other information. Also the community was able to receive the cooperation from many organizations such as the district forest officer, schools, sub-district councils as well as the private sector in community forest administration. Thus the social capital used for the headwater forest management was civil society as all agreed by the leaders that it would be a tool for the success of the community forest.

The Khaophraphutthabatnoi community forest project was informally established in 1995 when the abbot Prawate Waramungkalo and the

district council Somkuan Mongnatee were still alive. These two persons was the leader of religion and community. There was the time when the company of cement manufacture was rejected by Mr. Somkuan from having the concession (at that time, the surrounding area had been under concessions already). This event had created the trend for protecting the limestone mountain. Also there was a story about Mr. Suraphong Sodanin, the principle of Watphraphutthabatnoi School Mitrapab 69. He was the academic leader for protecting the forest. These three persons had guided the people and the youths to think about the benefits of forest and how to repay gratitude to it. Also the abbot Prawate Waramungkalo was an herbal specialist. He helped other with their sickness by using medicines made from herb that he collected from Phraphutthabatnoi mountain. He also taught his people about how important Phraphutthabatnoi mountain was, as a source for water, air and food for the people. As a consequence from what these three persons had done, the headwater forest management project had set forth for its journey. And it was not until 2002 the villagers had agreed to formally proceed the development plan. The social capital at this stage was the norm to conserve the forest.

For surveying the area in order to proceed the headwater forest management plan, the crews had been surprised by the distinctiveness of the forest community such as Prongsaraburi *(Cycas tansachana),* ChunPha *(Dracaena loureiri Gagnep.),* Chundeang *(Dracaena sp.)* Mayompha *(Glochidion coccineun* Muell. Arg.), Serow *(Capricornis sumtraensis)* threatened species, Limestone Wren Babbler (*Napothera crispifrons calcicola)* endemic species, beautiful caves, and isopods: Mang Kra darn tum Mongnatee *(Stensallus mongnatei* sp.nov.), the zoologists confirmed that this animal is of new distinct species and only exist in this mountain. Therefore, this has inspired the villagers to love and protect the animals as well as the natural resources as long as possible. Another social capital used to protect and manage the headwater forest is “trust and adherences to norm”, as all agreed by the group leaders.

One activity in developing the headwater forest management project is that there had been an extensive study on limestone. They used the schools

to be the place for providing the knowledge of limestone ecosystem to people in order to keep the community forest standing as long as possible. The community also received supports from the local forest department. For example, the local forest department had given them with knowledge and administration supports. The social capital used for this time was information/communication and group/network, as firmly agreed by leaders of project.

The policy of the community forest had been practiced more extensively. For example, in case of Mr. Saard and others, who had converted themselves to be forest protectors. They held on to the very true concept of community forest, which is “nature for human, human for nature”. Eventually, the watershed had literally become the blood vessel of the people in the community. The social capital used in this case was participation and reciprocity, as all agreed by the leaders of project.

The headwater forest management project had integrated many institution, such as family, school, religion. Also Mr. Boonmee Suppakhun (forest officer) had helped people using his advises. He helped people to understand many of the concepts better. For example, people now understand that to manage headwater forest and environment means to take care of the ecosystem in Phraphutthabatnoi mountain. This is due to the fact that the limestone act as water-provider, by which the water from the rain passes down through the crack-paths in the stone, accumulated, overflowed to the mountain’s border, and finally become the water source for the community. People had a better understanding of the two concepts “Human for nature, nature for human” and “social capitals used for managing community-based watershed and environment”, which mean “the capitals community used for developing and protecting the headwater forest”.

Finally, people in the community were authorized by the Royal Forest Department to formally establish an organization called the “Khaophraphutthabatnoi community Forest Center” which had the community committees to cooperate with people, and made the concept to become more tangible.

The concept they were holding on to were “nature for human, human for nature” and “water is life”. Thus the social capital used in this case is “empowerment” and “community organization”, as all agreed by the leaders of project.

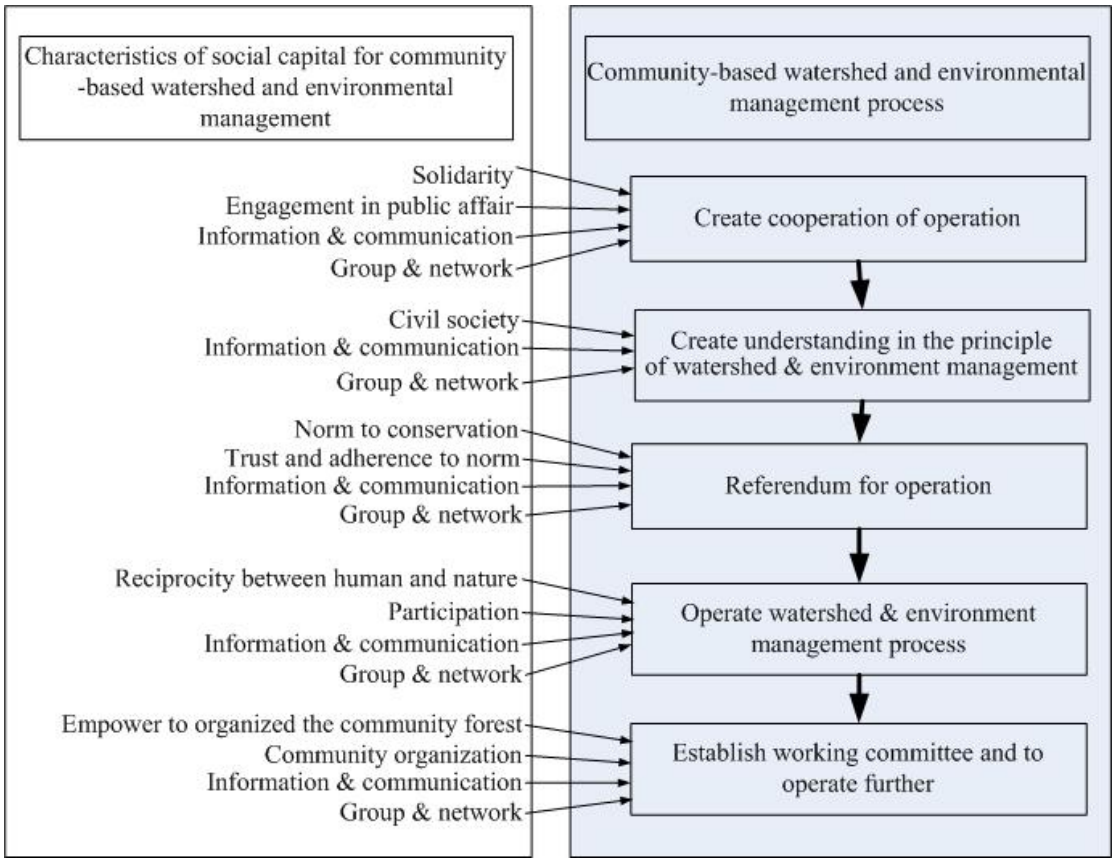

Figure 19 Characteristics of social capital used to manage the headwater forest of Khaophraphutthabatnoi community, Saraburi

1.2.4 The results obtained by using social capital to manage the watershed and environment

The obtained results had reflected upon the characteristics of ecological system of the headwater forest of community as well as other direct or indirect benefits of the forest’s fertility that the community received. The results can be described in the followings

a) The characteristic of ecological system of "the headwater forest"

The limestone surrounding Phraphutthabatnoi mountain had been destroyed and wiped out due to the concessions. However, some limestone still left in Phraphutthabatnoi mountain, which had survived from concession. Phraphutthabatnoi mountain also still has the forest that lives accordingly to the suitable environments. It is a mixed deciduous forest, consisting of the species of plants resistant to heat and dehydration.

According to the data analysis, by conducting on-site survey of 0.33% of total area (10 sample plots), it was found that there were 45 species of trees. There were the other important ecological aspects in the followings;

(1) The wood volume; the wood volume of level 1 (TQ1.1 and 1.2) was equal to 7.7651 m^3/hectare. The wood volume of level 2 was equal to 3.256 m^3/hectare. The wood volume of level 3 was equal to 2.2150 m^3/hectare. Thus the total wood volume was equal to 13.2363 m^3/hectare (shown in Table 15)

(2) The relative density; It was found that there were 45 species of trees. The trees (DBH: 10-30 cm.) had the density equal to 128 trees/hectare. The trees (DBH: 30-60 cm.) had the density equal to 14 trees /hectare. The sapling had the density equal to 1,640 trees /hectare. The seedlings had the density equal to 12,750 trees /hectare and Bamboos had the density 95 trunk/hectare. (shown in Table 16) In addition to the species that had maximum density was Ngewpa (*Bombax anceps* Pierre), which was equal to 11.97 %. The next succeeding species were Mayompha (*Glochidion coccineum* Muell. Arg) with 7.26% of density, Kook (*Lannea coromandelica* Merr.) had 6.41% of density, Mokmun (*Wrightia tomentosa* Roem. & Schult.), and Thonglhangpa *(Erythrina subumbrans* (Hassk.) Merr) had 5.98 % of density, Chundeang (*Dracaena sp.*) had 5.13% of density, respectively. (shown in Table 17)

(3) The relative frequency; the more frequency value indicated the more consistent distribution over the area. The species that had highest frequency

was Ngewpa (*Bombax anceps* Pierre), and Mayompha (*Glochidion coccineum* Muell. Arg) which has 5.94% of frequency, The next succeeding species were, Kook (*Lannea coromandelica* Merr.), Chundeang (*Dracaena sp.*), and Pradoo *(Pterocarpus macrocarpus* Kurz), with 4.95 % of frequency, (shown in table 13)

(4) The relative dominance; this value is obtained from the cross-sectional area of the trees. And it turned out to be that the species that had the highest dominance value was Ngewpa (*Bombax anceps* Pierre) with 22.63%. The next succeeding 4 species were Kook (*Lannea coromandelica* Merr.) with 9.55%. Pradoo *(Pterocarpus macrocarpus* Kurz) with 6.90%, ChunPha *(Dracaena loureiri* Gagnep.) with 5.30% and Mokmun (*Wrightia tomentosa* Roem. & Schult.) with 4.55 % (shown in Table 17)

(5) The importance value index (IVI); The species that had the highest importance value index (IVI) was Ngewpa (*Bombax anceps* Pierre) with 40.54 %. The next succeeding 4 species were Kook (*Lannea coromandelica* Merr.) with 20.91%, Mayompha (*Glochidion coccineum* Muell. Arg) with 16.76%, Pradoo *(Pterocarpus macrocarpus* Kurz) with 15.70 %, Mokmun (*Wrightia tomentosa* Roem. & Schult.) with 14.49 % (shown in Table 17) As can be seen that Ngewpa (*Bombax anceps* Pierre) has the highest importance value index, it implies the success in dominating the area by Ngewpa (*Bombax anceps* Pierre).

