Office of Natural Resources and Environmental Policy and Planning
Ministry of Natural Resources and Environment

Participatory Watershed Management for the Ping River Basin Project

The World Bank
ASEM II Trust Fund No. TF 053040 TH

Inception Report

Participatory Watershed Management Consultancy

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TRANSFORMING LIVES AND LANDSCAPES

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INCEPTION REPORT OUTLINE

FIGURES

A. Introduction

(1) Terms of reference

The Ministry of Natural Resources and Environment (MoNRE) has received a grant from ASEM Trust Fund in cooperation with the World Bank for a technical assistance team to help improve environmental quality in the Ping River Basin. The team will contribute to achieving enhanced livelihood and health outcomes for the communities in the basin, and to replicating the team's experience (especially the management model) to other river basins in the country. The main development objective of this TA team will be achieved by:

- Developing a participatory "micro-watershed" (sub-basin) management model that provides access to all stakeholders (communities, local government agencies and private sector enterprises) in the decision making process and demonstrating its implementation.
- Enhancing capacity of stakeholders, especially community groups and local government, to participate in the planning, implementation and monitoring of interventions.
- Strengthening regulatory and incentive mechanism to modify behavior of watershed users.
- Developing a result framework to monitor environment, health and livelihood outcomes.

Regarding these objectives, MoNRE has assigned the office of the Natural Resources and Environmental Policy and Planning (ONEP) to take a major role under this grant in arranging activities associated with participatory watershed management for Ping River Basin Project. In order to fulfill project objectives, four components of activities, have been designed as follows:

- Component 1: Participatory "micro-watershed" (sub-basin) management
- Component 2: Enhancing the capacity of community groups in the 3 "micro-watersheds" (sub-basins)
- Component 3: Strengthening the regulatory and incentive structure for improved behavior of users in the three "micro-watersheds" (sub-basins)
- Component 4: Project coordination, results measurement and dissemination

Part of the grant proceeds is applied to a contract under this TOR for an Expert (Watershed Management).

Objectives

The Watershed Management Expert will work with ONEP and the selected consulting firm on Component 1. The objective is to develop a participatory "micro-watershed" (sub-basin) management model that provides access to all stakeholders (communities, local government agencies and private sector enterprises) in the decision making process, and to demonstrate its implementation. The specific poverty-related objective of this component is to enable the testing of a watershed-level institutional model that will provide sustainable and equitable access to the use of water and ecological resources by stakeholders, including poor communities. The Ping River Basin watershed is comprised of twenty "micro-watersheds" (sub-basins). The project will target three "micro-watersheds" (sub-basins) in the upper, middle and lower sections of the basin, and results and findings will be applied to the remaining ones.

Scope of Services

The Watershed Management Expert shall report to the Director of the Natural Resources and Environmental Management Coordination Division of ONEP, who serves as Project Manager and shall carry out the following duties:

- To provide guidance and advice to ONEP and the selected consulting firm/individual in conducting a rapid survey of the entire watershed to assess the health, livelihood and environmental status. The assessment will assist in selecting the three priority "micro-watersheds" (sub-basins) out of the twenty "micro-watersheds" (sub-basins) in the Ping River Basin for a more detailed stock-staking exercise.

- To develop practical criteria (including a participatory selection process) for selecting the three priority "micro-watersheds" (sub-basins) out of the 20 in the Ping River Basin to serve as pilot "models" of watershed management for further implementation, and work with ONEP and other stakeholders in the selection process.
- Together with other stakeholders, develop a participatory micro-watershed management model based on existing literature and local wisdom, knowledge, and experience in Thailand.
- To participate in field visits as requested by ONEP.
- To develop an action plan which should include but not be limited to the following processes:
  - (i) Targeting of actions for improved livelihood, health and environment outcomes
  - (ii) Developing monitoring indicators
  - (iii) Developing a financing mechanism at 2 levels: capital investments through local government budgets, and operational budget through instruments like community savings and credit fund
  - (iv) Outlining implementation arrangements in which participatory processes will be embedded
  - (v) Preparing a capacity enhancement strategy
- To provide guidance and advice to ONEP and the selected consulting firm in developing relevant operational processes in the form of guidance notes, which shall cover the Technical, Organizational and Educational toolkits for the local communities along the Ping River Basin which shall cover the following:
  - (i) Technical toolkits for forest conservation, community forestry, biodiversity, waste re-use and re-cycling, water conservation, soil conservation, organic farming, etc.
  - (ii) Organizational toolkits for roles and responsibilities of communities, alternative dispute resolution mechanisms, consultative processes for budgets and expenditures, credit and savings fund; monitoring of action plan implementation, evaluating intervention results and disclosure.
  - (iii) Awareness and education toolkits for use in schools, health centers, community radio networks, village fairs, etc.

Expected Outputs

- An ***Inception report*** (10 copies) shall be provided to ONEP within six weeks after all consultant contracts are signed and the project begins. A report outline shall be approved by ONEP. The inception report shall include the identification of the practical criteria (including a participatory selection process) in selecting the three priority micro-watersheds. ONEP should provide comment and suggestion on the report within two weeks after receiving the report.
- An ***Interim report*** (10 copies) shall be provided to ONEP within four months after all contracts are signed and the project begins. A report outline shall be approved by ONEP. The interim report shall include the participatory micro-watershed management model. ONEP should provide comment and suggestion on the report within three weeks after receiving it.
- The ***Final report*** (20 copies) shall be provided to ONEP within seven months after all contracts are signed and the project begins. A report outline shall be approved by ONEP. The final report shall integrate the inception and interim reports with the action plan to implement the participatory micro-watershed management model. ONEP should provide comment and suggestion on the report within three weeks after receiving it.
- All reports shall be written in English.

Implementation Arrangement

The Watershed management Expert will be working closely with ONEP, the selected consulting firm/individual, project coordinator, and other stakeholders. The Expert will report directly to the Project Manager. Only office space (in Bangkok and Chiang Mai) and telephone/fax will be provided.

(2) Overview of Ping Basin[1]

Thailand has demonstrated impressive economic growth for more than 30 years, and its resilience is being demonstrated through its recovery from the Asian economic crisis. The development strategy that has brought this growth and structural change to the Thai economy has long relied on intensification of agriculture, rapid industrialization, and expansion of mining, fisheries, and tourism, which have drawn down natural assets such as forest, water, mineral ores, fisheries, and land resources. As a result, deforestation, water scarcity and pollution, declining fish stocks, haphazard urbanization and air pollution have emerged as important and growing issues of concern in the public policy arena. Much of the impact of these growing problems falls on the poor, whose livelihoods are disrupted and health is threatened. And as livelihood options of the poor become foreclosed, many are forced to turn to alternatives that cause further environmental degradation.

Recent establishment of the Ministry of Environment and Natural Resources (MoNRE) was in recognition that rapid economic growth cannot be sustained if natural assets are not well maintained. Its mission to conserve, protect and rehabilitate natural resources and the environment are consistent with government objectives that include sustainable development and equitable growth. And, since the 1997 national constitution specifically entrusts the environment and natural resources of the nation to its people, and mandates their participation and involvement in environmental management and conservation, the government is now seeking to delegate more responsibility to local communities, and encourage their participation in improving environmental quality.

Seasonal water availability and water quality are currently particularly high priorities for both the government and the general public. Given the perceived importance of forest, water and land management to these issues, the government is seeking to develop a river basin management framework for encouraging, facilitating and supporting participatory multi-sectoral collaboration that can help to improve management of natural resources and the environment, and to reduce rural poverty. Of the 25 officially delineated river basins of the country, the Ping Basin was selected as one of 3 initial basins for intensive development of this approach. It was selected both because of its strategic importance in relation to resources, livelihoods and rural poverty, and because of strong concern about impacts of deforestation, soil erosion, sedimentation, water use and pollution.

The Ping River Basin is the largest of the eight river basins that together form the Chao Phraya river 'system'. The Chao Phraya system covers about 30 percent of Thailand's land area, and is home to about 40 percent of its total population. It also is said to employ more than three-fourths of its work force, and generate about two-thirds of Thailand's GDP. Lower (southern) portions of the Chao Phraya system include the fertile Central Plains, often known as the major 'rice bowl' of Thailand's agricultural production, most of the historically important centers of power and dynasties in the Siamese Kingdoms, as well as the huge primate urban-industrial mega-city of Bangkok – the current capital of political and governmental power, as well as the central hub of the nation's growing and diversifying commercial, industrial and service sectors.

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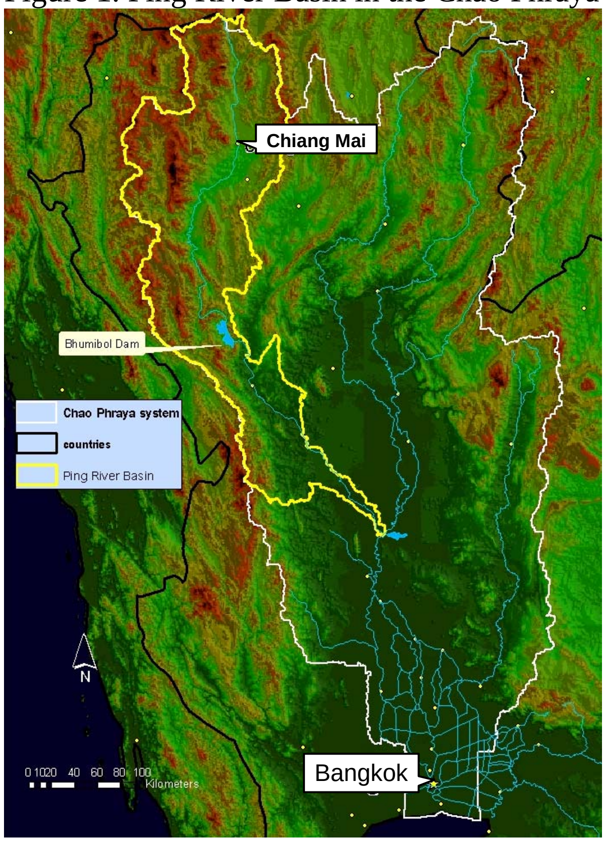
[1] This section is a very brief and preliminary overview of some of the key characteristics and processes of continuity and change in the Ping River Basin. This is meant to serve on an interim basis as a prelude to following sections that draw in more quantitative information in the context of specific discussions that develop and propose an approach for exploring the diversity of the Ping River Basin in order to help inform selection of a sample of pilot sub-basins where participatory sub-basin management approaches will be developed and tested under the project. Thus, its main objective is to develop an overall 'story line' about issues and processes underlying this project, that builds broadly on generalizations from background material from various sources, including reports commissioned by ONEP and other agencies of MoNRE. An expanded version of this introduction will be provided in the final consultancy report. This approach is being used because of the need to focus intensive initial effort on developing high priority information that can be directly used in initial project activities. Thus, while a somewhat more elaborated English language overview of the Ping River Basin in the context of changing conditions in Thailand is understood to be a component of the outputs to be by this consultancy, it must at this point be regarded as secondary to the immediate tasks at hand.

Figure 1. Ping River Basin in the Chao Phraya



With a catchment area of about 35,000 km^2, the Ping River Basin covers about 22 percent of the larger Chao Phraya river system within which it is nested (Figure 1), and contributes about 24 percent of the system's average annual runoff. During early days of opening to the international economy, much of northern Thailand's primary export product – teak – was floated down the Ping River to be taxed and traded in downstream centers. Along with the Wang, Yom and Nan river basins, the Ping is one of the four 'upper' tributary basins that join together at Nakhon Sawan to form the Chao Phraya River itself. Together, they contribute more than 70 percent of the total average annual runoff that feeds the entire river system and its highly complex system of downstream barrages and irrigation canals that have been an integral part of Siamese civilization and the Thai nation state. Thus, from the centers of political and economic power in the lower Chao Phraya, the four 'upper' river basins are viewed as areas to be protected from any activities that would threaten water-consuming downstream processes.

In 1964, the largest dam in the Chao Phraya system was completed, after which the Ping River Basin was conceptually and functionally split into lower and upper portions. The Bhumibol Dam has a live storage capacity of about 9.7 billion m^3, compared to an average annual inflow of 6.6 billion m^3 from a drainage basin of 26,400 km^2, and it is equipped with a hydroelectric generation capacity of 713 MW managed by the Electrical Generation Authority of Thailand (EGAT). Protection and maintenance of the capacity of this strategically important irrigation, water control and electrical generation facility has become another major feature of efforts to manage water and watersheds, especially in 'upper' portions of the Ping River Basin. The 'lower' portions of the Ping River Basin below the dam are located near the western margin of the 'lower north' region in Tak, Kamphaengphet, and Nakhon Sawan provinces, where commercialization of irrigated agriculture and industrial activity have been growing in major valleys along the Ping River, but with often fairly limited penetration into its smaller tributary valleys to the west.

Within the 'upper' portion of the Ping River Basin, lowlands of the intermontane Chiang Mai – Lamphun Valley is home for a major center of people and economic activity that has evolved from the Lanna empire, for which it was the center of power before its merger with Siam as part of Thailand's nation-building process. As with the Siamese further downstream, dominant Tai cultures in the Chiang Mai – Lamphun Valley have strong roots and traditions based in lowland irrigated paddy agriculture, water management, and river bank life. Major lowland valley areas have been integrated into Thailand's economic and social development infrastructure and programs, as symbolized by the emergence of Chiang Mai City as the second largest city in Thailand (albeit still more than an order of magnitude smaller than Bangkok). The boundaries of Chiang Mai and Lamphun provinces provide a close, but not quite perfect fit with natural boundaries of the 'upper' portion of the Ping River Basin.

Still within the 'upper' Ping, but beyond its large river valleys lie a set of 'uppermost' tributary valleys, where lowland paddy-centered civilizations have been limited to relatively small valley floors, nestled within large areas of steeply sloping lands that rise into mountain ridges that include the highest peaks in Thailand. As elsewhere across the montane mainland Southeast Asia

(MMSEA) ecoregion [Thomas 2003], which includes mountainous areas of northern Myanmar, Thailand, Laos, Vietnam, and southwest China, midland and highland zones in these 'uppermost' tributary areas are inhabited by a quite diverse range of ethnic groups employing various livelihood strategies and types of agroecosystem management practices. Some groups, such as the Lua and at least some of the Karen in midland zones of the Ping River Basin, are believed to pre-date ethnic Thai groups in the area, whereas others (especially highland groups) are seen as moving into Ping Basin areas during the last century, largely from China via Myanmar. Current day groups in the middle zone have traditions that employ combinations of paddy, rotational forest fallow agriculture, and preserved forest patches in their local landscapes, whereas some highland groups began with 'pioneer'-type shifting cultivation that included production of opium as a cash crop to provide food security. Until recent years, mountain ethnic minority communities in Thailand were not considered part of mainstream society, they had no citizenship, and government administration treated them as a 'welfare' issue or as a target for opium crop substitution, shifting agriculture eradication, or in some cases resettlement programs. Any land use claims they may have are precluded by declaration of forest reserves that blanketed those areas, and are now being replaced by more stringent protected watershed and expanded national park and wildlife sanctuary status. These areas are home for most of the rural poor in the Ping River Basin, and their land use practices are now seen as threats to the sustainability of water resources and biodiversity.

Overall, then, the Ping River Basin is part of a gradient of change that begins in Bangkok and passes through the Central Plains, before entering the Ping River Basin at Nakhon Sawan. It then passes from the lower North into major valleys of the upper North, before ending in mountainous upper sub-basins with very small areas where lowland traditions and practices can be established. This gradient is physical in terms of terrain and its upstream direction, it is demographic in terms of population density, it is economic in terms of integration, and it is cultural and linguistic in terms of traditions, language, livelihoods and lifestyles. The 'center-periphery' character of this gradient is underscored by the concentration of rural poverty in uppermost sub-basins.