Table 15 Average wood volume classified by saw timber quality of Khaophraphutthabatnoi community forest, Saraburi

Forest	average wood volume (m^3/ hectare)			
	Level 1: saw timber quality 1.1 and 1.2	**Level 2: saw timber quality 2**	**Level 3: saw timber quality 1.3 and 3**	**Total**
The forest of Khaophraphutthabatnoi community	7.7651	3.2562	2.2150	13.2363

Table 16 Tree density of trees, sapling, seedling and bamboo of Khaophraphutthabatnoi community forest, Saraburi

Forest	Tree density (tree/hectare)						
	classified of trees: dbh (cm)				sapling	seedling	Bamboo (trunk/hectare)
	10-30	30-60	60	Total			
The forest of Khaophraphuttha-batnoi community	128	14	-	142	1640	12750	95

Table 17 Relative density, relative frequency, relative dominance, importance value index and utilization of trees of Khaophraphutthabatnoi community forest, Saraburi

NO.	Common name	Sciencetific name	Relative density (%)	Relative Frequency (%)	Relative Dominance (%)	IVI (%)	Utilization
1	Ngewpa	*Bombax anceps* Pierre	11.97	5.94	22.63	40.54	Fd.
2	Kook	*Lannea coromandelica* Merr.	6.41	4.95	9.55	20.91	Fd.
3	Mayompha	*Glochidion coccineum* Muell. Arg	7.26	5.94	3.55	16.76	Fd.
4	Pradoo	*Pterocarpus macrocarpus* Kurz	3.85	4.95	6.90	15.70	Cons.
5	Mokmun	*Wrightia tomentosa* Roem. & Schult.	5.98	3.96	4.55	14.49	Hb.
6	Chundeang	*Dracaena sp.*	5.13	4.95	3.72	13.80	Hb.
7	Thonglhangpa	*Erythrina subumbrans* (Hassk.) Merr	5.98	2.97	4.02	12.97	-
8	ChunPha	*Dracaena loureiri* Gagnep.	2.99	3.96	5.30	12.25	Hb.
9	Khaephoo	*Barnettia kerrii* Santisuk	2.99	4.95	4.15	12.10	-
10	Seawkrua	*Bauhinia glauca* Wall. ex Benth	4.70	3.96	0.98	9.65	-
11	Prongkhao	*Cycas pectinata* Griff.	3.42	2.97	2.05	8.44	Hb.
12	Makok	*Spondias pinnata* (L.F.) Kurz	2.56	2.97	2.47	8.01	Fd.
13	Makluapa	*Diospyros montana* Roxb.	2.14	1.98	2.80	6.92	-
14	Teennok	*Vitex pinnata* Linn.	2.14	0.99	3.79	6.91	-

Table 17 (Continued)

NO.	Common name	Sciencetific name	Relative density (%)	Relative Frequency (%)	Relative Dominance (%)	IVI (%)	Utilization
15	Seawyai	*Bauhinia malabarica* Roxb.	2.14	1.98	1.94	6.06	Hb.
16	Khaw	*Haldina cordifolia* Ridsd.	1.28	1.98	2.50	5.76	Hb.
17	Mokluang	*Holarrhena antidysenterica* Wall.	2.99	1.98	0.62	5.59	Hb.
18	Payoong	*Dalbergia cochinchinensis* Pierre	2.56	1.98	0.68	5.23	-
19	Krapee	*Millettia brandisiana* Kurz	1.71	0.99	2.22	4.92	-
20	Edum	*Doispyros vaviegata*	1.71	1.98	0.86	4.55	Hb.
21	Pogenthao	*Grewia elatostemoides* Coll. et Hemsl	1.28	0.99	2.04	4.31	-
22	Khaehin	*Stereospermum colais* (Buch.- Ham.ex Dillwyn) Mabb.	1.28	1.98	0.75	4.01	-
23	Poegeng	*Pterocymbium javanicum* R. Br.	0.43	0.99	2.46	3.88	-
24	Trabagpluakbang	*Lagerstroemia duperreana* Pierre	1.28	1.98	0.59	3.85	-
25	Khaehuamoo	*Markhamia stipulata* Seem.	1.28	1.98	0.44	3.70	Fd.
26	Phasean	*Vitex canescens* Kurz	1.71	0.99	0.89	3.59	Cons.
27	Somkob	*Hymenodictyon excelsum* (Roxb.)Wall.	0.85	1.98	0.74	3.57	Hb.

Table 17 (Continued)

NO.	Common name	Sciencetific name	Relative density (%)	Relative Frequency (%)	Relative Dominance (%)	IVI (%)	Utilization
28	Maklamong	*Afzelia xylocarpa* Craib	0.85	0.99	1.45	3.29	Fd.
29	Sakaesang	*Cananga latifolia* Finet & Gagnep.	1.28	1.98	0.00	3.26	Hb.
30	khoi	*Streblus asper* Lour.	0.85	0.99	1.34	3.18	Hb., Fd.
31	Kumbok	*Crateva religiosa* Ham.	0.85	1.98	0.00	2.83	Hb.
32	Samudyai	*Micromelum glanduliferum* B. Hansen	0.85	1.98	0.00	2.83	Hb.
33	Prayamullek	*Strychnos lucida* R.Br	0.85	0.99	0.98	2.83	Hb.
34	Kheeai	*Terminalia nigrovenulosa* Pierre ex Laness.	0.85	0.99	0.89	2.73	Hb.
35	Chanhon	*Dalbergia nigrescens* Korz	0.85	0.99	0.74	2.58	Hb.
36	Chang	*Maerua siamensis* Pax	0.43	1.98	0.00	2.41	Fd.
37	Manawphee	*Atalantia monophylla* Correa	0.43	1.98	0.00	2.41	-
38	Yopa	*Morinda coreia* Ham.	0.85	0.99	0.46	2.31	Fd.
39	Madook	*Siphonodon celastrineus* Griff.	0.43	0.99	0.51	1.92	Fd.
40	Prongsaraburi	*Cycas Tansachana*	0.43	0.99	0.42	1.84	-
41	Yangdong	*Polyalthia obtusa* Craib	0.43	0.99	0.00	1.42	Cons.

Table 17 (Continued)

NO.	Common name	Sciencetific name	Relative density (%)	Relative Frequency (%)	Relative Dominance (%)	IVI (%)	Utilization
42	Sabsua	*Eupatorium odoratum* Linn.	0.43	0.99	0.00	1.42	Hb.
43	Khempa	*Greenia wightiana* Wall. ex Wight & Arn.	0.43	0.99	0.00	1.42	Hb.
44	Makhakrua	*Bridelia stipularis* (L.) BL.	0.43	0.99	0.00	1.42	Fd.
45	Makuk	*Spondias bipinnata* Airy Shaw & Forman.	0.43	0.99	0.00	1.42	Hb.
		Total	**100.00**	**100.00**	**100.00**	**300.00**	

Note: Fd. = Food, Fu. = Fuel (From dead tree), Cons. = Construction (From dead tree), Hb. = Herb

According to the tables, it can be concluded that Khaophraphutthabatnoi forest community is characterized as the forest is covered with the species of plants resistant to sunlight and dehydration. The trees are distributed sporadically over the areas and on the highlands. The areas that trees and plants can be found mostly, are the mountain's foot, valley, mountain's base, because they provided cohesive soils to those plants and trees. Usually the species of trees that grow very well on the mountaintop are the species which can stand firm excellently against the drought condition.

Ecological index shows that the forest's ecosystem has become more plentiful compared to the time before project came. The details are shown in the following paragraphs

(1) Species diversity; there are 45 species of tree. This indicates the large diversity as considering to the limestone condition which is not mercy to most species of trees, only some can survive.

(2) Numbers: due to the general characteristics of the area, which consists primarily of highland limestone very a great slope, the plants and trees found it hard to adhere themselves to those soil. Thus they usually grow very well in the mountain' base and valley, which is matched with the conditions and geophysical properties.

(3) Proportions and distributions; the ratio of trees to the sapling and seedling is quite small. If considering the succession of the forest, this small ratio indicates high quality of ecosystem. If drawing a chart according to the numbers of tree, it will resemble the shape of pyramid, which the fewer numbers of tree will be on top of the pyramid, and larger numbers of sapling and seedling will be at the base of pyramid. This pyramid implies that the succession of this forest very well.

From the above information, it shows that the Khaophraphutthabatnoi community forest is considerably good.

b) The benefits that can be obtained from the watershed service

Since the headwater forest of the community has become more abundant, as a result, the watershed shall have the valuable impact. The watershed has become a vital source for human well being in the following ways

(1) Direct benefits

(a) The community has perennially enough water for drinking and consumptions from more than 7 capillary-water sources. The community has perennially enough water for drink and consumptions from more than 7 capillary-water sources. Also the villagers have built 3 wells and constructed 1.5" pipe system to supply 50 households (186 residents). It was found that the total amount of water used is about 13,479,100 liters. If we assume that 1 m^3 of water costs 4 baths, it would be save about 53,916.4 baths/year, or 1,078.3 baths/year/household. Furthermore, people have made extra money to their earnings by producing 2 brand names of drinking-bottled water. For example Gumnun Nhu water makes about 132,000 baths/year to its owner. Tonprong Water which is produced by the cooperative group of people in Thungsaeng Village. Besides, temples, schools, police stations, and hospitals have also gained benefits from these capillary-water sources as well

(b) The abundant of the forest in this limestone mountain, enables a various endemic species to live; such as mountain goats, wild monkeys, pythons, hamadryads, squirrels, small gongs, rabbits, and other species of birds. In addition, there have been a report that Mangkranum Mongnatee *(Stenasellus mongnatei sp. nov.)* were found first time in here.

(c) The community can also benefit more foods from the forest, such as wild vegetables, mushrooms, etc. In addition, the people in community can make an extra income by making brooms out of grasses and sell them for money.

(d) The community can benefit from medical herbs. For example, abbot Prawate Waramungkalo who had helped others with their sickness by using herbal remedy. Also they can benefit some foods from the forest such as bamboo shoot.

As describe above, the benefits described previously can ensure the stability of foods, health as well as good access to the natural resources. Also these benefits can reflect upon human well being of the people in community as well.

(2) Indirect benefits

From the study on the important factors and the positive relationship that men have with the ecosystem of the watershed, it can be concluded that the watershed with stable ecosystem will yield benefits to mankind like in the following ways (Millennium Ecosystem Assessment, 2005);

(a) It controls and regulates the important factors that can affect human's quality of life. The factors are controlled for examples; water's quantity, quality and timing, climate regulation, disease regulation, soil erosion control. In additions, it was found that the forest's area was being washed away by as much 0.04 tons/acres/year, whereas the agricultural was being washed away by as much 20 tons/acres/year (Murakami, 1991)

(b) It gives the supports especially to the nutrient cycling, energy cycling, soil formation and primary production so that these natural processes occur regularly.

As previously stated, the headwater forest restoration has yield back to benefits to the community in both direct ways (which ensure the stability of foods and natural resources accessibility, for productivity of the community) and indirect ways (which constantly enable the balance of ecosystem).

Finally, it can be summarized as a whole picture of community-based watershed and environment management and the social capitals utilizations as the followings:

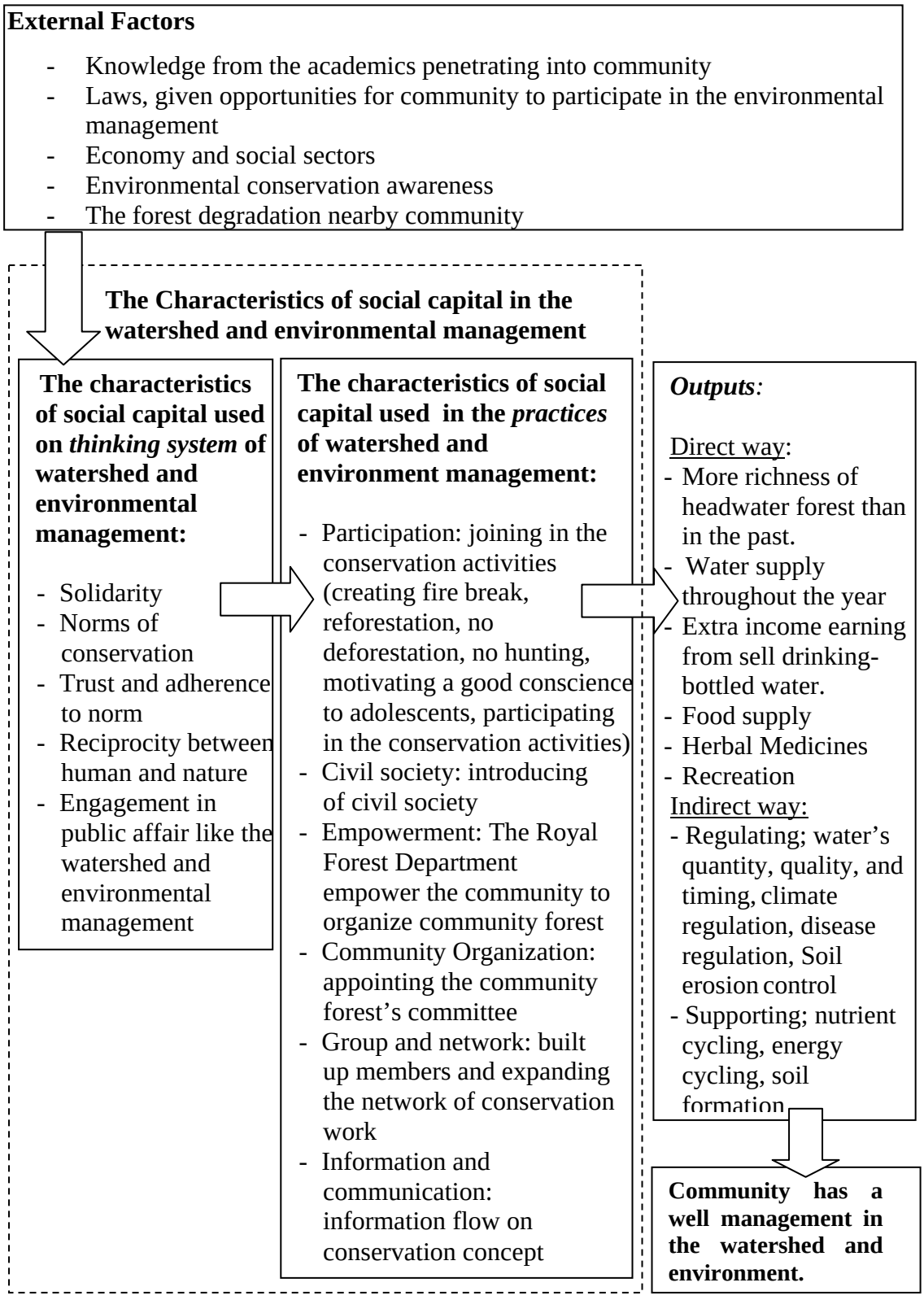

Figure 20 Characteristics of social capital for community-based watershed and environmental management of Khaophraphutthabatnoi community, Saraburi

From the characteristics of social capitals used for managing the watershed and environment, it is able to be classified the category of social capitals as follows:

Table 18 Social capitals for watershed and environmental management classified by category of Khaophraphutthabatnoi community, Saraburi

Cognitive Social Capitals	Structural Social Capitals
Solidarity	Engagement in public affairs
Trust and adherence to norms	Civil society
Norms	Empowerment
Reciprocity	Participation
	Community organization
	Groups and networks
	Information and communication

From the study, the socials capitals used for the watershed and environmental management of these 2 communities can be summarized as the followings:

1. The social capitals use for the Thinking System for the watershed and environmental management are (1) The trust, (2) The solidarity, (3) The norms of conservation, (4) The trust and adherence to norms, (5) The reciprocity between human and nature/environment and (6) The engagement in management of watershed and environment

2. The social capitals used for the Practicing System for the watershed and environmental management are (1) The participation on watershed and environmental management, (2) The civil society, (3) The empowerment to organize watershed and environmental management, (4) The community organization to transform the conceptual development plan into the tangible one, (5) The group and network and (6) The information and communication.

2. The management process (dynamic) of social capitals for community-based watershed and environment management

2.1 The management process (dynamic) of social capitals for community-based watershed and environment management of Romphothong community

For acquiring the social capitals used for the management watershed and environment of Romphothong community, we will see that the chronicle order of the social capitals acquiring can reflect upon the management process (dynamic) of the social capitals as in the following paragraphs.

Romphothong community was born to resolve the problems due to the stresses form outside, especially by the government. The people were living without trust, and live separately in groups. Therefore, it was hard to have all these people to participate in order to solve the public affairs. According to the study, Trust and Solidarity are the major forces to workout problems in the community. This can be seen as in the very first activities of the development project. Leaders of each group played the key role to bring together the participations. This is confirming to the concept about civic engagement by Putnum (2002). He explained that civic engagement is about realizing the duty which each individual should have for their community. The determination the serve the public should be in everyone's mind. Civic engagement will be a powerful tool, if it is implanted deeply into society in which the people are firm to help each other.

Thus, if the community is built upon trust and harmony which are the keys to the engagement in public affaires, then the civil society will happen, in order for the community to embark on the management plan for the watershed and the environment which are of the urgent issues and can impact greatly everyday livings. After that the Norm of conservation will receive good feedbacks, and makes ways for Participation and Reciprocity in order to be able to effectively and permanently utilize the natural resources.

Group/Network and Information/Communication were the social capitals used at the beginning of the watershed and environment management project. When the community embarked on the project as well as convinced people to protect the natural resources, the community will gain trust from the government. Thus the Empowerment to protect the resources can begin, leading to the beginning of the community organization (shown in Figure 21represents a system prototype of mobilization of social capital in stainable management in the communication-based watershed.)