There is nothing static, however, about conditions along this gradient. Major processes of change have already swept through the Ping River Basin into even its farthest reaches, and these processes are continuing to evolve rapidly. Perhaps the two strongest forces driving change at this point in time are grounded in economic and governance processes, and their growing links with change at international and global levels.

- Economic change has already brought commercialization, capitalization and industrialization of agriculture in valley lowlands, which in tandem with opium crop substitution and road programs has begun reaching even formerly remote mountain areas. Timber stocks in natural forests have already been largely logged out and sold. At the same time, a major tourism industry has emerged, and rapid growth associated with commerce, industry and service sectors is driving urbanization at strategic river valley locations. Government programs are emphasizing development of local entrepreneurship (such as OTOP) and local micro-finance mechanisms. This entire system, however, is now faced with questions about how economic activities can best adapt and restructure themselves in response to international free trade agreements, growing capacity of neighboring countries with lower costs of production, and perceptions of a deteriorating natural resource base.

- Changes in governance processes accelerated rapidly after passage of the 1997 national constitution and related reforms. Most all communities in the Ping River Basin now have citizenship and elected local governments at the sub-district level, even in more remote mountain areas. Tessabans and Tambon Administrative Organizations (TAO) are building their capacity in many areas, including the levying and management of local taxes. Mandates are in place for communities and sub-districts to increase their role and participation in natural resource governance. Many government ministries and their agencies and programs are being reorganized to provide more emphasis at local levels, and especially for support of initiatives by local communities. And, there has been a surge in efforts by local communities to organize themselves in various forms and formats, including local networks that are now beginning to develop alliances at broader levels.

All of these changes are overlaid by growing education, information flow, and public awareness that are increasingly linked with trends at international and global levels. One important dimension of these linkages that is of particular relevance to this project relates to environmental awareness and action. Many environmental problems are now perceived and identified in the Ping River Basin, and local initiatives are being developed and launched to help address them.

- Major problems perceived in lowland areas through which main river channels pass include lack of proper planning, administration and management of fluvial systems, environmentally insensitive river engineering projects, inappropriate development of flood plain areas, pollution of rivers from sewage and agricultural and industrial drainage, encroachment into river corridors and water bodies resulting in narrowing of rivers and canals and reduction of public access, and loss of river landscape quality, aesthetic beauty and cultural legacies. Excessive groundwater extraction is a problem in and around urban areas, as well as in some areas of intensive agriculture.
- In mountain areas, perceived environmental problems focus on deforestation of watershed headlands that is believed to result in loss of biodiversity, accelerated soil erosion, and a range of impacts on hydrological systems, with impact claims extending beyond dry season stream flow to include flooding, landslides, and even assertions about impacts on total annual water yield, rainfall patterns and climate change. Highland agriculture and roads are seen as the worst offenders, with added impacts from stream pollution by agricultural chemicals, and dry season water use by sprinkler irrigation. Forest fallow agriculture and its use of fire are seen as the source of major negative problems in the midlands, and together with expansion of field crop production into sloping lands above lowland paddies, they are seen to be generating serious negative impacts on watershed services and biodiversity.

Although environmental concerns began to be integrated into agendas of civil society organizations as they emerged in the national political arena 20 years ago, a significant division in their directions and positions has taken place during the last decade or so. Activities initially focused largely on opposition to dam construction, logging concessions and large forest plantations, and there still appears to be substantial agreement about issues and actions that need to be taken regarding environmental problems in lowland, urban and industrial areas, and along main river channels. All tend to place much of the blame for these problems on unbridled commercialization, growth of consumerism, and very weak planning and regulatory mechanisms that are easily overridden by the wealthy and powerful. Their division is most apparent, however, in rural, and especially mountain areas:

- On the one hand, 'deep green' environmental groups are pushing hard for severe restrictions on midland and highland land use that would segregate local communities from forest lands, including strong support for current efforts by conservation agencies striving to expand national parks and wildlife sanctuaries to cover all class 1 watersheds and remaining areas of natural forest cover in the Kingdom.
- On the other side, 'populist' environmental groups are pushing for community control and management of forest lands, based on local traditions, knowledge and practices. They have lobbied hard for passage of community forestry legislation that is 'stuck' in Parliament, and support resistance by communities threatened with displacement or relocation by protected area expansion.

Both sides have been very active in the Ping River Basin, and have built alliances that include different factions in academia, government and other sectors of society. Tension between them has sometimes erupted into open conflict, such as in the Chom Thong district of Chiang Mai province a few years ago. Both sides also appear to be learning from this experience, however, and few want to see a repeat of such unproductive and divisive events. And perhaps most importantly, as local communities are exposed to the arguments and advocacy from both sides, many are listening to both points of view and seeking to identify a 'middle way' to improve their overall quality of life and safeguard the legacy of future generations.

Moreover, Thailand's Royal Family have shown exceptional leadership in these issues, and are constantly urging Thai society to develop a common vision of the future that combines improved livelihoods with sustainable natural resource management. This has been a very important source of inspiration that helps efforts to seek unity across government, business, civil society, and local community sectors of society.

It is in this context that river basin management programs and this project have emerged. Anecdotal evidence already clearly indicates that communities and groups in various parts of the Ping River Basin are building organizational capacity and experience with multi-community networks, often across ethnic and other social boundaries, to manage local sub-watersheds (called *lamnamyoi* in this report). And in some areas, these local networks are building alliances and federations among themselves to extend their organizational and management capacities to sub-basin levels. These are efforts that can provide the localized building blocks upon which sub-basin and river basin level management organizations such as those envisioned by this project can and should be built to effectively address the wide range of intertwined livelihood and environmental issues that organizations promoted under this project must address.

(3) Sub-basin delineation

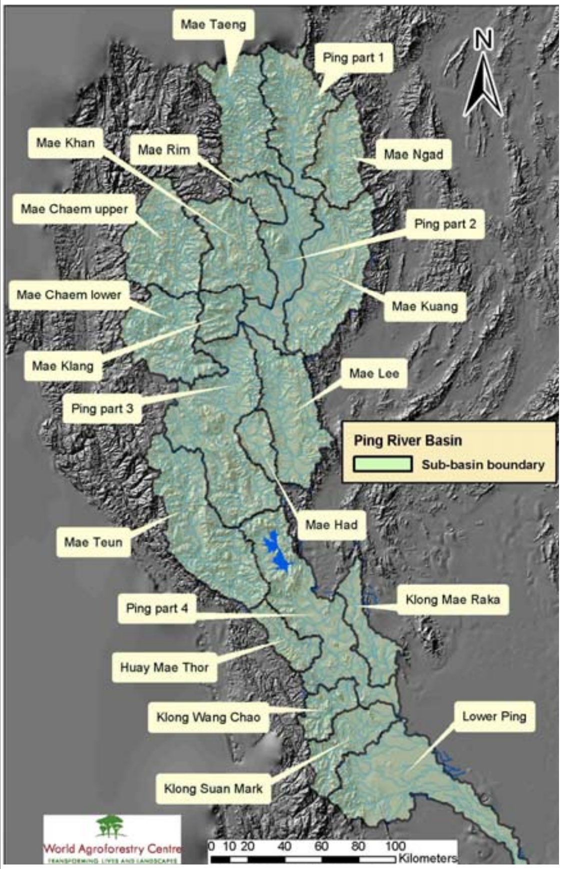
Associated with the difficulties commonly encountered in coordination among government agencies – even when located within the same Ministry – is the multiplicity of sub-basin delineations within the Ping River Basin that are presented as "official". Current classifications shown to this consultant range from 20 to 25 in number, with considerable variation in boundaries. Although sub-basin classification boundaries are associated with natural physical boundaries of watersheds, smaller watersheds are combined with others, presumably in order to be able to achieve more impacts and economies of scale for administration and management. At the same time, larger natural watersheds are sometimes split, either according to provincial administrative boundaries or other less apparent reasons.

The project recognized this issue from the outset, and this consultant collaborated in efforts to propose a reasonable compromise that would fit with ONEP's stated need to have a total of 20 sub-basins in the Ping River Basin, pursuant to a Cabinet resolution. Recommendations submitted to ONEP were mostly approved, with the major exception being the splitting of the Mae Chaem physical watershed into two sub-basins. Results are basically now the same as the delineation used recently by Chiang Mai University [CMU 2004].

In any event, there now is now a defined set of 20 sub-basins recognized by ONEP as the operational units for this project. The sub-basins are mapped and listed in Figure 2, along with data from ONEP on the area of each sub-basin. Boundaries and official area data have been provided by ONEP in a GIS shape file format.

While sub-basin delineation is an important initial clarification for operations under this project, there is still a need for ONEP to collaborate with other agencies of the Ministry of Natural Resources and Environment, as well as other relevant government agencies, to reach agreement on a common sub-basin delineation scheme for the Ping River Basin (and in the future other river basins). This is necessary in order to: (a) achieve common understandings that are essential for building participatory management organizations within the sub-basins, and (b) for coordinating communication with and support from the range of government agencies (as well as other public and private organizations and institutions) that will be associated with integrated basin management in both the immediate and longer-term future.

Figure 2. Ping Sub-Basins for this Project



		Area (sq km)
Upper Ping Basin		**25,370**
1	Ping part 1 *(Upper Ping)*	1,974
2	Mae Ngad	1,285
3	Mae Taeng	1,957
4	Ping part 2 *(includes Mae Aow)*	1,616
5	Mae Rim	508
6	Mae Kuang *(includes MaeTha)*	2,734
7	Mae Khan	1,833
8	Mae Lee	2,081
9	Mae Klang	616
10	Ping part 3 *(CM+LP+Tak portions)*	3,452
11	Mae Chaem upper	2,061
12	Mae Chaem lower	1,834
13	Mae Had	520
14	Mae Teun *(CM+Tak portions)*	2,896
Lower Ping Basin		**9,289**
15	Ping part 4	2,983
16	Huay Mae Thor	644
17	Klong Wang Chao	649
18	Klong Mae Raka	902
19	Klong Suan Mark	1,132
20	Lower Ping	2,980
Overall Ping River Basin		**34,659**

Source: ONEP, 2005

(4) Purpose of selecting priority sub-basins

This project aims to select three of these sub-basins where intensive pilot projects will develop, establish and test “model” participatory sub-basin management systems. Results from these pilot sub-basins are then to be applied to other sub-basins in the Ping River Basin.

In order to maximize the potential relevance of results in the pilot basins for application elsewhere in the larger basin, the three pilot sub-basins need to represent a reasonable range of conditions present in the Ping River Basin. Thus, from a technical point of view, sub-basin selection needs to focus to a large degree on sampling issues, and particularly on sampling those conditions that are likely to affect the nature of sub-basin management organization structure, composition and participatory processes, as well as the range of potential and actual natural resource management problems that need to be addressed.

At the same time, there may be substantial variation among sub-basins in the complexity and difficulty of building effective participatory management organization. While the sample needs to avoid selecting only the easiest cases, which would limit their relevance for other sub-basins, it also needs to avoid a focus on only the most difficult cases, which would make it unlikely that significant results could be achieved within the limited time frame of the pilot projects.

Moreover, it needs to be clear to local leaders in all sub-basins of the Ping River Basin that selection of the three pilot sub-watersheds does NOT mean that those not selected will receive no support for efforts to build participatory management organizations within their sub-basins. They need to clearly understand the government’s continuing commitment to efforts throughout the basin, and that anything they can do to help achieve significant positive results in the pilot sub-basins will help accelerate the rate at which broader, more inclusive efforts can be planned and implemented.

B. Sub-Basin Selection Criteria: Desirable and Practical

Although it is an intellectually interesting exercise to imagine innovative conceptual approaches for criteria that could help inform selection of pilot sub-basins (*aka* "micro-watersheds) under this project, reality calls for a far more pragmatic approach. Indeed, the approach must be able to build on existing data from readily available secondary sources, it must be relatively easy to implement within a very short time horizon, and it must be simple enough to be readily communicated to a wide range of stakeholders in the Ping Basin. At the same time, however, it should be reasonably rigorous, quantitative, logically sound, and able to address major issues that underlie motivation for initiating, conducting and providing funding support for this project. This section seeks to articulate an approach that aims to meet as many of these divergent needs as possible.

Relationships with Sub-Basin Rankings in Recent Studies of the Ping River Basin

The consultant has been provided reports on two previous efforts to rank sub-basins of the Ping River Basin: (1) Chiang Mai University Ping Basin Master Plan Study for ONEP [CMU 2004]; and (2) Panya Consultants Proposal to ONEP [Panya 2004] and an earlier report to DWP [Panya 2003]. These were based on recent and quite extensive efforts to collect, compile and assess various types of information and data in a systematic manner. For the purposes of pilot sub-basin selection under this project, key aspects of their approaches and the one used in this report include:

- ***Ranking Approaches.*** The CMU sub-basin study appears to be directed toward identifying priorities for investment according to the relative "importance" of sub-basins for conservation and development of the Ping Basin. Criteria were divided into three categories: physical and ecological, historical and cultural, and economic and social. The Panya study took an approach that sought to rank sub-basins according to the intensity of problems that need to be addressed in each sub-basin regarding natural resource management, with particular emphasis on water; needs for additional criteria are acknowledged in their proposal to ONEP. Given their somewhat different approaches to ranking, values for some indicators need to be inverted to make them conceptually compatible with the other source. This report draws on various of their data, and in some cases directly on indicators developed under both studies.
- ***Scoring Approaches***. The CMU sub-basin scoring system appears to be based on a mix of thresholds for quantitative data and (for indicators using multiple or less quantitative types of data or information) expert opinion said to be based on review of a quite wide range of data and information sources. The precise nature of many of these expert interpretations, however, remains somewhat obscure. The Panya scoring system relied more heavily on interpretation of quantitative data according to thresholds based on expert opinion. Since many of the new indicators proposed in this report seek to combine multiple data components in various ways, most rely primarily on a combination of quantitative data and relative weights. Relative weights can be adjusted according to expert opinion or stakeholder consensus.
- ***Scaling Systems***. Both reports produced sub-basin rankings based on indicators that employed a three-level scoring system, which appears to be a quite reasonable and useful approach. The CMU study used a scale of 1, 2, 3, while Panya used a scale of 0, 0.5, 1. Thus, results from one can be easily converted to be compatible with the other. Indicators in this report also use a 3 point maximum value scheme, which facilitates inclusion of some useful indicator values already estimated as part of those efforts.
- ***Indicator Weights***. The Panya approach used a simple average of scores across its indicators, implying equal weights for each, but giving de facto weights resulting from the relative number of indicators representing each subject area. Preliminary indicators in their proposal to ONEP reflect an emphasis on water resources, but they note that additional types of indicators need to be added. The CMU approach used weighting factors to equalize relative influence of its three major subject groupings on overall scores for sub-basin ranking. Various indicators proposed in this report use weights in calculating values for an individual indicator to affect relative influence of data components on overall indicator scores. Provision is also made for a transparent method of assigning relative weights among indicators.

(1) Grouping Sub-Basins into Lower, Middle and Upper Zones of the Ping Basin

This section develops a simple criterion and practical quantitative indicator for a more meaningful and systematic approach to classifying sub-basins according to lower, middle and upper sub-basin groups within the overall context of the Ping River Basin. A range of available data is then used to assess the characteristics of these groupings, and their relative scale and role in the context of the overall Ping River Basin. This provides a basis for a brief survey discussion of major types of stakeholders associated with forces driving change in land and water use in the Ping Basin, and how distribution of their relative role may vary across sub-basins and groupings. All of this provides input into articulation of a minimal simple set of key criteria that may be applied for pilot sub-basin selection under the limitations and constraints faced by the project. Following sections articulate specific indicators for each of the three remaining major sets of these criteria.

(a) Relative Sub-Basin Position in the Ping River Basin

Project documentation suggests that the three sub-basins should be selected so that "lower, middle and upper" sections of the Ping River Basin are represented by one sub-basin each. This was initially interpreted by Panya Consultants (and others) to mean southern, middle, and northern portions of the Ping River Basin. After considerable discussion among consultants and colleagues in ONEP, it has been agreed that other interpretations would be considered.

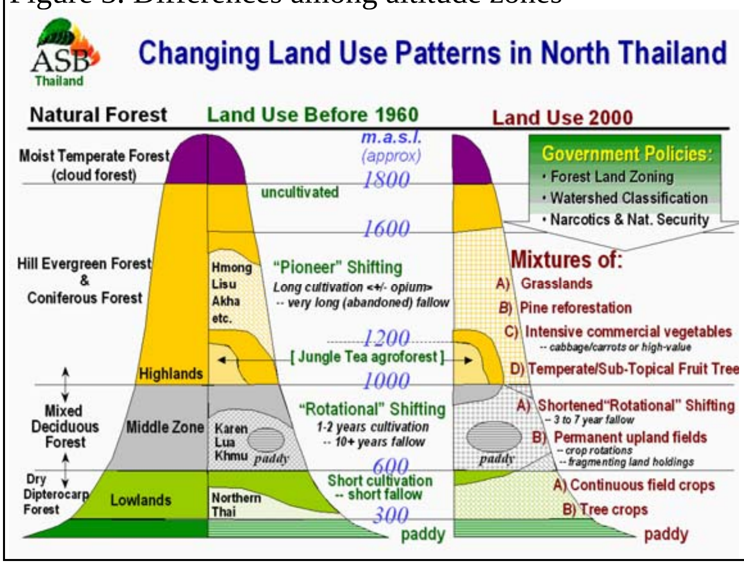
An alternative approach for interpreting the "lower, middle and upper" sub-basin issue is to consider the physical characteristics of the sub-basins. Our experience has been that many conditions and issues differ between what we have often called "upper tributary watersheds" and their more "lowland-dominated mainstream" counterparts. One of the major characteristics that helps distinguish between these types of watersheds is the relative proportions of the area that is located within different altitude zones.

Important differences among conditions and traditional agroecosystems found in mountain areas throughout mainland Southeast Asia correlate closely with altitudinal gradients. Accordingly, three major altitudinal zones have commonly been recognized around the region, corresponding to what can be characterized in the English language as: lowland, midland and highland zones. Indeed, this distinction is so basic that distinct terms in the Lao language [*Lao loum, Lao theung, Lao soung*] have been used for many generations to refer to the people whose history and culture is most closely associated with each zone.

A very generalized illustration of how these three altitudinal zones manifest themselves in northern Thailand is provided in Figure 3 [Thomas et.al. 2002]. The main features of this diagram are that natural forest and ecological conditions vary along an altitudinal gradient, as do the traditional (indicated here as before 1960) land use systems and associated ethnic groups. As suggested in the right side of the diagram, current land use and settlement patterns often deviate from traditional ones due to a variety of government policy, economic and social forces that have brought change to this region during recent decades.

The consultant proposes that distinctions between "middle" and "upper" portions of the Ping River Basin are more appropriate when made on the basis of the relative distribution of land among these three altitudinal zones.

Figure 3. Differences among altitude zones



There appears to be general agreement among consultants and ONEP staff that the "lower" portion of the Ping River Basin should refer to sub-basins located below the Bhumibol Reservoir, since the existence of this structure fundamentally affects the nature of conditions, issues and potential management approaches associated with at least the main channel of the Ping River. Indeed, this distinction between upper and lower portions of the Ping River Basin was made by the Office of the National Water Resources Committee after construction of this reservoir in 1964. Even for the sub-basins located in the "lower" portion of the Ping River Basin, however, it may still be instructive to assess the relative distribution of land and people among these altitude zones.

In order to incorporate altitude zone considerations into overall Ping River Basin assessments and the project's pilot sub-basin selection process, operational definition of zone boundaries needs to be agreed upon by project stakeholders. As a first step in this process, the following are proposed:

- Lowland-Midland Boundary. The altitude of 600 masl is proposed for this boundary because it appears to have been advocated and used by numerous natural resource management related agencies as the boundary above which land use (and land tenure) should be restricted by government policies. In addition, the survey of ethnic minority villages conducted in association with the National Security Council [DPW 1998] uses this as the lower boundary of their survey, in line with various "highland" policies of the government.
- Midland-Highland Boundary. The altitude of 1,000 masl is proposed for this boundary because it is considered as the rough lower boundary of what was the opium production zone in earlier years, and because areas near or above that altitude appear to generally be associated with hill evergreen or cloud forest types that are the highest priority concern of interests concerned with protection of watershed headlands and biodiversity.

This classification is easily converted into a spatial data format derived from sub-basin boundaries and a digital elevation (terrain) model. An example of this type of spatial classification of the Ping River basin and its sub-basins is provided in Figure 4. This map was constructed using sub-basin boundary data from ONEP, and a medium resolution digital elevation model constructed by World Agroforestry Center (ICRAF) staff using data from ICRAF and the Thailand Environment Institute (TEI) derived from 1:250,000 topographic maps with a 100 meter contour interval. This level of resolution should be sufficient for sub-basin classification purposes at this stage of the project.

This map also includes further sub-divisions of both the lowland and highland zones. The lowland zone is divided into areas above and below 300 masl, with the low portion approximating areas in major valley floors where paddy production is usually extensive. The highland zone is divided into areas above and below 1,600 masl, with the upper portion approximating mountain peak zones where cloud forest is often a prominent feature, and agricultural cultivation is relatively rare.

Criterion 1. Groupings of middle and upper sub-basins within the Ping River Basin should be made according to bias in their relative distribution of land area and human populations among lowland, midland and highland zones.

Indicator 1.1: Altitude Zone Area Bias Score. In order to derive a quantitative indicator that reflects variation among sub-basins in the distribution of land areas within these zones, Figure 5 illustrates how a "Lowland Zone Bias Score" can be calculated from land areas in each zone derived from the map. Under this method, a score of 3.0 would indicate all land is in the lowland zone, while 1.0 would indicate all land is in the highland zone. Reversing the values of the relative weights would produce a "Highland Zone Bias Score" that would reverse the order of the scores indicated in the table.

Based on these calculations, Ping sub-basins are listed in the order of their Lowland Area Bias Scores. Within the Upper Ping Basin, we can see that four sub-basins (Ping part 2, Mae Kuang, Mae Lee, Mae Had) have a strong area bias toward the lowlands, with scores of 2.5 or greater and more than 50 percent of their land area in the lowland zone. Thus, these form the core of the proposed "middle sub-basin" category. Six other sub-basins (lower & upper Mae Chaem, Mae

Taeng, Mae Tuen, Mae Klang, Mae Khan) have lowland bias scores less than 2.0, and all have more than 20 percent of their area in highland zones combined with less than 30 percent in lowland zones. They form the core of the proposed "upper sub-basin" category.

Figure 4. Altitude Zone Map of the Ping River Basin

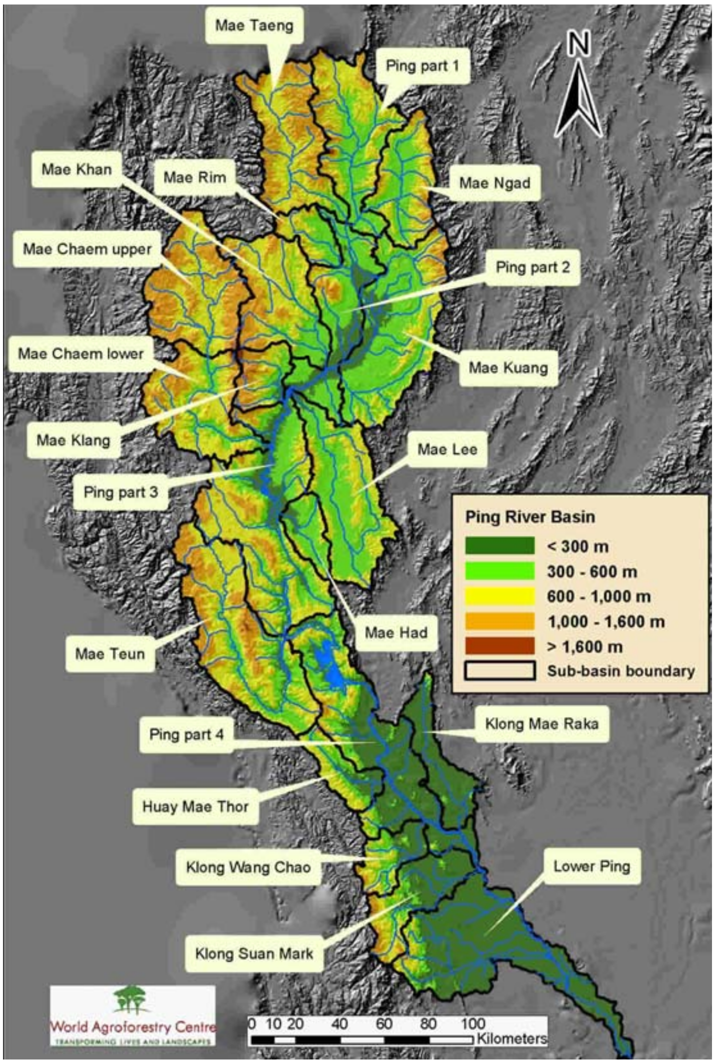


Figure 5. Calculation of the Lowland Zone Area Bias Score for Ping Sub-Basins

			unit: square kilometers					unit: Percent			unit: Score			1.1.
			Area Distribution					Percentage Distribution			Area Bias Score			
			Lowland		Midland	Highland		Lowland	Midland	Highland	Lowland	Midland	Highland	Lowland
Sub-Basin	*Share of Ping Basin*	*Total*	*<300 m*	*300 - 600m*	*600 - 1,000m*	*1,000 - 1,600m*	*> 1,600 m*	*<600m*	*600 - 1,000m*	*>1,000m*	Relative Weight multiplied by % of area			Zone Bias Score
	percent	*sq. km.*						**>50%**		**>20%**	**3.00**	**2.00**	**1.00**	
11 Mae Chaem upper	5.9	2,061	-	34	827	1,150	51	2	40	**58**	0.05	0.80	0.58	1.434
3 Mae Taeng	5.6	1,958	-	129	902	893	34	7	46	**47**	0.20	0.92	0.47	1.592
9 Mae Klang	1.8	616	33	145	177	227	34	29	29	**42**	0.87	0.57	0.42	1.866
12 Mae Chaem lower	5.3	1,834	21	320	938	531	23	19	51	**30**	0.56	1.02	0.30	1.884
14 Mae Teun (CM+Tak)	8.4	2,896	74	608	1,343	852	19	24	46	**30**	0.71	0.93	0.30	1.934
7 Mae Khan	5.3	1,833	10	417	894	496	16	23	49	**28**	0.70	0.98	0.28	1.954
1 Ping part 1	5.7	1,974	-	795	857	308	13	40	43	16	1.21	0.87	0.16	2.240
2 Mae Ngad	3.7	1,285	-	560	516	208	1	44	40	16	1.31	0.80	0.16	2.273
"upper sub-basins"	*42*	*14,458*	*138*	*3,009*	*6,453*	*4,666*	*192*	*22*	*45*	*34*	*0.65*	*0.89*	*0.34*	*1.882*
5 Mae Rim	1.5	508	7	225	206	71	0	45	41	14	1.36	0.81	0.14	2.315
10 Ping part 3 (CM+Tak)	10.0	3,452	511	1,033	1,511	395	1	45	44	11	1.34	0.88	0.11	2.332
8 Mae Lee	6.0	2,081	34	1,221	789	37	-	**60**	38	2	1.81	0.76	0.02	2.585
6 Mae Kuang (w/M.Tha)	7.9	2,734	307	1,583	670	167	8	**69**	24	6	2.07	0.49	0.06	2.627
13 Mae Had	1.5	520	55	331	126	8	-	**74**	24	2	2.22	0.48	0.02	2.725
4 Ping part 2 (w/M.Aow)	4.7	1,616	454	918	165	79	1	**85**	10	5	2.55	0.20	0.05	2.799
"middle sub-basins"	*31*	*10,911*	*1,367*	*5,310*	*3,467*	*757*	*10*	*61*	*32*	*7*	*1.84*	*0.64*	*0.07*	*2.542*
Upper Ping Basin	***73***	***25,370***	***1,506***	***8,319***	***9,920***	***5,423***	***202***	***38.7***	***39.1***	***22.2***	***1.16***	***0.78***	***0.22***	***2.166***
17 Klong Wang Chao	1.9	649	217	178	204	47	2	**61**	31	8	1.83	0.63	0.08	2.532
16 Huay Mae Thor	1.9	644	173	191	264	17	-	**56**	41	3	1.69	0.82	0.03	2.539
19 Klong Suan Mark	3.3	1,132	582	180	227	132	11	**67**	20	13	2.02	0.40	0.13	2.546
15 Ping part 4	8.6	2,983	1,856	614	447	67	0	**83**	15	2	2.48	0.30	0.02	2.805
20 Lower Ping	8.6	2,980	2,664	156	141	18	-	**95**	5	1	2.84	0.09	0.01	2.940
18 Klong Mae Raka	2.6	902	852	42	8	-	-	**99**	1	-	2.97	0.02	-	2.992
Lower Ping Basin	***27***	***9,289***	***6,343***	***1,361***	***1,290***	***282***	***14***	***82.9***	***13.9***	***3.2***	***2.49***	***0.28***	***0.03***	***2.798***

The remaining four sub-basins (Ping parts 1 & 3, Mae Rim, Mae Ngad) fall in between these two groups, and all have a similarly more balanced distribution among the three altitude zones. Of the three, Mae Rim differs in its much higher population density, and a more proportionate share of urban settlements and industry (see the following section for data). The Ping part 3 sub-basin differs in that it includes a long section of the main channel of the Ping River. Thus, it is proposed that a lowland bias score of 2.30 be used as the cut-off point between the "middle sub-basin" and the "upper sub-basin" categories.

These considerations result in this proposed grouping of sub-basins:

- ***Lower Sub-Basins***: Ping part 4, Lower Ping, Klong Wang Chao, Huay Mae Thor, Klong Suan Mark, Klong Mae Raka
- ***Middle Sub-Basins***: Ping parts 2 & 3, Mae Kuang, Mae Lee, Mae Had, Mae Rim
- ***Upper Sub-Basins***: Mae Taeng, Mae Chaem (lower & upper), Mae Tuen, Mae Klang, Mae Khan, Ping part 1, Mae Ngad

These groupings of sub-basins, as illustrated in Figure 6, appear to correspond rather well with our general perceptions of major differences in the relative distributions of natural resource characteristics of "upper tributary" versus "major lowland valley-oriented" sub-basins. This appears to support our perception that the Altitude Zone Area Bias Score is a useful tool for distinguishing between "upper" and "middle" sub-basins in the Upper Ping River Basin, as well as for identifying where middle and upper zone natural resources are more or less important in sub-basins of the Lower Ping Basin.