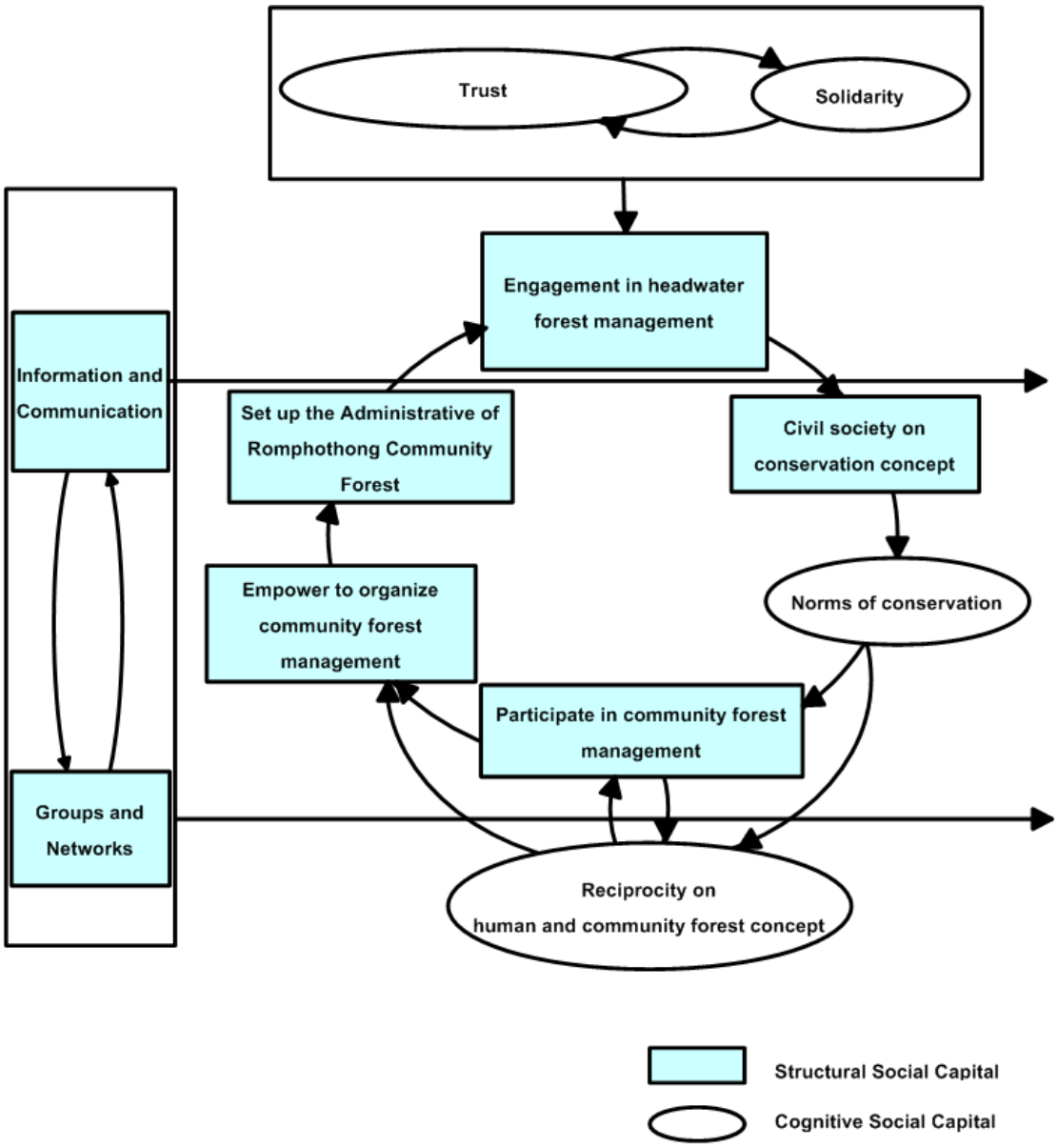

Figure 21 The management process (dynamic) of social capitals for community-based watershed and environmental management of Romphothong Community

2.2 The management process (dynamic) of social capitals for community-based watershed and environment management of Khaophraphutthabatnoi community

For acquiring the social capitals used for the managing watershed and environment of Khaophraphutthabatnoi community, we will see that the chronicle

order of the social capitals acquiring can reflect upon the dynamic of the social capitals as in the following paragraphs.

Due to the fact that it is hard to have the people from 4 villages to participate in the same public activity, people for these villages were eager to help or participate in the environmental management activity. This was due to the fact that the four villages had been established very long before, and people from each village are close relatives to each others. This can be seen as this community is solidarity. Solidarity is the major forces to build engagement in public affair. So, engagement in public affair played the key role to bring together the participations. This is confirming to the concept about civic engagement by Putnum (2002). He explained that civic engagement is about realizing the duty which each individual should have for their community. The determination to serve the public should be in everyone's mind. Civic engagement will be a powerful tool, if it is implanted deeply in society in which the people are firm to help each other.

Thus if the community is built upon engagement in public affaires which are the keys to communicate in conservation concept, then the civil society will happen, in order for the community to embark on the management plan for the watershed and the environment which are of the urgent issues and can impact greatly everyday livings. After that the Norm of conservation will receive good feedbacks, which mean the people trust and adherence to norm of conservation. So, that makes ways for Participation and Reciprocity in order to be able to effectively and permanently utilize the natural resources.

Group/Network and Information/Communication were the social capitals used at the beginning of the watershed and environment management project. When the community embarked on the project as well as convinced people to protect the natural resources, the community will gain trust from the government. Thus the Empowerment to protect the resources can begin, leading to the beginning of the community organization (shown in Figure 22)

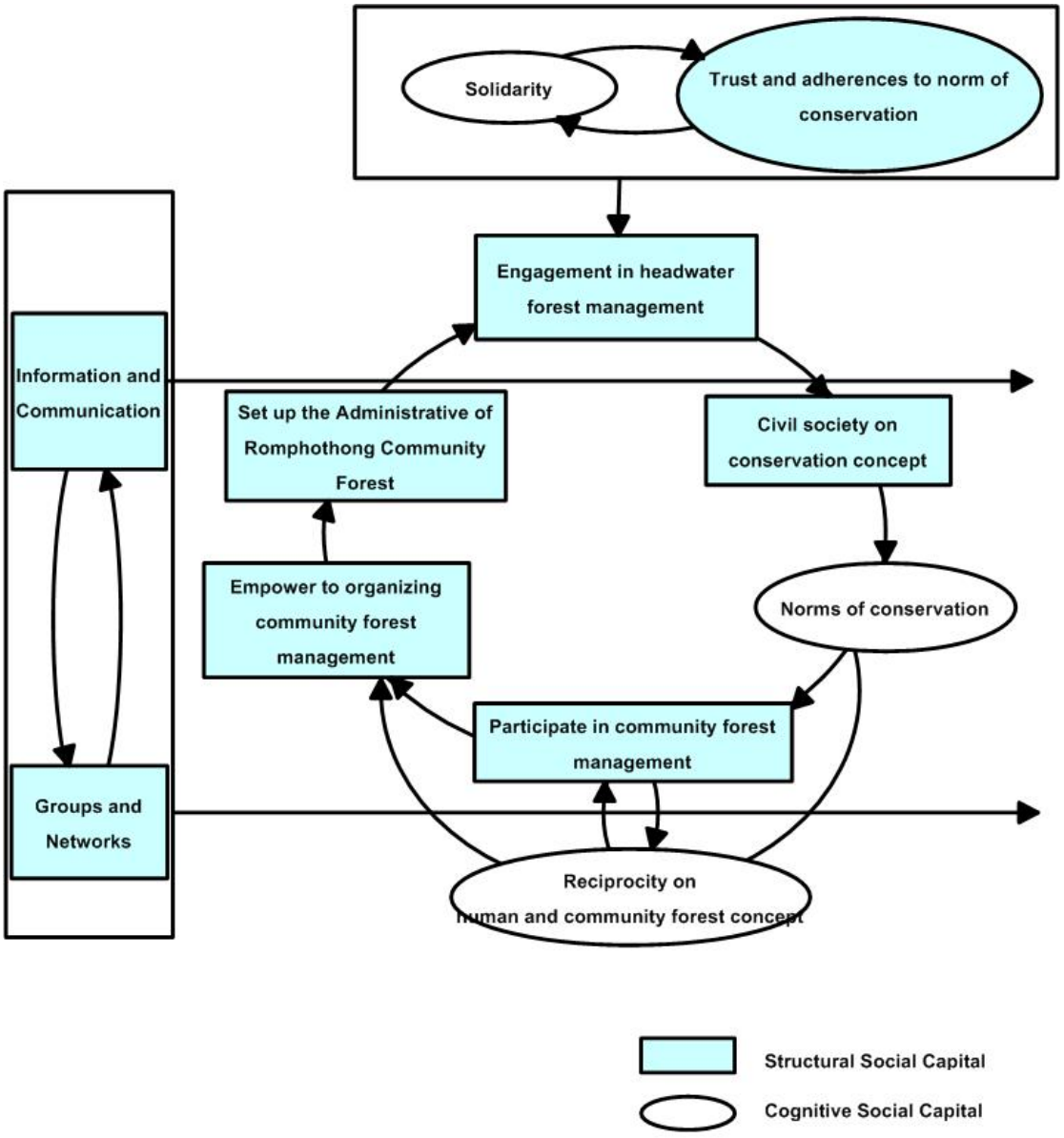

Figure 22 The management process (dynamic) of social capitals for community-based watershed and environmental management of Khaophraphutthabatnoi community

According to these studies, the community-based watershed and environment management of these 2 communities, started by the leaders' engagement to begin the project, and finally end up with the communities establishing the formal organizations to be in charge.

If considering about the permanency of the communities' organizations, people of these communities emphasized the leaders or the representatives of the villages by their essences to workout the development plan, just like the common saying "the person who will become the village leader must be the leader for the development project for the headwater forest and environment of the community as well".

3. A Prototype of the dynamic model of social capitals for community-based watershed and environmental management

3.1 The dynamic model of social capitals for community-based watershed and environmental management

The purpose in making the model is to be used as a guideline in a community-based watershed and environmental management, especially the community that considers social capitals very important and its people have to live on the natural resources. By creating the model from the real cases, it is easy to use or apply them to the community extensively and effectively.

According to the Figure 21 and 22, we can conclude about the dynamism model of social capital for community-based watershed and environmental management as the followings;

The dynamisms of the social capitals, in this case, exhibits the form of feedback loops which have positive chain-reactions. The loop starts with the awareness of the natural decadences and moves on to the engagement in public affaire/civic engagement. Thus the socials capitals are concealed in the form of relationships between humans and nature conservation. And Social capitals are characterized as the facilitator of the watershed and environmental management, which the dynamism can be shown in the Figure 23.

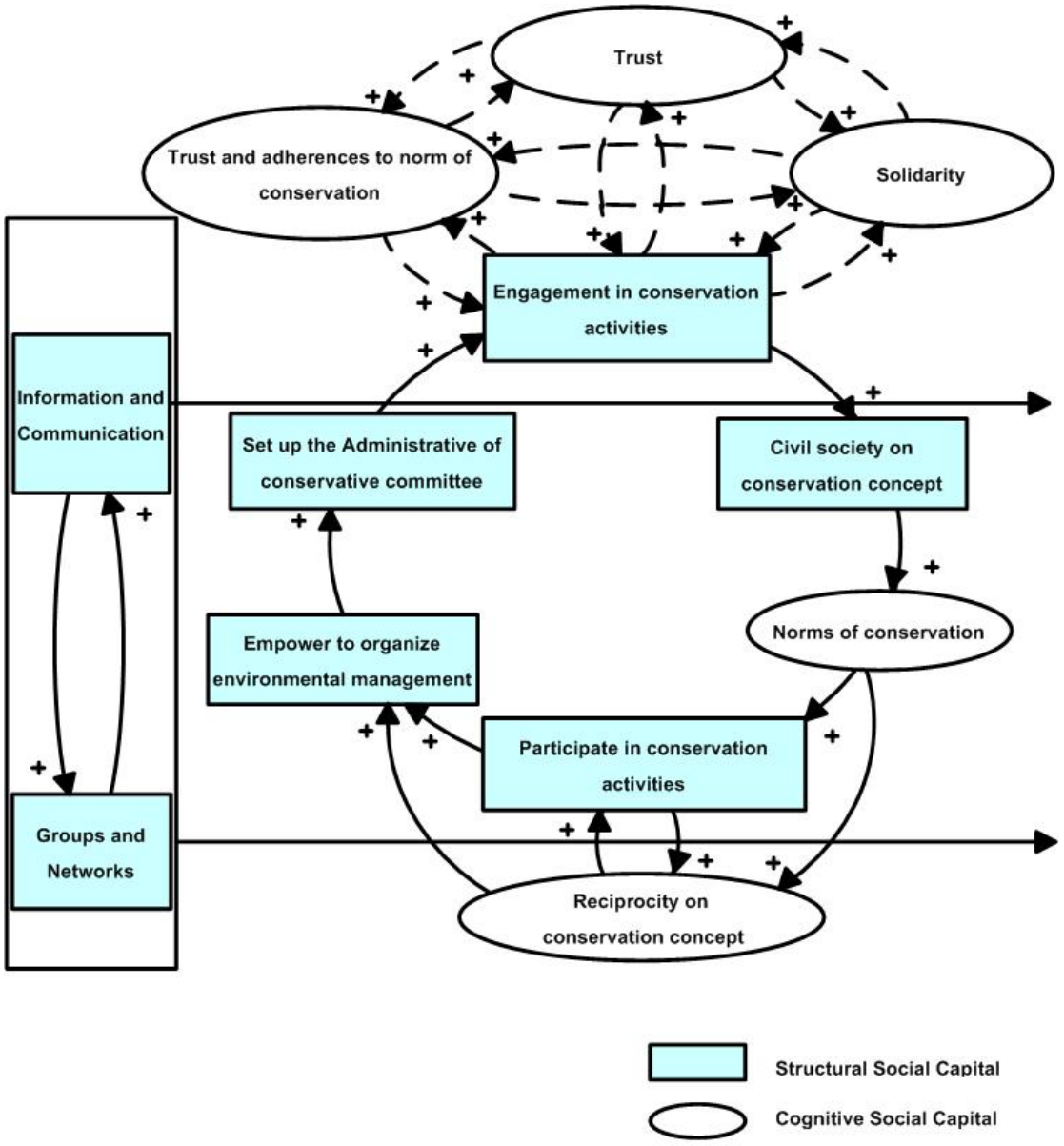

Figure 23 The system prototype model of social capitals for community-based watershed and environmental management

From the figure, The first social capital that initiated the activities for watershed and environment was “trust”. Then it brings about the “solidarity” which leads to the societal cooperation and participation. This watershed and environment management activity enable people to take part in the management project, since its commencement: for example, taking part in project planning, processing, follow-up

activity, and sharing the benefits. So it is necessary to start from making the community to realize and to see shared value to the natural resources in the watershed area first, then the sustain participation to manage watershed and environment which is reflect that Cognitive Social Capital is a mechanism to create cooperation of each individual for public benefits. Thereafter, Structural Social Capital comes to support to the structure of cooperation to operate the activity of watershed and environment management.

But the issue to be interested and also to be careful greatly are outside factor effected to social capital used for watershed and environment management such as capitalism emphasizing to great important value with “money” which may be affect to the concept and giving shared value, and the distrust to each other which is important obstacle to developing solidarity, which is the important power to the cooperation for the benefit of society totally.

In addition, there are outside factors such as Globalization, technology advancement, communication advancement, mobilization of industry to rural area and new attitude cause weight with consumption popularity. These are outside factors influenced to social capital available in the community and also it may be effected to the formation and the power of social capital non-compliance to the studying results as mentioned above

From the figure, it can be suggested the used of social capital for community-based watershed and environmental management as the following procedures

1. Inspiring and convincing people of the community to engage in watershed and environmental management that they are bounded to protect the natural resources in the watershed. Also implanting the believe about the reciprocity of community and environment.

2. Creating extensively the civil society to protect and manage the watershed and environment. The civil society can include sharing opinions or discussing the problems and solutions for watershed and environmental management

3. Setting up the regulations or rules for watershed and environmental management by the people in the community in order to archive the norms, rules and plans that fit nicely with community's living styles.

4. Appealing to people, organization networks, scholars to participate in the protection and management of the watershed and environment, in order to increase the watershed and environmental management project efficiency.

5. Setting up the community organization to be in charge and to follow up with plan.

3.2 The recommendations for utilizing the social capitals for managing the watershed and environment, by the dynamic model.

From studying results found that both communities formerly the community members have style of relationship to the forestry resources in type of taking advantages to utilization definitely. But, one day the members from 2 villages "change their minds" and change from "destroyers" to be "preserver", finally the working committee can be established to manage to forest of water origin of the community successfully, and also the community itself, uses benefit from the abundant of forest of water origin of the community both direct and indirect ways in various dimensions.

Important findings found that social capital is origin mechanism to make the community to change their minds and to turn to realize to the value and the ecological importance of the forest of water origin; that is Cognitive Social Capital which is the social capital related to the matters of imagine, spirit, attitude; those are Trust, Solidarity, Trust and Adherence to Norms, Reciprocity. While the Structural

Social Capital shall be brought to use in the end-activities of the process of management to forest of water origin in part of participation and to operate of establishment the working committee to take care such forest of water origin of the community. The Structural Social Capital is consisting of participation, civil society, empowerment, community organization, group /network and information / communication.

From the above consideration, the communication can coordinate to forest of water origin which is resulting from Cognitive Social Capital which is “special glue” to help to create “strong, sustainable structure of cooperation”. Therefore, in promotion to other communities with capability to manage forest of water of the community sustainability. Therefore, it is necessary to start from using Cognitive Social Capital before using Structural Social Capital, that means it is needed to “change thinking method” first, and change the community to realize to the ecological value which is linked to human well-being first, then the “Working Committee”. This method can develop sustainability to the management of forest of water origin, of the sustainable community.

In addition, for building “trust” in the community, which will bring about the solidarity in natural resource development activities, it could be carried out by empowering the wisdom-leaders such as elders, teachers, monks, local doctors, philosophers etc. The community that doesn’t divide into fractions and has the public activities is the ideal community. On the other hand, the community is ideal for building “trust” of this dynamism pattern is the one that has “Civic Group”, “Bonds of Family”, “Informal Community Networks”, “Kinship”, “Friendship”, “Norms of Reciprocity”, “Volunteerism”, “Altruism”, and also “Trust”.

3.3 The limitation of this dynamism model

Since this prototype model can be synthesized from studying by specific local; so this dynamism model is suitable only for rural Community or primary society. On the other hand, it works for the case where people are quite familiar with

each other, have similar style of livings, and naturally interact with each other (without the external force). This type of community is believed to have social capitals, corresponding to the current Thai community. The important is that this prototype model can be used only to the specific local realized/seen shared value to the natural resources and environment, that means the community itself shall try to operate the activity in order to manage natural resource to balance to the community

Further more, this model is derived from the actual study on what is happening in the community. However, it sill needs to be under trial and adjustment, and thus this prototype model aims to reflex the social capitals' movement that impacts the management of the watershed and environment. It also suggests that the social capitals can be one of the many options that can be used to manage watershed or environment of Thai communities

Discussion

1. The Prototype of the dynamic of social capitals for community-based watershed and environment management

According to the study results, it is found that social capitals are the most important factors that results in society's harmony and synchronization in managing the watershed and community's environment. The social capitals that unite the community, in this case, are "trust" and "solidarity". These social capitals bring to the people of society, the awareness of engagement in public affairs. This awareness brings about the harmonious firm to protect and manage the watershed and the environment. Consequently, this will result in "the structure of cooperation" which is the vital mechanism that helps the management of watershed and environment to be carried on with fairness and social equality, such as, social empowerment, community organization, group/ network, information / communication, civil society

According to the systematize dynamic model of community-based watershed and environment management for both communities, "trust" is the

important social capital. The result indicates that the Romphothong Community, which is of a forest village (by the government's forestation project), was formed by the pressure on the people from the government. However, "trust" was one mechanism that droves people to gather and to take care of natural resources. We can see from the activities of watershed and environment management: first, building "trust" among people from different groups. The same situation happened to the community of Khaopraputtabatnoi. The people from 4 different villages gathered up and helped each other by taking care of and managing the watershed and the environment. This solidarity is a consequence of kinship which enforces the "trust" that becomes a key device of engagement in public affaires. This confirms the concept of civic engagement by Putnum (2002). He explained that civic engagement is about realizing the duty which each individual should have for their community. The determination the serve the public should be in everyone's mind. Civic engagement will be a powerful tool, if it is implanted deep into society in which the people are firm to help each other.