Figure 6a. Lower Sub-Basins

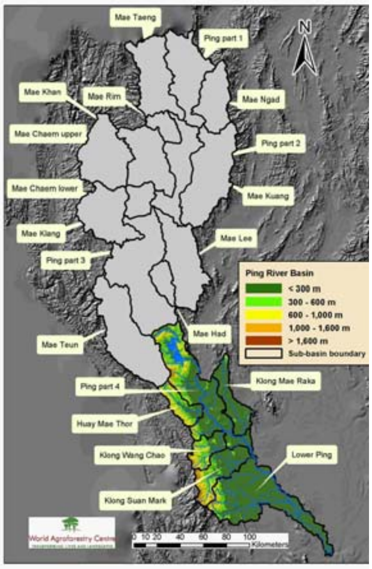


Figure 6b. Middle Sub-Basins

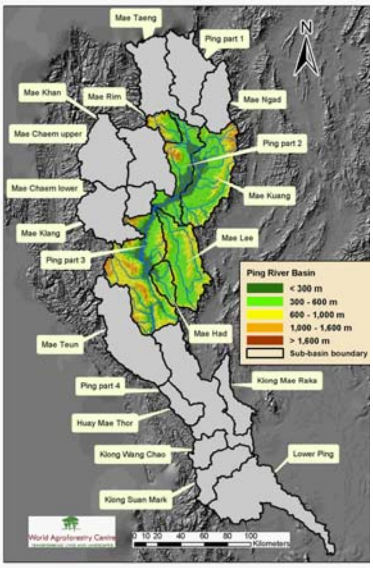
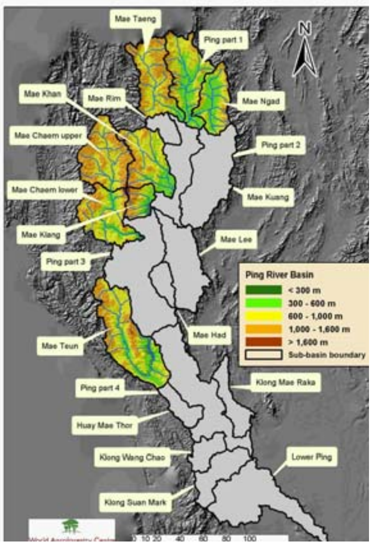


Figure 6c. Upper Sub-Basins



(b) Relative Scale and Role of Sub-Basin Groupings

Having established a rationale, criterion and quantitative indicator for grouping sub-basins into lower, middle and upper categories, we can now turn to their relative importance in the biophysical and human settlement regimes of the overall Ping River Basin. In order to assess distributions of some of the Ping River Basin's major overall characteristics among the various sub-basins and groupings, Figure 7 has been constructed from a combination of data available from ONEP, Panya, and the study by CMU [2004]. Some data for Mae Chaem was not in formats that could differentiate between "upper" and "lower" areas where ONEP seeks to divide the physical sub-basin. Otherwise, the table is reasonably complete.

To help assesses the degree to which the proposed criterion and quantitative indicator for establishing sub-basin groupings appear to be effective in differentiating among groups with significantly different characteristics, we can see the following patterns in the data in Figure 7:

Figure 7. Sub-Basin Shares of Major Ping River Basin Characteristics

	Terrain	Land		People, Settlement, Income						Cropped Area		Forest Cover Area			State Forest Zone Area			Soil Loss	Water		River
Sub-Basin	Lowland Bias	TOTAL AREA	URBAN AREA	POP Density	TOTAL PEOPLE	UPLAND MINORITY	URBAN PEOPLE	NO. OF INDUST	OVERALL INCOME	TOTAL AGRIC	IRRIG AGRIC	SCRUB FOREST	DEGRAD FOREST	TOTAL FOREST	FOREST LANDS	PROTECT FOREST	WS 1AB ZONE	TOTAL EROSION	ANNUAL RUNOFF	DRY SEAS RUNOFF	STREAM LEVEL
unit:	score	% total	% total	per/km2	% total	% total	% total	% total	% total	% total	% total	% total	% total	% total	% total	% total	% total	% total	% total	% total	score
11 Mae Chaem upper**	1.43	6	1	**	**	**	0	0	**	1	**	0	1	8	7	0	11	**	**	**	2
3 Mae Taeng	1.59	6	3	37	3	6	1	1	2	4	7	0	2	7	7	11	11	6	7	8	2
9 Mae Klang	1.87	2	1	72	2	5	2	2	2	1	1	3	1	2	2	4	2	3	3	3	2
12 Mae Chaem lower**	1.88	5	1	25	4	21	0	0	4	2	2	1	2	7	6	11	8	13	13	16	2
14 Mae Teun	1.93	8	1	18	2	12	0	0	2	3	2	0	7	12	10	10	14	15	11	9	2
7 Mae Khan	1.95	5	5	59	4	8	4	2	4	3	5	9	2	6	6	2	6	7	5	6	2
1 Ping part 1	2.24	6	3	40	3	7	1	0	2	4	1	1	21	5	6	11	7	7	6	6	3
2 Mae Ngad	2.27	4	3	52	3	2	1	0	3	2	4	1	2	4	4	9	5	4	4	4	2
Upper Sub-Basins	***1.88***	***42***	***15***	*36*	***21***	***62***	***9***	***6***	***18***	***20***	***22***	***16***	***39***	***52***	***49***	***58***	***64***	***55***	***49***	***52***	
5 Mae Rim	2.32	1	2	153	3	2	2	2	3	1	1	0	2	2	2	1	2	4	3	4	2
10 Ping part 3	2.33	10	5	23	3	10	1	0	1	4	0	20	3	12	11	14	8	4	5	5	3
8 Mae Lee	2.59	6	6	71	6	12	1	1	6	5	6	17	6	6	5	1	3	4	3	2	2
6 Mae Kuang	2.63	8	20	108	12	2	7	9	12	10	13	13	9	6	6	3	5	5	9	6	2
13 Mae Had	2.73	2	1	84	2	1	1	0	2	1	3	1	1	2	2	1	1	3	4	5	2
4 Ping part 2	2.80	5	26	404	25	4	40	29	32	8	7	8	8	2	2	2	2	2	4	4	3
Middle Sub-Basins	***2.54***	***31***	***60***	*117*	***51***	***31***	***52***	***41***	***56***	***29***	***30***	***58***	***29***	***29***	***28***	***23***	***22***	***22***	***26***	***25***	
17 Klong Wang Chao	2.53	2	0	31	1	2	0	1	1	2	0	0	3	2	2	3	2	2	2	2	2
16 Huay Mae Thor	2.54	2	0	25	1	1	1	1	1	0	0	0	3	2	2	2	2	2	1	1	2
19 Klong Suan Mark	2.55	3	1	60	3	0	0	2	2	4	2	0	1	3	4	5	3	4	4	4	2
15 Ping part 4	2.81	9	8	57	7	1	6	8	6	8	6	20	19	7	7	6	5	6	6	6	3
20 Lower Ping	2.94	9	14	121	15	4	30	40	15	32	38	2	0	2	5	3	2	7	10	8	3
18 Klong Mae Raka	2.99	3	1	31	1	0	2	1	1	4	2	4	5	2	2	0	0	1	2	2	2
Lower Sub-Basins	***2.80***	***27***	***25***	*72*	***28***	***8***	***39***	***53***	***26***	***50***	***48***	***26***	***32***	***19***	***23***	***19***	***14***	***23***	***25***	***23***	
Ping Basin	**2.33**	**100**	**100**	*70*	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	

** These data for Mae Chaem cannot yet be split into upper and lower sub-basins – overall data listed under lower Mae Chaem

- ***Lower Sub-Basins*** include a quite balanced 27 percent of the area, 28 percent of the people, and 26 percent of the total income of the Ping River Basin. They have a disproportionately large share, however, of the urban people (39%), industry (53%), and agriculture – both total (50%) and irrigated (48%) – due largely to their high concentrations in two larger sub-basins (Ping part 4, Lower Ping) through which the Ping River's main channel flows. Perhaps not surprisingly, they also account for disproportionately low shares of the Ping River Basin's total forest cover (19%) and protected conservation (19%) and watershed (14%) forest zones, about half of which is located in three smaller tributary sub-basins. Their shares of runoff and soil erosion are roughly proportionate to their share of overall basin area.

- ***Middle Sub-Basins*** account for 31 percent of the area, but 51 percent of the people and 56 percent of the total income of the Ping River Basin. They also have more than half (51%) of the people living in urban areas, and 41 percent of the listed industries in the Ping Basin. These high shares are largely due to concentrations of these features in the Ping part 2 and Mae Kuang sub-basins. The grouping has a roughly area proportionate overall share of agriculture (29% of total, 30% of irrigated), upland ethnic minorities (31%), total forest cover (29%) and total forest lands (28%), but a somewhat lower share of protected conservation (23%) and watershed (22%) forest zones, runoff (26% annual, 25% dry season), and estimated soil erosion (22%).

- ***Upper Sub-Basins*** cover 42% of the area, but include only 21% of the people and 18 percent of the total income of the Ping River Basin. They account for only 9% of urban people and 6% of industry, but they have a share of agriculture (20% of total, 22% of irrigated) proportionate to their share of total population. Their disproportionately large shares are in upland ethnic minority populations (62%), total forest cover (52%), protected conservation (58%) and watershed (64%) forest zones, total state forest lands (49%), runoff (49% of annual, 52% of dry season), and estimated soil erosion (55%). Their spatially proportionate share of degraded forest (39%) is due to a concentration in the Ping part 1 sub-basin, whereas estimated soil erosion is disproportionately high in Mae Tuen and Mae Khan sub-basins.

These characterizations further confirm significant differences among lower, middle and upper sub-basins of the Ping River Basin, even though groups are based only on consideration of land area distributions. In selecting sub-basins to "represent" these conditions, however, it is also very important to note the significant variation among sub-basins that remains within each of these categories. While smaller sub-basins (in terms of area or people) may appear attractive for a short-term pilot project such as this one, it is the smaller sub-basins that appear to vary the most from overall characteristics of each of the groupings. And for many factors, this type of variation appears to be greatest in the lower and middle sub-basin groupings.

(c) Mix of stakeholders and forces driving change in land and water use

The project seeks to focus on pilot efforts to develop participatory approaches, methods and tools for building sub-basin management organizations. Results from these pilot efforts are intended to provide the basis for informing efforts in the remaining sub-basins of the Ping River Basin. Since requirements for engaging major stakeholders in participatory processes are likely to vary across different types of interests, groups and organizations, there should be a substantial priority placed on inclusion of as many of the major stakeholder groups in the Ping River Basin as possible (and practical) in the pilot projects.

Given the substantial differences in characteristics of sub-basins in the lower, middle and upper groupings that have been assessed in previous sections, however, we do not necessarily need to believe that all stakeholders with a presence in the basin need to have an equal emphasis in each of the pilot sub-basins. On the other hand, it would not be prudent to focus on only one or two major elements in a particular sub-basin if important minority interests are also present. Thus, the emphasis needs to be on including an appropriate “mix” of stakeholders in pilot participatory management processes.

Patterns that emerge from the data in Figure 7 can provide a good starting point for identifying some important characteristics of the “footprint” left by major stakeholder groups associated with forces driving land use change in each sub-basin. There are also very important elements associated with human organization that underlie these patterns, which are particularly important for characterizing the full range of key stakeholders that should or could play key roles in pilot sub-basin management organizations.

Thus, the following quite simplified discussion seeks to summarize the rationale through which various stakeholders are linked with trends of change associated with natural resource management in the Ping Basin and major underlying driving forces [Thomas et.al. 2004]. This information sets the stage for identification of further criteria and indicators in the following sections.

- **Forestry:** About 80 percent of the total land area of the Ping River Basin has been designated as state forest land, with various categories of forest land status legally restricting land use for other purposes. About 46 percent of the basin is designated as reserved forest land. Yet there are many villages and their associated agroecosystems that occupy portions of land in reserved forest zones, many of which (but not all) have been doing so since long before reserved forest status was established. Logging concessions in reserved forest land were a quite substantial source of local conflict between forestry interests and local communities in the past, but since logging concessions were revoked logging conflicts have moved into the realm of entirely illegal activity. Similarly, there are various national parks and wildlife sanctuaries that cover about 34 percent of the Ping River Basin, for which there are very strong laws against other forms of land use. A relatively small but significant number of people are dependent on portions of these areas for their livelihoods. And, within the last 20 years, all land in the Ping River Basin has been classified by its watershed characteristics, resulting in increasingly strong restrictions on land use according to watershed classification zones. These restrictions culminate in class 1 status wherein only undisturbed natural forest is viewed as an “acceptable” land use; about 37 percent of the Ping River Basin has been assigned class 1 status. As indicated in Figure 7, class 1 watershed lands are present in all sub-basins, but upper sub-basins account for nearly two-thirds of the total area. Moreover, all lands zoned as class 1 watershed that are not already within the boundaries of a national park or wildlife sanctuary have been quietly placed by forestry officials into the category of lands being “prepared” for protected conservation area status (*i.e.* national park or wildlife sanctuary). Local communities in these areas, which cover nearly 20 percent of the Basin’s total area, have virtually no input into, or usually even knowledge of, these processes prior to the formal announcement that their area has been declared a national park or wildlife sanctuary. Tensions and conflict in these areas are high.

Different government agencies are responsible for each of these types of forest land zones, and each considers themselves to be the guardian and manager, if not the "owner", of land within that zone – any other land use conducted without specific written permission from higher level authorities in Bangkok is technically illegal, and those who engage in such practices are subject to expulsion and legal punishment at any time. While in reality, forestry officials often accept and work with many of the local communities in their area, this is dependent of the views of the individual officials involved, and thus subject to change as officials are reassigned or policies change in Bangkok. In areas where illegal logging still occurs, there are often influential people who support, direct and benefit from it behind the scenes, whereas local villagers are often hired to do the work and take the blame if authorities catch them in the act.

- **Agriculture:** While agriculture uses an estimated 30 percent of the land area of the Ping River Basin and is, of course, present in all sub-basins, there is very substantial variation in its forms and relative extent. A clearly major characteristic of larger Lower Ping sub-basins is very substantial areas of irrigated lowland agriculture. Although somewhat less dramatic, the same is essentially true for most of the Middle Ping sub-basins. Intensification and commercialization of lowland agriculture, including increasing use of various types of agricultural chemicals, has been occurring for several decades in major valley areas. This has also been proceeding in association with industrialization of agriculture that is linked with small to large-scale private enterprise, as well as various forms of producer cooperative organization. In addition to rice and paddy-based field crops, commercial vegetable production and fruit tree horticulture is extensive in many areas. Expansion and intensification of lowland agriculture has also brought growing demand for reliable, increasingly year-round supplies of water.

  Commercial field crops. In upper sub-basins, as well as in midland zones of some middle and lower sub-basins, intensive commercial field crop production, which includes use of improved seed and agricultural chemicals, has been expanding up into sloping lands above major lowland paddy areas. In some cases this is being conducted in association with contract farming arrangements between local growers and medium to large-scale agro-industrial firms. In other areas, upslope expansion is associated with commercial fruit tree orchards that also bring additional demand for irrigation water.