2. A Prototype of the dynamism model of social capitals for community-based watershed and environmental management

The first social capital that initiated the activities for watershed and environment was "trust". Then it brings about the "solidarity" which leads to the societal cooperation and participation. This watershed and environment management activity enable people to take part in the management project, since its commencement: for example, taking part in project planning, processing, follow-up activity, and sharing the benefits. This means that, by obtaining the rights to self-manage the watershed and environment, the community enables the "equity" for everyone. Everyone has an equal access to the natural-resources as well as the producing factors, under the "good governance"

In addition, the fairness has been established between humans and the watershed. This type of concomitance will allow equality in benefit-taking as well as balance of natural resources. Thus, both sides (human and nature) can live together

reciprocally, perpetually and equally. Then, the community becomes stronger, and everyone has a better living, under the good environment and the balanced ecosystem. This is in concordant with the article “Ecosystems and human well being” by Millennium Ecosystem Assessment Panel (2005), concluding that human-well being is all depended on the support form the balanced ecosystem like in the following figure.

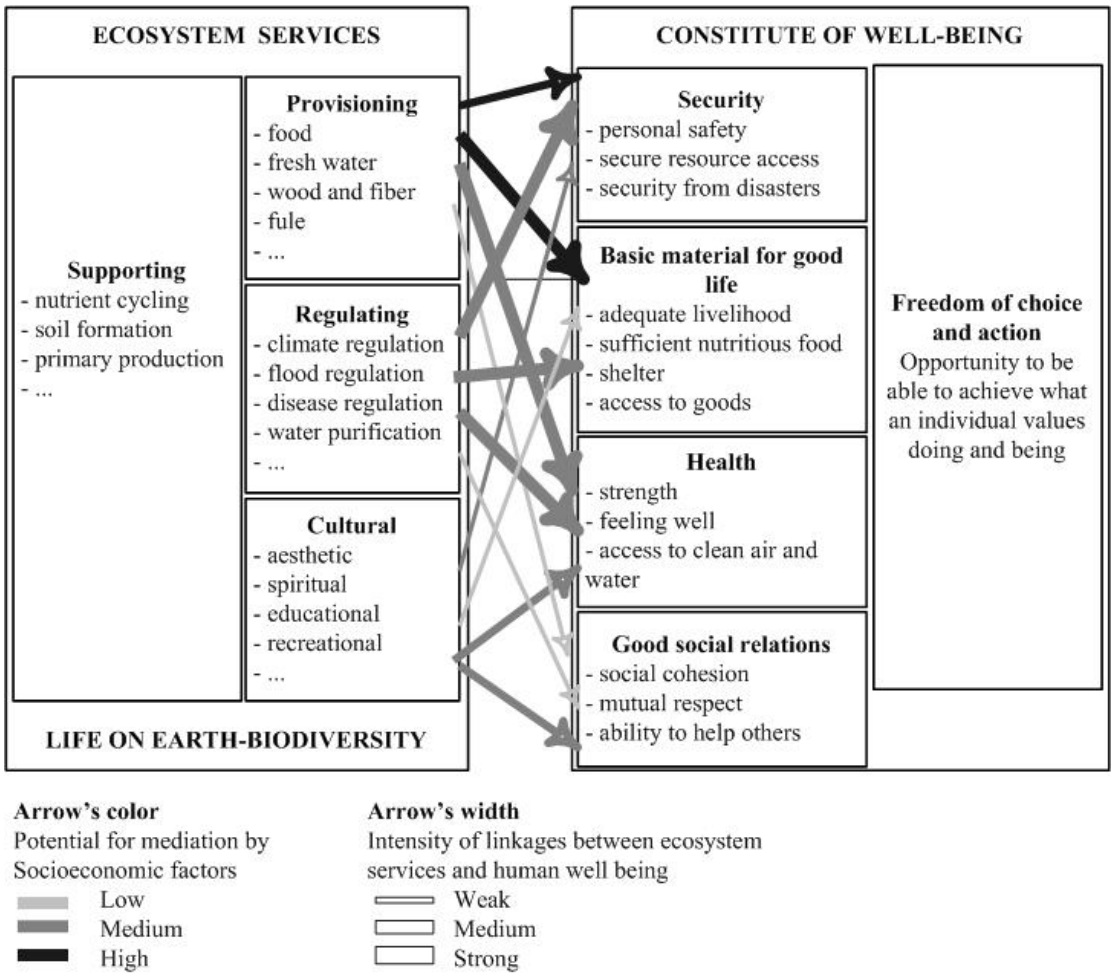

Figure 24 Linkages between ecosystem services and human well being

Source: Millennium Ecosystem Assessment Panel (2005)

CONCLUSION AND RECOMMENDATION

Conclusions

The study on mobilizing of social capital for community-based watershed and environmental management aims to 1) to investigate the characteristics of social capital for watershed and environmental management 2) to investigate the management process of social capital for watershed and environmental management 3) to synthesize the models of social capital management process for community-based watershed and environmental management.

This study can be concluded as follows:

1. The characteristics of social capital for watershed and environmental management are;

1.1 The characteristics of social capitals used of the Thinking System for the community-based watershed and environmental management projects include:

1.1.1 The trust which brings solidarity and collaboration

1.1.2 The solidarity which brings the participation

1.1.3 The norm of conservation which brings the understanding and the specific action in order to conservation concept

1.1.4 The trust and adherence to norms which bring conformity, collaboration and the specific action in order to conservation concept

1.1.5 The reciprocity between human and nature which brings the understanding concept of conservation and the participation

1.1.6 The engagement in management of watershed and environment which brings the participation

1.2 The characteristics of social capitals used in the Practicing System for the community-based watershed and environmental management projects are:

1.2.1 The participation which brings the specific action in order to conservation concept such as building the fore break, reforestation, implanting the awareness of conservation in the youths

1.2.2 The civil society which brings the extensive discussion on the watershed and environmental management project

1.2.3 The empowerment which bring the community rights to organize conservation projects

1.2.4 The community organization which brings the conceptual plan into the tangible one

1.2.5 The group and network which bring extensive communications and experience sharing.

1.2.6 The information and communication for preservation project, between the community and the organization networks from outside, which bring knowledge and experience sharing on conservation concept.

2. The system dynamics model of social capital for watershed and environmental management in this case, starts with the cognitive social capitals such as trust, solidarity, trust and adherence to norms, all of which lead to the engagement in management of watershed and environment. And then it leads to the norm of conservation, participation, reciprocity, and finally community organization to

formally take care of the watershed and environment. Then it brings about more determination to participate the community-based watershed and environmental management project. And throughout the dynamism, Group and network serve as tools for communication and information exchanging.

3. The model of social capital management process for community-based watershed and environmental management as the dynamism is in positive feedback loop which mean the dynamism of the social capitals in this case results in positive results.(shown in the Figure 23) This model can be manage effectively and sustainability the watershed and environment.

Based on previously described, this study, demonstrates a new understanding on how to use social capitals in order to sustainably manage the watershed and environment. The study has shown that, by using social capitals, it is like bringing out the internal forces of the community to archive the benefits. This is because social capitals are born from the trust and relationships among the residents, and being transformed into participation and cooperation which enable the accomplishment of public affairs.

By learning from the successful cases, we can revise the definition of watershed and environment management issue as follows:

Watershed and environmental management (WSEM) is defines as developing the community to change thinking method to “allowing to realize / to see shared value of natural resources in the watershed area that the natural resources are important and can be linked to create good human well-being in view of capability to utilize natural resources directly and also in view of benefits from balanced ecological system and also help to control and to support to biosphere to proceed further normally”. Changing thinking method by creating “new image-image of conservation” in the heart of community to be occurred. This will be morale mechanism (spirit) to decision for quality of natural resources in the sustainable watershed. That mean, when the community change thinking method to giving value to the natural resources in the

watershed, then the community shall support or take part absolutely to any activity causing good results to the natural resources in the area with jointly thinking base. In the contrary, any activity with trend to cause damage to occur to the natural resources in the area with jointly thinking base, then the community shall not take part, omit to perform or not to support in these activities. Decisions to follow or to omit any performance are the results from "thinking method" of the community directly. The thinking method "friendly to natural resources" in the area with jointly thinking base shall develop to the management of watershed management and natural resources. In the area with jointly thinking base, it shall create sustainable watershed management and natural resources.

The new one should be that: Social Capital which is a mechanism help to make sustainable watershed management and natural resources because the Structural Social Capital can create strong cooperation management and natural resources under the atmosphere of solidarity of the community. That is the results from thinking method to focusing to the important to the mutual benefit of the community from mutual trust in the community.

Recommendations

1. Recommendation for future research

Since this research aims to study the characteristics of social capitals and how their mechanisms could contribute to managing the watershed area and environment of the community, by deriving a prototype model, this is just only the beginning of the prototype model which lacks completeness and details as well as trials on the real cases.

Thus, in order to obtain an dynamic model of social capitals that can be applied to the real management of watershed and environment, it is suggested that the

dynamic model, from this study, should be under trails and adjustments, in the following procedures.

1.1 Studying the effectiveness of this prototype model by using the quantity and direct correlation among social capital variables. This is in order to clearly reflex their applications to manage watershed and environment.

1.2 Studying the options which can be used as adjustments for each social capital as well as the consequences of selected options; due to the current situations, consideration should be given to the external impacts, that may influence the social capitals used for managing the watershed and environments.

2. Recommendation for the community-based watershed and environmental management of rural community

2.1 The project for watershed and environmental management aiming for the sustainability is to foster people in the way that they have a willing determination to protect and manage the environment and watershed. According to the result of this study, the starting point of the management is to gain enthusiasm and to end up with establishing the formal organizations to be in charge directly for the duties, plans and activities. Therefore, the government can promote or direct the communities, which can enable the same management project, in the following ways;

2.1.1 As the “driving forces of cooperation” to manage watershed and environment, according to the result, by which the government may use the community’s leaders as tools to inspire their people.

2.1.2 As the “structure of cooperation” in terms of community’s organizations to be in charge, after people have extensively and firmly participate in the community-based watershed and environmental management project.

The concept of “Creation of the driving forces and the structure” implies the truths that happened in the two communities study. It is true for other organizations which were not born by the wills of their people, but by the government’s will. As a result, these organizations could not survive after the government no longer supported them.

2.2 The first and important factor that will drive the community-based watershed and environmental management to success is “Solidarity or Harmony” of the community. Solidarity is characterized as the cement of the society, which bring the participation on the watershed and environmental management

2.3 The followings the guidelines for creating the conformity for the community;

2.3.1 Allowing religions temples (religion) or schools to become the center of people’s heart, will enable people to join and participate in the traditional ceremonies and have interactions or chatting with their neighbors. This will lead to trust, solidarity and harmony in the community, and the government can convince the people about the idea to mange the watershed and environment based on the determination of the community.

2.3.2 Encouraging the “leaders” especially the wisdom-leaders, to become as the tool to bring people together and build solidarity of the community, especially in the community which the people insolently and separately live as groups

2.3.3 Enabling the exchange-meetings or forums to let people share their opinions and information fairly. This will lead to the civil engagement in the community.

2.4 The government needs to educate the community about the knowledge of watershed and environmental management. According to the result, both 2 communities study were educated with the knowledge of watershed and environmental management from the scholars such as researchers, NGOs, local

officers, etc. Another type of knowledge is local wisdom, the ability to discern or judge what is true, right, or lasting in the watershed and environmental management.

From previously described, it can be concluded that knowledge management drawn from of the communities study are the followings:

2.4.1 Explicit knowledge about the watershed and environmental management from the scholars is an important factor that drives the community-based watershed and environmental management to success. So, the government needs to educate the community about the explicit knowledge of watershed and environmental management.

2.4.2 Government officers who are partnership in the community-based watershed and environmental management must accept and acknowledge the tacit knowledge of local wisdom about the watershed and environmental management from the local people. That reflects to the equity in partnerships.

2.4.3 The knowledge base built on both the explicit and tacit knowledge are important factors that drive the community-based watershed and environmental management to be successful and sustainable. This needs the mechanism of civil society to pass on experiences and knowledge.

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APPENDICES

Appendix A

Questionnaires

The characteristic of social capital for watershed and environmental Management Questionnaire of Romphothong community

This questionnaire is part of the research of "Organizing of social capital for community-based watershed and environmental management" This study aims to investigate the characteristics and the dynamics of social capital; and to synthesize the findings to provide a model of social capital for community-based watershed and environmental management. Your opinion will be of great benefit in the conclusion of this study.

Instructions: Please complete the questionnaire following the steps outlined below:

In section 1: please provide brief personal information by ticking the boxes/filling in the blanks as appropriate.

Name……

Status: □ Leader □ Member

In section 2: please indicate the characteristics of social capital that caused your community success in headwater forest management by placing a tick in the appropriate box.

characteristics of social capital	Yes	No
1. Trust		
2. Solidarity		
3. Information and Communication about the community forest concept		
4. Civil society about the conservation and community forest concept		
5. Groups and networks in term of conservation		
6. Engagement in the headwater forest management project		
7. Participation in the headwater forest management project		
8. Empowerment to organized the headwater forest management project		
9. Reciprocity between human and nature		
10. Norm of conservation		
11. Community organization to manage the headwater forest management project		

The characteristic of social capital for watershed and environmental Management Questionnaire of Khaoproputhabatnoi community

This questionnaire is part of the research of "Organizing of social capital for community-based watershed and environmental management" This study aims to investigate the characteristics and the dynamics of social capital; and to synthesize the findings to provide a model of social capital for community-based watershed and environmental management. Your opinion will be of great benefit in the conclusion of this study.

Instructions: Please complete the questionnaire following the steps outlined below:

In section 1: please provide brief personal information by ticking the boxes/filling in the blanks as appropriate.

Name……

Status: □ Leader □ Member

In section 2: please indicate the characteristics of social capital that caused your community success in headwater forest management by placing a tick in the appropriate box.

characteristics of social capital	Yes	No
1. Trust and adherence to norms		
2. Solidarity		
3. Information and Communication about the community forest concept		
4. Civil society about the conservation and community forest concept		
5. Groups and networks in term of conservation		
6. Engagement in the headwater forest management project		
7. Participation in the headwater forest management project		
8. Empowerment to organized the headwater forest management project		
9. Reciprocity between human and nature		
10. Norm of conservation		
11. Community organization to manage the headwater forest management project		

Appendix B

Results from questionnaire

Appendix Table B1 Percent of social capitals were used in community-based watershed and environmental management of Romphothong community, Chachoengsao

characteristics of social capital	Leader n = 24	Member n = 75
1. Trust	100.0	87.0
2. Solidarity	100.0	87.0
3. Information and Communication about the community forest concept	100.0	90.0
4. Civil society about the conservation and community forest concept	100.0	84.0
5. Groups and networks in term of conservation	100.0	90.0
6. Engagement in the headwater forest management project	100.0	94.0
7. Participation in the headwater forest management project	100.0	99.0
8. Empowerment to organized the headwater forest management project	100.0	99.0
9. Reciprocity between human and nature	100.0	95.0
10. Norm of conservation	100.0	99.0
11. Community organization to manage the headwater forest management project	88.9	97.0

Appendix Table B2 Percent of social capitals were used in community-based watershed and environmental management of Khaoproputhabatnoi community, Saraburi

characteristics of social capital	Leader n = 25	Member n = 125
1. Trust and adherence to norms	100.0	91.1
2. Solidarity	100.0	100.0
3. Information and Communication about the community forest concept	83.3	64.4
4. Civil society about the conservation and community forest concept	88.9	95.4
5. Groups and networks in term of conservation	100.0	98.5
6. Engagement in the headwater forest management project	100.0	96.9
7. Participation in the headwater forest management project	100.0	83.1
8. Empowerment to organized the headwater forest management project	100.0	100.0
9. Reciprocity between human and nature	100.0	96.9
10. Norm of conservation	87.5	80.0
11. Community organization to manage the headwater forest management project	100.0	100.0

Appendix C

Forest tree

Appendix Table C1 Tree species list of Romphothong community forest, Chachoengsao

No.	Sciencetific name	Family
1	*Mangifera caloneura* Kurz	ANACARDIACEAE
2	*Lannea coromandelica* Merr.	ANACARDIACEAE
3	*Spondias pinnata* Kurz	ANACARDIACEAE
4	*Uvaria hahnii* Sincl.	ANNONACEAE
5	*Xylopia vielana* Pierre	ANNONACEAE
6	*Cananga latifolia* Finet & Gagnep.	ANNONACEAE
7	*Cananga latifolia* Finet & Gagnep.	ANNONACEAE
8	*Ichnocarpus frutescens* R. Br.	APOCYNACEAE
9	*Oroxylum indicum* Vent.	BIGNONIACEAE
10	*Markhamia stipulata* Seem.	BIGNONIACEAE
11	*Bombax anceps* Pierre	BOMBACACEAE
12	*Canarium subulatum* Guill.	BURSERACEAE
13	*Bauhinia glauca* Wall. ex Benth. subsp. tenuiflora K. & S. Larsen	CAESALPINIACEAE
14	*Bauhinia malabarica* Roxb.	CAESALPINIACEAE
15	*Bauhinia scandens* Linn. var. horsfieldii K. & S. Larsen	CAESALPINIACEAE
16	*Dialium cochinchinense* Pierre	CAESALPINIACEAE
17	*Afzelia xylocarpa* Craib	CAESALPINIACEAE
18	*Siphonodon celastrineus* Griff.	CELASTRACEAE
19	*Peltophorum dasyrachis* Kurz	CAESALPINIACEAE
20	*Terminalia dafeuillana* Pierre ex Laness	COMBRETACEAE
21	*Eupatorium odoratum* Linn	COMPOSITAE
22	*Diospyros variegata* Kurz	EBENACEAE
23	*Diospyros castanea* Fletch.	EBENACEAE
24	*Croton oblongifolius* Roxb.	EUPHORBIACEAE
25	*Croton cascarilloides Raeusch.*	EUPHORBIACEAE

Appendix Table C1 (Continued)

No.	Botanical name	Family
26	*Phyllanthus elegans* Wall. ex Muell. Arg.	EUPHORBIACEAE
27	*Mallotus philippensis* Muell. Arg	EUPHORBIACEAE
28	*Hydnocarpus ilicifolius* King	FLACOURTIACEAE
29	*Homalium tomentosum* Benth.	FLACOURTIACEAE
30	*Cratoxylum formosum* Byer	GUTTIFERAE
31	*Cratoxylum formosum* Byer subsp. pruniflorum Gogel.	GUTTIFERAE
32	*Litsea glutinosa* C.B. Robinson	LAURACEAE
33	*Lagerstroemia loudonii* Teijsm. & Binn.	LYTHRACEAE
34	*Lagerstroemia duperreana* Pierre	LYTHRACEAE
35	*Lagerstroemia calyculata* Kurz	LYTHRACEAE
36	*Memecylon geddesianum* Craib	MEMECYLACEAE
37	*Memecylon ovatum* J.E. Smith	MEMECYLACEAE
38	*Adenanthera pavonina* Linn.	MIMOSACEAE
39	*Albizia odoratissima* Benth.	MIMOSACEAE
40	*Ficus pubigera* Wall.	MORACEAE
41	*Streblus asper* Lour.	MORACEAE
42	*Knema linifolia* Warb.	MYRISTICACEAE
43	*Pterocarpus macrocarpus* Kurz	PAPILIONACEAE
44	*Pterocarpus indicus* Willd.	PAPILIONACEAE
45	*Erythrina subumbrans* (Hassk.) Merr	PAPILIONACEAE
46	*Millettia leucantha* Kurz	PAPILIONACEAE
47	*Dalbergia cochinchinensis* Pierre	PAPILIONACEAE
48	*Hymenodictyon excelsum* (Roxb.)Wall.	RUBIACEAE
48	*Tarenna collinsae* Craib	RUBIACEAE
50	*Greenia wightiana* Wall. ex Wight & Arn.	RUBIACEAE
51	*Catunaregam spathulifolia* Tirveng.	RUBIACEAE
52	*Haldina cordifolia* Ridsd	RUBIACEAE