  Forest fallow. Especially in upper sub-basins with extensive lands in the midland zone, many ethnic minority villages have long conducted rotational forest fallow shifting cultivation of upland rice (and a mix of associated minor subsistence crops) to supplement their small areas of paddy, expansion of which is limited by terrain characteristics. As traditional forest fallow rotation cycles were usually 10 or more years in length, and fallow fields are mixed into a landscape that also includes patches of permanent forest managed for additional subsistence products, the overall amount of land required for these systems seems very extensive to lowlanders. The large difference in the nature of these practices compared to lowland systems, as well as the ethnic differences that are usually characteristic of those who employ them, have been associated with widespread lack of understanding, and a virtually total lack of acceptance of the "legitimacy" of these practices by government and much of lowland society. As a result, state forest land zones were designated over most of these areas without consideration of the existence of these systems. Thus, most are now categorized as "illegal encroachers" on state forest lands, regardless of their history in the area. Moreover, forestry and conservation interests interpret patches of permanent and regenerating forest, along with the use of fire to clear patches as they are prepared for crop cultivation, as indicators of degraded or deteriorated forest. The still ongoing expansion of national parks and wildlife sanctuaries aims to place most all of these areas under protected conservation forest status, and thereby force an end to such practices. Not surprisingly, tension, conflict, and resistance are increasing. Many villagers are being forced to reduce their forest fallow cycle length, and in some areas they have yielded to government pressure to convert to fixed field cultivation. This conversion has been associated with introduction of agricultural chemicals to replace the ecological functions formerly provided by forest fallow, and has thus also been accompanied by the commercialization of agriculture in these areas. Linkages in such areas with lowland agro-industrial firms are growing, including contract farming practices.

"Miang" forest gardens. A somewhat parallel set of circumstances has involved areas of sub-basins in the Ping River Basin where "miang" tea production has been a traditional practice. Ecological requirements for these production systems result in their clustering near the midland-to-highland transition zone. Practices involve interplanting of the *camellia* tree species into natural hill evergreen forest. This results in the failure of many people not familiar with the systems to even realize they exist, and in very poor records and documentation about them. This "invisibility" has also resulted in their inclusion in reserved and protected forest land zones, which also places them in the category of illegal forest encroachers. Despite decreasing demand for "miang" associated with generational change, many of these systems still appear viable as new product forms and markets are found, and in some areas additional economic trees are mixed into their complex structures that often continue to mimic natural forest.

Highland horticulture. Yet another set of major agriculture stakeholders is associated with highland zones, which are most extensive in upper sub-basins, but are also present to some degree in middle and lower sub-basins that have minor portions of their area within the highland zone. These zones include areas where opium production was once a major activity, making them a central target for successive waves of opium crop substitution projects during the last 40 years. These projects and associated development programs have brought roads and a range of government services to many of these formerly very remote areas, and have successfully facilitated conversion of agricultural practices from pioneer shifting cultivation systems that included opium, into settled areas where intensive commercial production of horticultural products has expanded dramatically. Production has largely focused on temperate and sub-tropical zone crops that have an ecological comparative advantage in highland zones, and which have little or no direct competition in lowland zones. Both annual and tree crop production have been adopted (and adapted), with emphasis varying in different areas. Many of the ethnic minority communities involved – most notably the Hmong – have proved to be very capable producers and entrepreneurs, and the profitability of their agricultural systems is often equal to or greater than those found in lowland zones of upper sub-basins [Thomas et.al. 2002]. Ethnic Thai producers are now also very active in various areas, with operations varying from small to quite large (by northern Thai standards) scale.

Probably not surprisingly, these highland systems have undergone very substantial and quite rapid expansion. This has made them a focus of much concern among forestry officials and lowland stakeholders who believe they are destroying hill evergreen forest in critical watershed headwater zones, and thus threatening the longer term sustainability of agricultural and natural resource systems upon which all those in the Ping River Basin depend. These concerns are accentuated by the use of substantial levels of agricultural chemicals and often sprinkler irrigation systems in intensive highland commercial systems, raising further downstream worry about chemical pollution of water resources and reduced dry season stream flow. Thus, even though those engaged in these types of highland agricultural practices often account for only a quite small percent of the area and people of a given sub-basin, their profile in natural resource management-related concerns is usually disproportionately large. During the initial field visits of the project team of ONEP staff and consultants, concerns over this type of agriculture were a very prominent feature of views expressed throughout the Ping River Basin.

- **Urban Centers:** As data in Figure 7 confirm, urban centers with increasingly very intensive use of land and water resources for residential, commercial, service and industrial purposes have already become a major stakeholder in several lower and middle sub-basins of the Ping River Basin. Moreover, many of the larger urban centers are located along the main channel of the Ping River itself, and have emerged from evolution of cultures that have focused much attention on river banks and adjacent lowland areas. Given the weaknesses of land use planning, zoning or associated types of efforts to manage patterns of land use change during periods of rapid economic growth and social change, there are numerous problems associated with impacts of competing and conflicting forms of land use on the quality of urban life, as well as with development of systems to provide services related to provision of urban water supply, sanitation, wastewater treatment, and solid waste disposal services. As a result, urban centers are considered important sources of water pollution, waste, and sometimes air pollution that are public health concerns. Those located along main channel riverbanks have additional issues that have been discussed to a substantial extent by the CMU study team [CMU 2004]. Those located along smaller irrigation canals can be even worse, since they appear to be exempt from laws restricting construction along banks of natural streams; many are candidates to become similar to the 'black khlongs' in the vicinity of Bangkok.

At wider sub-basin levels, urban centers tend to have quite large spheres of influence in sub-basins where they are prominent, through the reach of their business, financial, trade, industry, tourism, and other sectoral bases, as well as through their roles as markets for agricultural and forest products, suppliers of agricultural inputs and consumer goods, bases for land speculators, sources of wage labor, centers of education, and other functions that penetrate into surrounding rural areas. Thus, key stakeholders in urban areas need to include leaders of both municipalities and the various sectoral groupings that are present.

- **Industry:** While much of the industry in the Ping River Basin is associated with urban centers, there are also a few industrial estates and industries located in or near smaller district towns. Some industries such as agricultural processors, wood products, and handicrafts have direct linkages with forestry and agriculture sectors. Others provide employment that affects wage labor rates and employment alternatives to land-based enterprise. There is also growing concern about impacts of industrial activity on consumption and pollution of water resources, as well as air pollution and waste disposal. Where present, they should be considered an important stakeholder. Another relevant dimension of industrial activity that is frequently obscured by industry data such as that presented in Figure 7, is the outreach operations and/or broker functions that allow agro-industrial firms to engage in operations such as contract farming, even in relatively remote portions of the Ping River Basin.

- **Tourism:** Tourism is an important and still growing and developing part of the economy in many sub-basins of the Ping River Basin, and data in Figure 7 does not yet capture information about how tourism activities are distributed among sub-basins. While tourism tends to be discussed as though it is a single set of activities, the tourism market has been moving toward increasing differentiation among a substantial range of types. Each type tends to have its own demands from and impacts on natural resources and the environment. Trade-offs among types are also increasingly common, wherein expansion of one type of tourism can undermine potential for the viability or expansion of other types. Both trade-offs and complementarities can appear among esthetics important for tourism and local residents. Yet, maintenance of esthetic components of rural landscapes and urban environments has a low priority, and there is no legal basis for damages incurred by activities or investments dependent on them. In any event, key stakeholders related to the operation and development of the various types of tourism services present in or envisioned in a sub-basin should definitely be included in pilot watershed management activities.

- **Central and Local Government**: Agencies of the central government include those operating directly under central control, as well as those that have moved toward decentralization by assigning staff to units that are under the direct supervision of local administrations at provincial and district levels. Examples of units under direct central control that are very relevant to natural resource management in the Ping River Basin include forestry units in charge of national parks, wildlife sanctuaries and headwater conservation units, as well as units responsible for forest protection, forest fire control and community forestry. These examples all play especially prominent roles in upper sub-basins, but may also be strategically important in other sub-basins. While data on state forest zone areas in Figure 7 help indicate their likely distribution among sub-basins, spatial datasets with specific unit locations and jurisdictional domains would be even more useful. Irrigation and land development units, as well as military and border patrol police, also operate in this mode and have their own jurisdictions. Other types of government organizations, such as higher-level academic institutions, for example, can also play roles that can be important at particular points in space and time, but these tend to occur on more of an ad hoc than a programmatic basis.

Local administration itself centers on hierarchical linkages among provincial and district levels, and down to sub-district kamnan and village headmen. While the local administration apparatus is ubiquitous throughout all sub-basins, the presence or absence of units representing 'line' ministries can vary somewhat, as can their relative capacities and resources. Agriculture, public health, education, community development, police and others have a history of representation at district levels, but reorganization during recent years is reducing their presence. A wider range of agencies is represented at the provincial level.

Local government centers on sub-district level elected Tambon Administration Organizations (TAO), and on municipalities (*tessaban*) in larger *tambons* and urban areas. TAO and municipalities are of increasing strategic importance, due both to their elected local leadership, and to their growing mandates and authority under the 1997 constitution and governance devolution policies. Mandates include the ability to levy property taxes and to issue approvals required before a wide range of activities can take place within their jurisdictions. Their capacities to conduct the full range of activities that fall within their growing mandates, however, vary substantially, and tend to be particularly weak in upper sub-basins where many of their constituents are ethnic minority communities who have only recently gained access to full participation in local governance processes, and where extensive legal restrictions on land use undermine their ability to raise revenues from property tax. Associations of TAO at least at provincial level are seeking to assist members facing some of these types of difficult situations, as are a number of other governmental, academic and non-governmental organizations.

At all these levels, jurisdictional boundaries of administrative units often diverge from natural boundaries such as watersheds, and effective sub-basin management can vary widely in the number of administrative units that need to be involved, as well as the level of difficulty involved in coordination among them.

- **Civil Society**: There has been a quite dramatic surge in the development of various forms of non-governmental civil society institutions, especially just prior to and since passage of the 1997 national constitution. In addition to the range of more longstanding groups, such as professional associations and charities, a range of "NGO's" and "people's organizations" has also emerged. During the earlier years of their recent emergence and evolution, NGO's based in Bangkok or other urban areas, or who were subsidiaries of international organizations, tended to play the most prominent non-governmental role in rural development, environmental, and natural resource management initiatives. During more recent years, however, there has been very distinct movement toward emergence of much more initiative by "people's organizations" and networks, with "NGO" roles beginning to shift more to provision of various forms of organizational, technical, analytical, management, and in some cases policy advocacy types of support for local organizations and networks. A number of domestic, and a few international NGO's are operating in sub-basins of the Ping River Basin, and most appear to be focusing their efforts on support for networks of communities, schools, women's groups, producer groups, village volunteers, or other types of institutions or local organizations.

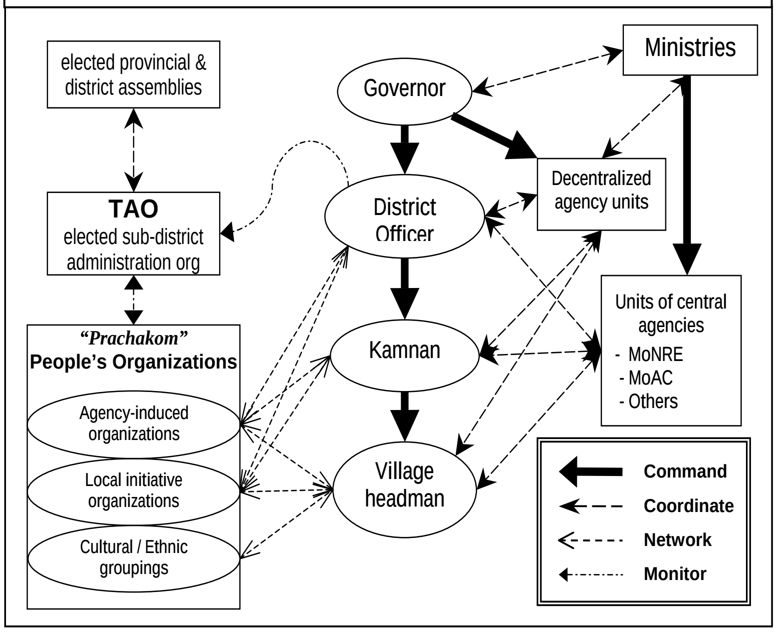
  In relation to natural resource management, three generic types of these people's organizations have become particularly relevant:

  - Agency-induced groups. These include local organizations that may have begun under agency control but evolved into a more independent form, such as agricultural cooperatives, as well as recent efforts by agencies to encourage and induce formation of local groups, such as has been the case with many forest conservation groups. Agency links with 'village volunteers', such as those working on public health, soil problems, and environmental issues for example, are a related approach. Various types of support for these groups have been provided by agencies. This has been an increasingly common tactic employed by various government agencies, resulting in varying degrees of success and impact.

- Local initiative groups. These include groups based in longstanding local traditions, such as the *muang fai* water user groups, more recent local initiatives such as growers associations, as well as the new generation of networks being formed at multiple levels. Since most are derived from local efforts to support group activity that is in the best interest of the membership of the group, many began with a relatively narrow focus on a particular type of function, activity or product. Networks providing linkages among such groups appear to be a still relatively informal, but practical means of federating to increase the scale of coverage, mobilization capacity, economic and/or political bargaining power, and other types of attributes that are needed or useful from time to time. Various outside NGO, government and/or business actors often provide encouragement and support. The most recent wave of networks emerging in some areas can even be called 'networks of networks' as they seek to bring higher-level coordination and integration at various scales, which often correspond with watersheds. Where they exist and have developed enough capacity, these are likely to be important building blocks and prototypes for the sub-basin management organizations envisioned under this project and the Ping River Basin rehabilitation and management efforts more generally.
- Cultural, religious and ethnic groups. These groups can be organizationally quite similar to local initiative groups in many ways, but their membership is more specifically confined to particular groups who share specific ethnicity, or cultural or religious beliefs and traditions. Ideally, such groups can, and in many cases increasingly do, play a very important and useful supporting role in natural resource management activities. Caution needs to be exercised, however, especially in cases where competition, tension or conflict related to natural resource issues are among groups that coincide with ethnic or religious differences, that involvement of such groups does not increase divisiveness or conflict. In any event, the pilot project needs to at least avoid alienating such groups, as their opposition can often be quite powerful.

A very simple, generalized depiction of how most of these types of government and civil society institutions and organizations, and relationships among them, can be seen from a local level is provided in Figure 8. Basic components of this diagram were conceived by a team of CMU graduate students studying resource governance institutions and issues in the Mae Chaem sub-basin [Thomas et.al. 2004]. The role of members in the local administration hierarchy as brokers and coordinators is quite noteworthy, as is the potential for strengthening links between TAO and people's organizations through mechanisms available to provide for interaction with, and even funding for local *prachakom* organizations. Since many local sub-basin management-related networks demonstrate potential for becoming important building block components of sub-basin management organizations, such links with TAO could prove to be an important means for integration and support at local levels.

Figure 8. Local resource governance institutions



References in remaining sections of this chapter to major stakeholders and the land use change processes with which they are associated will rely on these discussions.

(d) Criteria that reflect these issues

The Ping River Basin project seeks to focus on pilot efforts to develop participatory approaches, methods and tools, and apply them in developing 'model' management organizations in three selected pilot sub-basins, as a prelude to their wider application in other sub-basins. In order to provide the most robust test of this approach as possible, these pilot efforts need to provide a reasonable representation of the conditions, stakeholders and issues discussed in previous sections.

It is both tempting and relatively easy to draft a very long list of selection criteria to consider the substantial range of often fairly complex conditions, actors and issues relevant to our task. It is far more challenging, however, (and no doubt more controversial) to articulate a quite brief list of practical selection criteria. Moreover, these criteria must be subject to assessment by indicators for which secondary data is immediately available for the entire area, and in a form that can be quickly aggregated at the sub-basin level. Considering the nature of much readily available secondary data – and particularly that related to economic, social, cultural, and organizational factors – this is a very severe limitation on this current exercise.

It is also important to note that the objective of developing criteria and indicators for sub-basin selection is to seek to help inform the decision-making process. Since final decisions on sub-basin selection are intended to be derived from a participatory process among people in the Ping River Basin, it will ultimately be their choice to determine the degree to which these criteria and quantitative indicators play a role in that process.