Appendix Table C1 (Continued)

No.	Botanical name	Family
53	*Canthium parvifolium* Roxb.	RUBIACEAE
54	*Nauclea orientalis* Linn.	RUBIACEAE
55	*Morinda coreia* Ham.	RUBIACEAE
56	*Hesperethusa crenulata* Roem	RUTACEAE
57	*Clausena guillauminii* Tanaka	RUTACEAE
58	*Micromelum glanduliferum* B. Hansen	RUTACEAE
59	*Murraya paniculata* Jack	RUTACEAE
60	*Schleichera oleosa* Merr.	SAPINDACEAE
61	*Lepisanthes rubiginosa* Leenh.	SAPINDACEAE
62	*Harrisonia perforata* Merr.	SIMAROUBACEAE
63	*Solanum seaforthianum* Andr.	SOLANACEAE
64	*Pterospermum jackianum* Wall.	STERCULIACEAE
65	*Pterospermum diversifolium* Bl.	STERCULIACEAE
66	*Pterocymbium javanicum* R. Br.	STERCULIACEAE
67	*Sterculia pexa* Pierre	STERCULIACEAE
68	*Antidesma bunius* Spreng.	STILAGINACEAE
69	*Schoutenia hypoleuca* Pierre	TILIACEAE
70	*Grewia elatostemoides* Coll. et Hemsl.	TILIACEAE
71	*Microcos tomentosa* Smith	TILIACEAE
72	*Vitex pinnata* Linn	VERBENACEAE
73	*Vitex canescens Kurz*	VERBENACEAE

Appendix Table C2 Tree species list of of Khaoproputabatnoi community forest, Saraburi

No.	Sciencetific name	Family
1	*Dracaena loureiri* Gagnep.	AGAVACEAE
2	*Dracaena sp.*	AGAVACEAE
3	*Spondias pinnata* (L.F.) Kurz	ANACADIACEAE
4	*Spondias bipinnata* Airy Shaw & Forman.	ANACARDIACEAE
5	*Lannea coromandelica* Merr.	ANACARDIACEAE
6	*Polyalthia obtusa* Craib	ANNONACEAE
7	*Cananga latifolia* Finet & Gagnep.	ANNONACEAE
8	*Wrightia tomentosa* Roem. & Schult.	APOCYNACEAE
9	*Holarrhena antidysenterica* Wall.	APOCYNACEAE
10	*Barnettia kerrii* Santisuk	BIGNONIACEAE
11	*Markhamia stipulata* Seem.	BIGNONIACEAE
12	*Stereospermum colais* (Buch.- Ham.ex Dillwyn) Mabb.	BIGNONIACEAE
13	*Bombax anceps* Pierre	BOMBACACEAE
14	*Afzelia xylocarpa* Craib	CAESALPINIACEAE
15	*Bauhinia glauca* Wall . ex Benth	CAESALPINIACEAE
16	*Bauhinia malabarica* Roxb.	CAESALPINIACEAE
17	*Crateva religiosa* Ham.	CAPPARACEAE
18	*Maerua siamensis* Pax	CAPPARACEAE
19	*Siphonodon celastrineus* Griff.	CELASTRACEAE
20	*Terminalia nigrovenulosa* Pierre ex Laness.	COMBRETACEAE
21	*Eupatorium odoratum* Linn.	COMPOSITAE
22	Cycas pectinata Griff.	CYCADACEAE
23	*Cycas Tansachana*.	CYCADACEAE
24	*Diospyros montana* Roxb.	EBENACEAE
25	*Doispyros vaviegata*	EBENACEAE

Appendix Table C2 (Continued)

No.	Sciencetific name	Family
26	*Bridelia stipularis* (L.) BL.	EUPHORBIACEAE
27	*Glochidion coccineum* Muell. Arg	EUPHORBIACEAE
28	*Lagerstroemia duperreana* Pierre	LYTHRACEAE
29	*Streblus asper* Lour.	MORACEAE
30	*Millettia brandisiana* Kurz	PAPILIONACEAE
31	*Dalbergia nigrescens* Korz	PAPILIONACEAE
32	*Erythrina subumbrans* (Hassk.) Merr	PAPILIONACEAE
33	*Pterocarpus macrocarpus* Kurz	PAPILIONACEAE
34	*Dalbergia cochinchinensis* Pierre	PAPILIONACEAE
35	Greenia wightiana Wall. ex Wight & Arn.	RUBIACEAE
36	*Haldina cordifolia* Ridsd.	RUBIACEAE
37	*Morinda coreia* Ham.	RUBIACEAE
38	*Hymenodictyon excelsum* (Roxb.)Wall.	RUBIACEAE
39	*Atalantia monophylla* Correa	RUTACEAE
40	*Micromelum glanduliferum* B. Hansen	RUTACEAE
41	*Pterocymbium javanicum* R. Br.	STERCULIACEAE
42	*Strychnos lucida* R.Br	STRYCHNACEAE
43	*Grewia elatostemoides* Coll. et Hemsl	TILIACEAE
44	*Vitex pinnata* Linn.	VERBENACEAE
45	*Vitex canescens* Kurz	VERBENACEAE

Appendix D

Tree density, frequency, Dominance, Important value index

Tree density

Tree density means amount of any tree per one area unit or per volume unit. In studying plant society, tree density shall be the amount of plant species per area unit or per plot. For saplings and seedling, if it is found of density of saplings or seedling have much value, it is shown of good natural reproduction. For tree density value, it can be obtained from the formula:

$$\text{Density (trees/hectare)} = \frac{\text{total of such species of plant}}{\text{Area of sample studying plot}}$$

$$\text{Relationship of density (\%)} = \frac{\text{Tree density} \times 100}{\text{All species of tree density in plant society}}$$

$$\text{or} = \frac{\text{Total amount of such trees} \times 100}{\text{All species of tree density in plant society}}$$

Species frequency

Frequency is a value to point of dispersion of each trees in the area. The frequency value shall be in percentage. The tree with thorough dispersion shall have its opportunity to present in all studying plots shall have much value, with frequency value almost 100 %. While the trees with dispersion in any area in the forest, although a lot of trees, but the dispersion is not thoroughly, so the frequency value of such tree shall be low. With this reason, any tree with high frequency shall be in evenly dispersion thoroughly the area.

$$\text{Frequency (\%)} = \frac{\text{No. of ample plot with such tree appeared} \times 100}{\text{Total sample plots}}$$

$$\text{Relative frequency} = \frac{\text{Frequency value of such tree} \times 100}{\text{Sum total of frequency value of all trees}}$$

Dominance

Dominance of trees is an index to show that such species on how much it is influence to plant society. The plant species with much dominance shall be the plant with influence to such area; that is influence to shade out light onto the ground and also the influence to soil properties etc. Such dominance of plant can be explained in for of covering, meaning the content of the ground covered by the canopy or part above the ground of plants which is always presented in percentage of the sample plot area and the crow- section area, which is the value of dominance of the plants. Since the cross-section area shall be relative to with the canopy; namely the plant species with much cross-section shall have much dominance. Measuring cross-section or biomass of plant is the indicator of such plant species also. Therefore, the dominance species is the plant species with the most biomass. For the dominance of plant species can tell in form of relative dominance from the below formula:

$$\text{Dominance (sq. meter/hectare)} = \frac{\text{All cross-section area of species determined}}{\text{All area of sample plot surveyed}}$$

$$\text{Relative dominance (\%)} = \frac{(\text{Dominance in plant species A}) \times 100}{\text{Total dominance of all plants}}$$

$$\text{or} = \frac{(\text{Total of cross-section area of plant species A}) \times 100}{\text{Total crow-section of all plants}}$$

Important value index: IVI

Important value index : IVI of a species of plant is the value obtained from the sum total of relative density, relative frequency and relative dominance of such plant together that the value shall be from 0–300 %. Any species has high important value index, it is the dominance species and also is important in such area which is showing to the ecological success of the plant species in occupying the area.

$$\text{Important value index: IVI} = \text{Relative density} + \text{relative frequency} + \text{relative dominance}$$

Appendix E

Saw timber quality (TQ)

Sawtimber quality discrimination (TQ)

Sawtimber quality discrimination (TQ), divided into 3 layers as follows:

1. Saw timber quality level 1: a log with diameter at breast height (DBH) from 30 centimeter up, divided into:

Saw timber quality 1.1: quality means the log with straight trunk and capability to transform every category with less scraps of wood.

Saw timber quality 1.2: quality means the log with lesser straight trunk but still capable to transform economically, but there shall be many scraps of wood.

Saw timber quality 1.3: quality means the log without capability to transform into sheet since the trunk is bent, hollow, or been destroyed naturally and good to use as firewood or charcoal.

2. Saw timber quality level 2: a log with diameter at breast height (DBH) during 10-30 cm, with straight trunk with capability to use as circle post.

3. Saw timber quality level 3: a log with diameter at breast height (DBH) during 10 cm up, bent trunk, hollow or some defects with incapacity to use as round post or transform, but generally used as firewood.

Appendix F

Watershed classification

Watershed classification (WSC)

Watershed class, divided into 5 classes as follows:

Appendix Table F1 Watershed Classification

Class	Topographical condition	Purpose
Class 1	very high elevation and very steep slopes	Protected or conservation forest and headwater source
Class 1A: Permanent Forest Cover	very high elevation and very steep slopes	Protection
Class 1B: Permanent Forest with already cleared areas	very high elevation and very steep slopes	Should be reforested or maintain in permanent agroforestry
Class 2	high elevation and steep up to very steep slopes	Commercial forest
Class 3	uplands with steep slopes	Fruit tree plantation
Class 4	gentle slope areas	Upland farming
Class 5	gentle slopes, flat areas	Lowland farming

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