Given these mandates and limitations, the following modest set of four major selection criteria are proposed, along with necessary sub-criteria required to allow development of indicators that can be implemented with readily available data. The overall structure and logic of the criteria are presented in this section, and summarized in Figure 9, whereas development of specific indicators is presented in following sections.

1. Sub-Basin Groupings.

The first criterion to be applied in the site selection process provides the basis for logical and systematic assignment of sub-basins into lower, middle and upper sub-basin groups.

***Criterion 1*. Groupings of middle and upper sub-basins within the Ping River Basin should be made according bias in their relative distribution of land area among lowland, midland and highland zones.**

The rationale for and role of this criterion has already been discussed in previous sections, along with a proposed quantitative indicator for which data and calculations have been provided, and discussion of its implications for classifying sub-basins into three groups for further sample selection. It is listed here for completeness in clarifying the overall logic of the proposed pilot site selection criteria.

2. Natural Resource Issues

The overall set of 3 pilot sub-basins needs to include representation of at least four types of key issues directly related to the status and physical condition of natural resources, as summarized in previous sections.

***Criterion 2*. Selected sub-basins should include conditions making it likely that issues will arise related to forest and land degradation, natural hazards, water use, and water quality.**

In order to apply this criterion, four more specific sub-criteria are proposed to assess conditions associated with each of the key issues included in this criterion:

Forest and land resource degradation in the Ping River Basin is a major issue in the public policy arena. Moreover, it features prominently all previous studies, and in the logic and arguments underlying the very existence of this project. Impacts are linked with biodiversity loss and impaired watershed services. Thus, *Sub-Criterion 2.1.* **Priority should be assigned to sub-basins where conversion of forest to agriculture and other uses is substantial, and where deterioration of remaining forest and soil erosion rates are relatively high.**

Natural hazards. Impacts of natural disasters are major concerns both among the general public and in the public policy arena. Floods and landslides make headlines in the media, and have provided major trigger events for revoking logging concessions in national forests (the "logging ban"), launching many emergency assistance programs, and driving new programs for prevention and early warning systems. The recent tsunami disaster is likely to help further intensify such concerns. Thus,

Sub-Criterion 2.2. **Priority should be assigned to sub-basins where conditions indicate there are high risks of flooding and/or landslides.**

Water use. Competition for water is recognized as an important and growing concern, and it is likely that it will feature prominently among stakeholder negotiations and management tasks faced by all new sub-basin management organizations. Motivation for actions to more effectively manage water use is most likely where irrigated agriculture faces constraints on access to dry season stream flow and groundwater. Thus,

Sub-Criterion 2.3. **Priority should be assigned to sub-basins where high proportions of irrigated agriculture are associated with low dry season stream flow and high rates of groundwater use. Highest priority should apply in selecting the middle sub-basin.**

Pollution and waste disposal. There is also strong and growing concern about the quality of water available for agricultural and domestic use, and for maintenance of aquatic resources and environmental quality. Major sources of water pollution are associated with domestic waste, industrial waste, and agricultural chemicals. Considering data limitations on considering other aspects of this issue, it is proposed that:

Sub-Criterion 2.4. **Priority should be given to sub-basins where water quality is low, and problems are associated with waste water from multiple sources.**

3. Socio-Economic Issues

While socio-economic issues are (and should be) of major concern under this project, this is the area where constraints on the content and form of available data are most severe. Somewhat paradoxically, it is also the area where proliferation of criteria is most tempting and common, due largely to the complexity of many of the considerations involved. Given the focus articulated by this project on poverty and public health, as well as the focus on resource access and competition that includes mountain ethnic minority and urban communities, we propose:

Criterion 3. Selected sub-basins should include areas with where poverty and health problems are relatively high, where land use is restricted and conflict is likely, and to areas where upland minorities and/or urban populations should play significant roles.

In order to apply this criterion, four more specific sub-criteria are proposed to assess conditions associated with each of the key issues included in this criterion:

Poverty. Reduction of rural poverty is a major theme of this project, as well as most major government development programs. Moreover, poverty is usually associated with activities leading to environmental deterioration. While average income is one measure of poverty, it is also associated with other issues. Thus,

Sub-Criterion 3.1. **Priority should be given to areas with relatively low incomes and overall conditions are indicative of economic and social difficulties.**

Land use access and competition. Interests associated with commercial agriculture, forest conservation, and various types of tourism are all seeking substantial expansion of their activities in the Ping River Basin. Especially in midland and highland zones, traditional subsistence-oriented agroecosystems are caught between these powerful expansionist forces, leading to transformations in livelihoods, landscapes and lifestyles. These forces and processes are very often associated with substantial tension and conflict that will be a major challenge for many sub-basin management organizations. Thus,

Sub-Criterion 3.2. **Priority should be given to areas where legal restrictions constrain local land-based livelihoods, and where agriculture is occurring in conflict with those restrictions. This priority should be highest for the upper sub-basin, but some presence would also be desirable in other sub-basins.**

Ethnicity, settlement density & urbanization. There is a substantial division within northern Thai society between lowland society dominated by ethnic Thai communities in relatively densely settled valley floors and urbanizing areas, and mountain society where more sparsely settled communities have been historically dominated by various ethnic minority groups usually referenced by a single common term (*chao khao*). Minority communities are a major component of the rural poor, and various of their livelihood and land use activities are often, and increasingly, cited as an important issue and cause of environmental deterioration. High settlement densities are associated with population centers where commercial, service and industrial sectors are driving agricultural intensification, urbanization, economic growth and restructuring, and other powerful forces associated with 'modernization' and changing patterns of natural resource use and abuse. More than 60 percent of mountain ethnic minority populations are located in upper sub-basins, whereas high settlement densities are primarily associated with middle and lower sub-basins. Thus,

Sub-Criterion 3.3. **The upper sub-basin should give priority to areas with strong upland ethnic minority presence, and other sub-basins should give priority to inclusion of densely settled areas.**

Health. Public health is a major element of concern related to environmental management issues generally, and it features prominently in the logic underlying development of this project. In the context of the Ping River Basin, the currently most commonly perceived aspects of public health that might be improved through basin management relate to illness associated with water-borne diseases or air pollution (including smoke), or with toxic effects from chemicals increasingly used in agriculture and industry. Thus,

Sub-Criterion 3.4. **Priority should be given to sub-basins with relatively high levels of health problems associated with water or air pollution, or use of toxic chemicals.**

4. Local Capacity and Administrative Complexity

While it is clearly important to have representation of conditions under which a reasonable range of natural resource and socio-economic issues are likely to be key elements of pilot sub-basin management activities, it is also important to consider elements affecting the likelihood of significant progress being made under the project. We also need to consider how other sub-basins will view the relevance of project activities in terms of the capacity of their local governments to provide essential support services. Thus,

Criterion 4. Selected sub-basins should represent a reasonable mix of local organizational capacities, but avoid areas where excessive administrative complexity may prevent adequate testing of model approaches within the project timeframe.

In order to apply this criterion, two more specific sub-criteria are proposed to assess conditions associated with each of the key issues included in this criterion:

Local organizational capacity. Two components of local organizational capacity are likely to have a substantial effect on the outcome of this project. Of key importance will be the degree to which very local watershed and/or natural resource management networks have begun to emerge within a given sub-basin. Progress is likely to be most rapid where such networks have emerged and are seeking to build alliances that can allow them to work at a wider level. If other conditions are relevant, progress in these areas could provide a powerful demonstration effect for areas where such networks are not yet active. Since the longer term viability and sustainability of such efforts depends on linkage with local governments, however, it is also important that pilot project experience includes those with currently high and low capacities. Thus,

Sub-Criterion 4.1. **Priority should be given to sub-basins where local resource management-related networks are already emerging, and especially to those where efforts to federate at larger watershed levels have begun. A mix of low and high capacities of supporting local (sub-district) government should be included in the overall set of selected sub-basins.**

Administrative simplicity. Given the project's very short time frame, it seems to be wise to try to avoid sub-basins where mis-matches between administrative and watershed boundaries result in a complex set of administrative units that would require major coordination efforts before the project could progress. Thus,

Sub-Criterion 4.2. **Priority should be given to sub-basins with relatively lower requirements for coordination across administrative units.**

Figure 9. Proposed sub-basin criteria and sub-criteria.

1 Groupings of middle and upper sub-basins within the Ping River Basin should be made according bias in their relative distribution of land area among lowland, midland and highland zones.

2 Selected sub-basins should include conditions making it likely that issues will arise related to forest and land degradation, natural hazards, water use, and water quality.

2.1 Priority should be assigned to sub-basins where conversion of forest to agriculture and other uses is substantial, and where deterioration of remaining forest and soil erosion rates are relatively high.

2.2 Priority should be assigned to sub-basins where conditions indicate there are high risks of flooding and/or landslides.

2.3 Priority should be assigned to sub-basins where high proportions of irrigated agriculture are associated with low dry season stream flow and high rates of groundwater use. Highest priority should apply in selecting the middle sub-basin.

2.4 Priority should be given to sub-basins where water quality is low, and problems are associated with waste water from multiple sources.

3 Selected sub-basins should include areas with where poverty and health problems are relatively high, where land use is restricted and conflict is likely, and to areas where upland minorities and/or urban populations should play significant roles.

3.1 Priority should be given to areas with relatively low incomes and overall conditions are indicative of economic and social difficulties.

3.2 Priority should be given to areas where legal restrictions constrain local land-based livelihoods, and where agriculture is occurring in conflict with those restrictions. This priority should be highest for the upper sub-basin, but some presence would also be desirable in other sub-basins.

3.3 The upper sub-basin should give priority to areas with strong upland ethnic minority presence, and other sub-basins should give priority to inclusion of densely settled areas.

3.4 Priority should be given to sub-basins with relatively high levels of health problems associated with water or air pollution, or use of toxic chemicals.

4 Selected sub-basins should represent a reasonable mix of local organizational capacities, but avoid areas where excessive administrative complexity may prevent adequate testing of model approaches within the project timeframe.

4.1 Priority should be given to sub-basins where local resource management-related networks are already emerging, and especially to those where efforts to federate at larger watershed levels have begun. A mix of low and high capacities of local (sub-district) government should be included in the overall set of selected sub-basins.

4.2 Priority should be given to sub-basins with relatively lower requirements for coordination across administrative units.

(2) Severity of natural resource issues

Biophysical dimensions of perceived natural resource degradation in the Ping River Basin are a central focus of concern regarding the sustainable provision of important environmental services, and especially biodiversity and watershed functions. In addition to their implications for maintenance of biodiversity and general ecosystem 'health', deforestation and deterioration of forest quality are being linked with decreased infiltration of rainfall into natural soil water and groundwater storage reservoirs, thus disrupting seasonal stream flows and resulting in increased downstream flooding and dry season water scarcity. Changes in soil properties associated with deforestation and agriculture in sloping lands are also believed to result in increased soil erosion and landslides, with especially serious consequences in local sub-watersheds, but also in contributing to siltation of large reservoirs and water infrastructure at more distant downstream locations. Increased use of water for intensive agriculture and other human activities at various positions in watershed landscapes are seen as further exacerbating water scarcity problems by contributing to low dry season stream flows and groundwater depletion. Human agricultural, domestic/urban, and industrial uses of water are also seen as the primary causes of decreasing water quality that threatens aquatic and ecological health, as well as the health and well-being of downstream human populations. Sub-basin management organizations will need to develop effective means for addressing these issues and concerns.

Thus, the overall guiding criterion under which sub-criteria and indicators related to natural resource issues are developed is:

***Criterion 2*. Selected sub-basins should include conditions making it likely that issues will arise related to forest and land degradation, natural hazards, water use, and water quality.**

This criterion disaggregates overall logic underlying concern about biophysical changes in natural resources into four interrelated elements reflecting major issue areas advanced by components of the population of the Ping River Basin who believe they are suffering from, or are likely to suffer from negative impacts resulting from these changes. In order to implement this criterion, sub-criteria have been developed for each of the four major issue areas included in the overall criterion. They are articulated in the following sections, along with specific indicators that can be used to assess each sub-criterion. An overall picture of the sub-criteria and indicators is provided in Figure 10, along with indicator scores for Ping sub-basins where data is available from secondary sources. Overall scores are relative within sub-basin groupings, and relative weights are all 1.0.

Figure 10. Natural Resource Indicator Scoring for Ping Sub-Basins

	2. Overall Natural Resource Issues			2.1. Degradation			2.2. Hazards		2.3. Water Use			2.4 Water Quality	
				2.1.1.	2.1.2.	2.1.3.	2.2.1.	2.2.2.	2.3.1.	2.3.2.	2.3.3.	2.4.1.	2.4.2.
	Score	weighted total		Forest Conversion Score	Forest Deterior Score	Soil Erosion Score	Flooding Risk Score	Landslide Risk Score	Agric Irrigation Score	Groundwater Use Score	Low Dry Season Flow Score	Water Quality Problem Score	Wastewater Problem Score
Sub-Basin			***source:***	CMU data	CMU data	Panya data	Panya	Need data	Panya data	Panya data	Panya data	Panya	CMU
Upper Sub-Basins				***0.4***	***0.5***	***1.8***		-	***1.8***	***0.1***	***1.4***		
			weight:	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*
1 Ping part 1	**2.9**	11		0.6	2.4	1.6	1.4	-	0.7	0.0	1.4	1	2
2 Mae Ngad	**2.4**	9		0.6	0.3	1.6	1.2	-	2.3	0.1	2.2	1	0
3 Mae Taeng	**3.0**	12		0.7	0.2	1.4	2.8	-	2.7	0.0	0.8	1	2
7 Mae Khan	**2.7**	10		0.5	0.4	1.8	1.4	-	3.0	0.5	0.7	1	1
9 Mae Klang	**2.5**	9		0.5	0.5	2.3	1.6	-	1.5	0.0	1.0	1	1
11 Mae Chaem upper	*****	*		*	*	*	*	-	*	*	*	*	*
12 Mae Chaem lower	**2.0**	8		0.3	0.1	1.6	1.6	-	0.9	0.0	0.9	1	1
14 Mae Teun	**2.3**	9		0.2	0.4	2.3	1.3	-	1.1	0.0	2.4	1	0
Middle Sub-Basins				***1.0***	***0.9***	***1.0***		-	***1.9***	***1.3***	***1.8***		
			weight:	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*
4 Ping part 2	**2.7**	16		2.0	3.0	0.7	1.5	-	1.5	2.2	1.9	2	1
5 Mae Rim	**1.7**	10		0.6	0.6	3.0	1.1	-	1.7	0.1	0.8	1	1
6 Mae Kuang	**3.0**	18		1.3	1.1	0.9	0.8	-	2.5	3.0	3.0	3	2
8 Mae Lee	**1.9**	11		0.8	1.1	0.9	2.2	-	1.7	1.0	2.5	1	0
10 Ping part 3	**1.3**	8		0.5	0.4	0.6	0.6	-	1.1	0.2	1.2	2	1
13 Mae Had	**1.3**	8		0.8	0.6	2.8	0.9	-	1.6	0.1	0.0	1	0
Lower Sub-Basins				***1.6***	***1.2***	***1.2***	***1.7***	-	***1.6***	***0.4***	***1.9***		
			weight:	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*
15 Ping part 4	**2.3**	12		1.1	2.0	1.0	1.0	-	1.2	0.0	1.7	2	2
16 Huay Mae Thor	**1.8**	9		0.2	0.9	1.7	1.0	-	0.3	0.1	2.1	1	2
17 Klong Wang Chao	**2.0**	10		0.7	0.8	1.7	3.0	-	0.2	0.0	0.9	1	2
18 Klong Mae Raka	**2.1**	11		1.3	1.7	0.7	1.1	-	0.7	0.0	2.2	1	2
19 Klong Suan Mark	**1.9**	10		1.1	0.3	1.7	1.4	-	0.7	0.1	1.8	1	2
20 Lower Ping	**3.0**	16		3.0	0.3	1.1	2.2	-	2.0	0.6	2.3	2	2
Ping Basin				**0.9**	**0.7**	**1.4**	**1.5**	**-**	**1.7**	**0.6**	**1.6**	**-**	

(a) <u>Forest and Land Resource Degradation</u>

Forest and land resource degradation in the Ping River Basin is a major issue in the public policy arena, and it features prominently in all previous studies as well as in the logic and arguments underlying this project. Deforestation and forest deterioration are claimed by many to be major primary causes of negative impacts on biodiversity reserves, as well as hydrological regimes, natural disasters, and damage to downstream water resource infrastructure [Tomich et.al. 2004]. Thus, the specific sub-criterion related to forest and land resource degradation is:

<u>Sub-Criterion 2.1.</u> **Priority should be assigned to sub-basins where conversion of forest to agriculture and other uses is substantial, and where deterioration of remaining forest and soil erosion rates are relatively high.**

In order to assess Ping sub-basins according to this sub-criterion, three indicators have been developed, all of which employ a 3-point scale to indicate relative differences among Ping sub-basins. Preliminary calculation of sub-basin scores for each of these indicators can be made from data obtained from Panya and the CMU study. Calculations of indicator values using data from these sources are provided in Figure 11.

<u>Indicator 2.1.1: Forest Conversion Score</u>. This indicator provides a single value description of the relative degree to which land in a sub-basin has been converted from forest to 'non-forest' types of land use. Thus, a value of three indicates the sub-basin has the highest proportion of its land converted to 'non-forest' land cover, and smaller numbers indicate relatively larger proportions of land remain under some type of forest, scrub or grass vegetative cover. Data are derived from interpretation of remote sensing data, and the calculations in Figure 11 employ interpretations reported by CMU [2004].

That this is an indicator of 'deterioration' is a reflection of the widely-held perception that natural forest is the 'best' land use in the Ping Basin, and that anything less than large proportions remaining under natural forest will threaten the future environmental sustainability of the basin. As data in Figure 11 indicate, however, the most extensive amounts of forest conversion have occurred in middle and lower sub-basins where lowland irrigated agriculture and high density settlements are also common features. Conversion of lowland forest to agricultural and urban uses, however, is seen as the 'highest and best use' of land converted from forest, whereas the primary function of sloping land and highland areas should be to provide the reliable water supplies and other environmental services upon which lowland systems depend. Thus, foresters, environmentalists and natural resource management agencies advocate minimum thresholds of natural forest cover required for natural resource sustainability at national, regional, and more recently river basin levels. And, with lowland areas already converted to other use and mountains seen as headwater areas, midland and highland zones are seen as the logical site for remaining natural forest to achieve minimum threshold targets. The basis for and accuracy of such targets may be a topic worthy of more careful assessment and consideration by basin management organizations as they mature in the future.

<u>Indicator 2.1.2: Forest Deterioration Score</u>. This indicator provides a single value description of the relative degree to which remaining forest areas are considered to be in deteriorated condition, scrub or grassland. Thus, a value of 3.0 indicates the sub-basin has the highest proportion of its "forest" cover classified as deteriorated, scrub or grassland, whereas a value of zero indicates it has the highest proportion of its "forest" cover under relatively healthy forest status. These data are again derived from interpretation of remote sensing data, and calculations in Figure 11 employ data from CMU [2004]. There is very wide scope for improvement of this indicator, but limitations relate to availability of accurately and appropriately interpreted remote sensing data. In any event, deteriorated forest is seen as an indicator of conditions where negative impacts on the ability of natural forest ecosystems to provide environmental services are likely to be occurring, as well as 'hot spots' where further conversion of forest land to other uses may be very likely.

Indicator 2.1.3: Soil Erosion Score. This indicator provides a single value description of the relative rate of estimated soil erosion in a Ping sub-basin. Thus, a value of 3.0 indicates the highest rate of estimated soil erosion among sub-basins. While the basis for these gross estimates has substantial limitations, and differences follow from terrain and soil characteristics as well as land use patterns, this is probably the best readily available indicator for an issue that appears to carry substantial weight in public policy debate. Data on soil erosion estimates used in Figure 11 originates at the Department of Land Development, and was obtained from Panya.

Figure 11. Forest & Land Degradation Indicator Scores for Ping Sub-Basins

	Land & Cover Areas				Soil	Ratios		Rate	Nat Res Degradation Scores		
									2.1.1	2.1.2	2.1.3
	A	B	C	D	E	Forest	Forest	Soil	Forest	Forest	Soil
Sub-Basin	*Total Area*	*Good Forest*	*Deteriorated Forest*	*Scrub & Grass*	*Soil Erosion*	*Conversion* (a-b-c-d)/a	*Deterioration* (c+d)/b	*Erosion* e/a	*Conversion Score**	*Deterioration Score**	*Erosion Score***
	km2	km^2	km^2	km^2	tons/year			ton km^{-2} yr^{-1}			
1 Ping part 1	1,978	1,263	392	6	5,698,469	0.16	0.31	2,881	0.56	2.39	1.58
2 Mae Ngad	1,281	1,032	28	6	3,799,979	0.17	0.03	2,968	0.59	0.25	1.63
3 Mae Taeng	1,954	1,548	45		4,873,823	0.19	0.03	2,494	0.65	0.22	1.37
7 Mae Khan	1,808	1,479	36	43	5,912,140	0.14	0.05	3,269	0.49	0.41	1.79
9 Mae Klang	615	489	19	15	2,527,393	0.15	0.07	4,112	0.53	0.52	2.25
11 Mae Chaem upper	*	*	*	*	*	*	*	*	*	*	*
12 Mae Chaem lower	3,896	3,531	61	4	11,672,216	0.08	0.02	2,996	0.27	0.14	1.64
14 Mae Teun	3,147	2,787	136	1	13,222,372	0.07	0.05	4,202	0.25	0.37	2.30
Upper Sub-Basins	***14,678***	***12,130***	***716***	***74***	*47,706,392*	***0.12***	***0.07***	***3,250***	***0.42***	***0.50***	***1.78***
4 Ping part 2	1,505	451	141	37	1,956,664	0.58	**0.39**	1,300	2.05	3.00	0.71
5 Mae Rim	556	420	33		3,041,530	0.18	0.08	**5,475**	0.65	0.60	3.00
6 Mae Kuang	2,688	1,464	156	58	4,277,070	0.38	0.15	1,591	1.32	1.11	0.87
8 Mae Lee	2,082	1,407	118	77	3,299,319	0.23	0.14	1,585	0.81	1.05	0.87
10 Ping part 3	3,317	2,683	53	90	3,425,324	0.15	0.05	1,033	0.52	0.40	0.57
13 Mae Had	531	388	22	6	2,713,823	0.22	0.07	5,113	0.76	0.56	2.80
Middle Sub-Basins	***10,678***	***6,813***	***524***	***268***	*18,713,730*	***0.29***	***0.12***	***1,753***	***1.01***	***0.88***	***0.96***
15 Ping part 4	3,026	1,666	354	90	5,318,599	0.30	0.27	1,757	1.06	2.03	0.96
16 Huay Mae Thor	645	542	61		1,998,545	0.06	0.11	3,099	0.23	0.85	1.70
17 Klong Wang Chao	648	471	47		1,952,736	0.20	0.10	3,016	0.70	0.77	1.65
18 Klong Mae Raka	989	518	93	19	1,216,566	0.36	0.22	1,230	1.27	1.65	0.67
19 Klong Suan Mark	1,086	730	25	-	3,287,910	0.31	0.03	3,027	1.07	0.26	1.66
20 Lower Ping	3,135	442	8	8	6,497,799	**0.85**	0.04	2,073	3.00	0.28	1.14
Lower Sub-Basins	***9,529***	***4,369***	***589***	***118***	*20,272,155*	***0.47***	***0.16***	***2,127***	***1.64***	***1.23***	***1.17***
Ping Basin	**34,885**	**23,312**	**1,829**	**459**	86,692,277	**0.27**	**0.10**	**2,485**	**0.94**	**0.75**	**1.36**

* calculated as (ratio / (max ratio value)) * 3
** calculated as (rate / (max rate)) * 3

(b) Natural Hazards

Impacts of natural disasters are major concerns both among the general public and in the public policy arena. Floods and landslides make headlines in the media, and have provided major trigger events for revoking logging concessions in national forests (the "logging ban"), launching many emergency assistance programs, and driving new programs for prevention and early warning systems. The recent tsunami disaster is likely to help further intensify such concerns. Thus, the specific sub-criterion focusing on natural hazards is:

Sub-Criterion 2.2. **Priority should be assigned to sub-basins where conditions indicate there are high risks of flooding and/or landslides.**

There are two types of floods that can have very important negative impacts on people and their assets in the Ping River Basin.

- Main channel floods. This type of flood occurs when levels of major streams and rivers rise beyond their usual channels to inundate adjacent flood plains and/or other low-lying areas. They are usually associated with fairly sustained and reasonably high rainfall patterns that occur during a similar period of time over a large portion of tributaries feeding catchments that approach the scale of sub-basins or river basins. Individual upper tributaries may be less directly affected, but the cumulative additions of flow from numerous upper tributaries increases the amount of inundation along more distant downstream main river channels. Thus, these types of floods are a more important concern in Middle Ping sub-basins; impact of such flooding is minimized in some Lower Ping sub-basins due to the river flow "buffering capacity" of the Bhumibol reservoir.

- Flash floods. This type of flood tends to be associated with more localized extreme rainfall events, combined with particular physical characteristics of local catchments and their spatial terrain and drainage patterns. Especially when extreme rainfall events are preceded by rain that has already saturated soils in local catchments, flash floods can also be associated with landslides. Since such extreme events are usually rather localized, flash floods (and landslides) have their strongest impacts at scales that are smaller than most sub-basins. Except perhaps in the smallest sub-basins, this would correspond more closely with smaller sub-watersheds (tentatively termed *lumnamyoi* in this report) of tributaries that feed into the main streams and rivers of sub-basins.

Both types of floods can be disastrous for those who are in their path, and accounts in popular media often associate both types with headwater deforestation or other types of land use that are classified as “inappropriate”. Although accurate historical data appears to be quite spotty and scarce, there are popular perceptions that floods and landslides are increasing in frequency.

Unfortunately, the watershed consultant has been unable to identify readily available data that could be used to develop an indicator of relative risk of flash flood conditions. Data have been identified, however, that could provide a basis for calculating two indicators of natural hazard risks in Ping sub-basins:

Indicator 2.2.1: Flooding Risk Score. This indicator provides a single value description of the relative risk of flooding from relatively larger main channels within Ping sub-basins. Its basic formulation and data used for it calculation are directly from Panya Consultants, who used it in their proposal to ONEP and in their earlier study for the Department of Water Resources. Its calculation is based on maximum, minimum and mean flows, as shown in Figure 13. Rather than using thresholds based on expert opinion, ratios are converted directly to a score relative to a maximum value of 3 for the sub-basin with the highest ratio. This appears to be the best readily available indicator for main channel flooding risk at this time. Further work is certainly warranted on developing indicators of relative risk of both flash floods and main channel floods.

Indicator 2.2.2: Landslide Risk Score. This indicator would provide a single value description of the relative extent and intensity of landslide risks within a sub-basin. Its calculation is based on landslide risk maps prepared by the Department of Land Development, as illustrated in Figure 12 for their ‘region 6’ area in northern Thailand; similar maps are presumably available for ‘lower’ portions of the Ping Basin that are not included in this map. Considerations in developing this map appear to be based largely on terrain, geology and soil characteristics. Maps need to be obtained in a GIS spatial data format so that they can be combined with sub-basin boundaries to obtain proportions of land area in each sub-basin contained in each landslide risk class. Proportions are then weighted according to their degree of risk on a scale of zero to three. Thus, at the extremes, a value of 3.0 indicates all areas in a sub-basin are subject to high landslide risk, whereas a value of zero indicates all areas have a low or very low risk level. Since it has not yet been possible to obtain spatial data versions of LDD landslide risk maps, only the tabular format for calculating landslide risk scores is presented in Figure 13.

Figure 12. LDD Landslide Risk Map

Figure 13. Natural Hazard Indicator Scoring for Ping Sub-Basins

	2.2.1						unit: square kilometers			unit: Percent			unit: Score			2.2.2
	Channel Flood Risk Score						Area Distribution			Percentage Distribution			Landslide Risk Score			
	A	B	C		Flood		Landslide Risk Level			Landslide Risk Level			Low	Medium	High	Landslide
Sub-Basin	Q_{ave} a. ave	Q_{max} b. high	Q_{min} c. low	(b-c)/a ratio	Risk Score	**Total**	Low or very low	medium	high	Low or very low	medium	high	Relative Weight multiplied by % of area			Risk Score
													0.00	1.50	3.00	
1 Ping part 1	209	451	69	1.8	1.36	1,974				-	-	-	-	-	-	-
2 Mae Ngad	277	563	126	1.6	1.17	1,285				-	-	-	-	-	-	-
3 Mae Taeng	194	782	51	3.8	2.81	1,958	Data not yet available			-	-	-	-	-	-	-
7 Mae Khan	201	441	63	1.9	1.40	1,833				-	-	-	-	-	-	-
9 Mae Klang	179	451	72	2.1	1.57	616				-	-	-	-	-	-	-
11 Mae Chaem upper	*	*	*	*	*	-				-	-	-	-	-	-	-
12 Mae Chaem lower	443	1,093	121	2.2	1.63	3,896				-	-	-	-	-	-	-
14 Mae Teun	249	520	101	1.7	1.25	2,896				-	-	-	-	-	-	-
Upper Sub-Basins						***14,458***	-	-	-	-	-	-	-	-	-	-
4 Ping part 2	174	398	56	2.0	1.46	1,616				-	-	-	-	-	-	-
5 Mae Rim	71	135	33	1.4	1.07	508										
6 Mae Kuang	185	281	85	1.1	0.79	2,734	Data not yet available			-	-	-	-	-	-	-
8 Mae Lee	170	530	23	3.0	2.22	2,081				-	-	-	-	-	-	-
10 Ping part 3	178	184	43	0.8	0.59	3,452				-	-	-	-	-	-	-
13 Mae Had	197	308	72	1.2	0.89	520				-	-	-	-	-	-	-
Middle Sub-Basins						***10,911***	-	-	-	-	-	-	-	-	-	-
15 Ping part 4	561	994	253	1.3	0.98	2,983				-	-	-	-	-	-	-
16 Huay Mae Thor	138	244	62	1.3	0.98	644				-	-	-	-	-	-	-
17 Klong Wang Chao	224	916	14	4.0	3.00	649	Data not yet available			-	-	-	-	-	-	-
18 Klong Mae Raka	147	305	79	1.5	1.14	902				-	-	-	-	-	-	-
19 Klong Suan Mark	303	611	40	1.9	1.40	1,132				-	-	-	-	-	-	-
20 Lower Ping	879	2,715	127	2.9	2.19	2,980				-	-	-	-	-	-	-
Lower Sub-Basins	***314***	***787***	***85***	***2.2***	***1.66***	***9,289***	-	-	-	-	-	-	-	-	-	-
Ping Basin	**237**	**557**	**73**	**2.0**	**1.52**	**34,659**	-	-	-	-	-	-	-	-	-	-

(c) <u>Water use and competition</u>

Competition for water is recognized as an important and growing concern, and the major drought conditions that are emerging this year promise to be a good example of the type of conditions where calls for improved water management become very strong. Government response is already formulating programs in the context of river basin management, and it is likely that water use and competition issues will feature prominently among stakeholder negotiations and management tasks faced by all new sub-basin management organizations. Motivation for actions to more effectively manage water use is most likely where irrigated agriculture faces constraints on access to dry season stream flow and groundwater. Thus, the specific sub-criterion focusing on water use and competition is:

<u>Sub-Criterion 2.3.</u> **Priority should be assigned to sub-basins where high proportions of irrigated agriculture are associated with low dry season stream flow and high rates of groundwater use. Highest priority should apply in selecting the middle sub-basin.**

In order to assess Ping sub-basins according to this sub-criterion, three indicators have been adapted, all of which employ a 3-point scale to indicate relative differences among Ping sub-basins. Preliminary calculation of sub-basin scores for each of these indicators can be made from data obtained from Panya Consulting, which presumably originated in the Royal Irrigation Department and the Department of Water Resources. The main current weakness is the inability to separate data for Mae Chaem into the two sub-basins required by ONEP. And, the consultant suspects that it is quite unlikely that orchards or other areas under sprinkler irrigation are included in the area of irrigated agriculture. It is also unlikely that irrigation from small weirs and tanks outside official irrigation project service areas are included, especially when they are located in midland and highland areas. Similarly, it is not clear how comprehensive are the data on groundwater extraction, or what is the estimated margin of error regarding potential groundwater supply.

<u>Indicator 2.3.1: Agriculture Irrigation Score</u>. This indicator provides a single value description of the relative extent to which agriculture in a sub-basin is irrigated. It is based on the ratio of the area of irrigated agriculture to total agriculture area, relative to a value of 3 for the sub-basin with the highest ratio. Thus, a value of 3.0 indicates the sub-basin has the highest proportion of its agriculture under irrigation, and is therefore most likely to be utilizing a high proportion of its water resources for irrigation. The indicator is calculated in Figure 14 using data from Panya.

Indicator 2.3.2: Groundwater Use Score. This indicator provides a single value description the extractions of groundwater in a sub-basin relative to estimates of its potential supply. It is based on the ratio between estimates of groundwater use and supply, relative to a value of 3 for the sub-basin with the highest ratio. Thus, a value of 3.0 indicates the sub-basin with highest extraction of groundwater relative to estimates of groundwater supply, and is therefore most likely to be over-exploiting its groundwater resources. Indicator scores for Ping sub-basins are calculated in Figure 14 using data from Panya.

Indicator 2.3.3: Low Dry Season Streamflow Score. This indicator provides a single value description of the degree to which dry season stream flow is a small proportion of total annual stream flow from a sub-basin. Its calculation is based on the proportion of annual stream flow occurring during the wet season. Its value represents position of the sub-basin on a 3-point scale ranging between sub-basins with the highest and lowest ratios of wet season to total annual flow. Thus, a value of 3 indicates the sub-basin has the highest ratio of wet season to total annual flow, and therefore the lowest proportion of its annual flow occurring during the dry season; a value of 0 indicates the sub-basin has the greatest proportion of its total annual flow occurring during the dry season flow. Sub-basin indicator score values are calculated in Figure 14 using data from Panya.

All of these indicators are quite standard and were adapted from forms also used by Panya in its study. The main change here from calculations in the Panya study is only to eliminate the expert threshold component of their approach to interpreting the data, in favor of an approach that reflects actual relative values. Calculation tables are presented in Figure 14 for all three indicators.

Figure 14. Water Use and Competition Indicator Scoring for Ping Sub-Basins

				2.3.1				2.3.2				2.3.3
	Irrigated Agriculture Score				Groundwater Use Score				Low Dry Season Stream Flow Score			
	A	B	C		D	E	F		G	H	I	
Sub-Basin	*Agriculture Area*	*Irrigated Area*	*Irrig/Agric Ratio*	*Irrigated Agric Score***	*Groundwater Potential*	*Used*	*Used/Pot Ratio*	*Ground-water use Score***	*Annual Flow*	*Wet Season Flow*	*Wet/Annual Ratio*	*Low Dry Seas Flow Score****
	km²	*km²*	*b/a*		*mill m³*	*mill m³*	*e/d*		*mill m³*	*mill m³*	*h/g*	
1 Ping part 1	273	56	0.21	0.70	5	0	0.07	0.04	501	371	0.74	1.35
2 Mae Ngad	207	140	0.68	2.31	5	1	0.22	0.13	365	287	0.79	2.17
3 Mae Taeng	351	275	0.78	2.66	6	0	0.05	0.03	642	455	0.71	0.78
7 Mae Khan	234	206	0.88	3.00	15	13	0.85	0.51	431	303	0.70	0.67
9 Mae Klang	116	53	0.45	1.55	7	0	0.04	0.03	259	186	0.72	0.99
11 Mae Chaem upper	*	*	*	*	*	*	*	*	*	*	*	*
12 Mae Chaem lower	304	84	0.28	0.94	20	1	0.03	0.02	1,214	867	0.71	0.87
14 Mae Teun	203	64	0.32	1.07	4	0	0.01	0.00	1,034	830	0.80	2.44
Upper Sub-Basins	***1,687***	***879***	***0.52***	***1.77***	***63***	***16***	***0.25***	***0.15***	***4,445***	***3,298***	***0.74***	***1.37***
4 Ping part 2	612	272	0.44	1.51	18	66	3.59	2.15	354	272	0.77	1.85
5 Mae Rim	94	48	0.51	1.72	4	1	0.19	0.11	265	188	0.71	0.76
6 Mae Kuang	706	517	0.73	2.49	9	43	5.00	3.00	790	659	0.83	3.00
8 Mae Lee	458	232	0.51	1.73	13	21	1.64	0.98	228	184	0.81	2.52
10 Ping part 3	40	13	0.32	1.07	8	2	0.28	0.17	410	300	0.73	1.18
13 Mae Had	242	110	0.46	1.55	9	1	0.10	0.06	323	215	0.67	-
Middle Sub-Basins	***2,152***	***1,192***	***0.55***	***1.88***	***61***	***134***	***2.19***	***1.31***	***2,370***	***1,817***	***0.77***	***1.81***
15 Ping part 4	643	236	0.37	1.25	18	1	0.06	0.04	521	395	0.76	1.67
16 Huay Mae Thor	38	4	0.10	0.34	1	0	0.12	0.07	126	98	0.78	2.06
17 Klong Wang Chao	122	6	0.05	0.17	2	0	0.05	0.03	169	122	0.72	0.95
18 Klong Mae Raka	301	60	0.20	0.68	11	0	0.03	0.02	161	127	0.79	2.22
19 Klong Suan Mark	312	65	0.21	0.71	5	1	0.11	0.06	368	281	0.76	1.76
20 Lower Ping	2,534	1,522	0.60	2.04	55	57	1.05	0.63	883	702	0.79	2.31
Lower Sub-Basins	***3,949***	***1,893***	***0.48***	***1.63***	***91***	***60***	***0.66***	***0.39***	***2,229***	***1,725***	***0.77***	***1.95***
Ping Basin	**7,788**	**3,963**	**0.51**	**1.73**	**215**	**209**	**0.97**	**0.58**	**9,044**	**6,841**	**0.76**	**1.63**

* combined with lower Mae Chaem data ** calculated as (<ratio> / <max ratio>) * 3 *** calculated as ((<ratio> - <min. ratio>) / (<max. ratio> - <min. ratio>)) * 3

(d) Pollution and waste disposal

There is also strong and growing concern about the quality of water available for agricultural and domestic use, and for maintenance of aquatic resources and environmental quality. Major sources of water pollution are associated with domestic waste, industrial waste, and agricultural chemicals. Given data limitations associated with other aspects of this topic, we propose a specific sub-criterion focusing on water quality:

Sub-Criterion 2.4. **Priority should be given to sub-basins where water quality is low, and where problems are associated with waster water from multiple sources.**

In order to assess Ping sub-basins according to this sub-criterion, two indicators have been adapted from studies by Panya and CMU, both of which employ a 3-point scale to indicate relative differences among Ping sub-basins. At least preliminary calculation of sub-basin scores for each of these indicators is provided in reports of studies of the Ping Basin conducted by Panya [2003, 2004] and CMU [2004].

Indicator 2.4.1: Water Quality Problem Score. This indicator provides a single value description of water quality levels in Ping sub-basins, based on data obtained by Panya Consulting that they adapted to a 3-point scale. Thus, a value of 3 indicates a severe water quality problem, whereas a value of zero indicates very little problem with water quality.

Indicator 2.4.2: Wastewater Problem Score. This indicator provides a value that reflects the number of types of sources of wastewater-related problems in a sub-basin. It is based on data compiled under the CMU study [CMU 2004], wherein sources of wastewater problems were associated with human settlements, industry and/or agricultural chemicals. Each type of source receives a value of one in sub-basins where it is perceived to be a problem. Thus, a value of 3 indicates all three of these sources of wastewater are perceived to be creating problems, whereas a value of zero indicates that no problems are perceived with any of these types of sources.

Although data used to estimate values for both of these indicators are subject to very substantial limitations, more revealing data on water quality is very limited, and this is probably the best that can be accomplished for a rapid assessment across all Ping sub-basins using secondary data sources at this time. Values calculated for these indicators are presented in Figure 15. We hope that in the future ONEP will be able to help facilitate development of systematic datasets that can be used to assess other aspects of these issues in the future. Obvious examples of such elements include pollution from various types of smoke, as well as growing problems related to solid waste disposal.

Figure 15. Water Quality Indicator Scoring for Ping Sub-Basins

	2.4.1	2.4.2
	Water Quality	
Sub-Basin	Water Quality Problem Score	Wastewater Problem Score
	< Panya >	< CMU >
1 Ping part 1	1	2
2 Mae Ngad	1	0
3 Mae Taeng	1	2
7 Mae Khan	1	1
9 Mae Klang	1	1
11 Mae Chaem upper	1	1
12 Mae Chaem lower	1	1
14 Mae Teun	1	0
Upper Sub-Basins		
4 Ping part 2	2	1
5 Mae Rim	1	1
6 Mae Kuang	3	2
8 Mae Lee	1	0
10 Ping part 3	2	1
13 Mae Had	1	0
Middle Sub-Basins		
15 Ping part 4	2	2
16 Huay Mae Thor	1	2
17 Klong Wang Chao	1	2
18 Klong Mae Raka	1	2
19 Klong Suan Mark	1	2
20 Lower Ping	2	2
Lower Sub-Basins		
Ping Basin		

(3) Severity of socio-economic issues

Many of the social and economic dimensions of natural resource management, use and deterioration in the Ping River Basin that will need to be high priorities for sub-basin management organizations cluster around issues associated with the equitable social distribution of benefits and costs of natural resource use and management. Rural poverty is widely believed to be both a cause and an effect of resource degradation, and reduction of rural poverty is a very clearly stated major objective of both government policies in general, and this project in particular. Rural poverty is also linked with inequitable access to a range of types of resources and social and financial services, and secure access to use of the land upon which their livelihoods depend has come to the forefront of work with the rural poor around the world.

At the same time, however, there is also growing global recognition that the natural resource base is limited, and that sustainable provision of the environmental services upon which societies depend requires careful management and maintenance of many types of ecosystem functions that are being disrupted or threatened as humans seek to further increase the total amount of immediate benefits they can derive from natural resources. Moreover, different elements of society are developing different visions for the future, and competition is growing among the claims they are making on various components of the natural resource base. This competition is reflected in political and legal arenas and the human institutional arrangements they devise, establish and enforce to facilitate, regulate or restrict how resources may or may not be used.

Clearly, if sub-basin management organizations are to become, as this project envisions, an important means for improving both the equity and sustainability of natural resource use and conservation within their domain, they must be able to include the major elements of society among whom costs and benefits of improved management must be distributed [Tomich et.al. 2004]. As indicated in the general discussion of Ping River Basin stakeholders in section B.1.c., above, this means that ethnic minorities, who have often been marginalized, ignored, or demonized in the past, must be brought into these mechanisms, especially in upper sub-basins and other areas where their activities are believed to have substantial implications for natural resource management. It also means that densely settled cities and urbanizing areas need to have sufficient voice, especially in middle and lower sub-basins where their presence is most prominent.

Also from a social point of view, it is a major objective of improved river basin management is to improve the health and well-being of the people and communities living within their domain. Links between public health and environmental issues is currently an area of growing interest and study, but conclusive empirical analyses will require much more systematic data from monitoring key variables of both public health and environmental quality than are currently available.

Indeed, while socio-economic issues such as these are (and should be) of major concern under this project, this is the area where constraints on the content and form of available data are most severe. It is also the area where proliferation of criteria is most tempting and common, due largely to the complexity of many of the considerations involved. Efforts by organizations such as the National Economic and Social Development Board (NESDB) to develop quality of life and related indicators are an area worthy of further exploration for applications such as this, but the consultant has not yet seen such data in a format that would allow for aggregation at a sub-basin level in time for initial sub-basin assessments under this project. Some further directions are discussed in section 3(e) on additional socio-economic data.

Therefore, for the purpose of this initial sub-basin selection process, a very simple and focused criterion is proposed. Since considerable further exploration of socio-economic factors is to be conducted within selected pilot sub-basins, those findings need to be incorporated into the learning processes under the project. This should help assure that more meaningful and appropriate criteria and indicators can be developed for application in adapting and implementing project approaches in other sub-basins and basins.

Thus, given the focus articulated by this project on poverty and public health, as well as the focus of resource access and competition that includes mountain ethnic minority and urban communities, we propose:

Criterion 3. Selected sub-basins should include areas with where poverty and health problems are relatively high, where land use is restricted and conflict is likely, and to areas where upland minorities or urban populations should play significant roles.

In order to apply this criterion, four more specific sub-criteria are proposed to assess conditions associated with each key issue areas included in this criterion. Sub-criteria and indicators are summarized in Figure 16. Overall scores are relative within sub-basin groupings and relative weights are all set to 1.0.

Figure 16. Socio-Economic Indicator Scoring for Ping Sub-Basins

	3. Overall Social & Economic Issues			3.1. Poverty		3.2. Competition		3.3. Minorities & Urban		3.4. Health
				3.1.1.	3.1.2.	3.2.1	3.2.2	3.3.1	3.3.2	3.3.1.
				Low Income Score	Econ & Social Weakness Score	Land Use Restriction Score	Agricultural Conflict Score	Upland Ethnicity Score	Population Density Score	Health Problem Score
Sub-Basin	Score	weighted total	source:	Panya data	CMU data	Panya/onep	Panya/onep	ONEP, Panya	Panya	Needs data
Upper Sub-Basins				1.9	-	2.8	2.3	0.8	0.3	-
			weight:	1.0	1.0	1.0	1.0	1.0	1.0	1.0
1 Ping part 1	2.6	10		3.0	1	2.6	2.2	0.8	0.3	-
2 Mae Ngad	1.9	7		1.4	1	2.8	1.4	0.3	0.4	-
3 Mae Taeng	2.6	10		2.3	1	3.0	2.8	0.7	0.3	-
7 Mae Khan	2.1	8		1.4	2	2.3	1.5	0.5	0.4	-
9 Mae Klang	2.7	10		1.6	2	2.8	2.6	0.8	0.5	-
11 Mae Chaem upper	0.0			*	2	*	*	*	*	-
12 Mae Chaem lower	2.8	11		1.4	2	2.9	3.0	1.5	0.2	-
14 Mae Teun	3.0	12		2.2	2	2.9	3.0	1.3	0.1	-
Middle Sub-Basins				0.5	-	1.8	0.7	0.2	0.8	-
			weight:	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4 Ping part 2	1.6	5		0.0	1	1.0	0.4	0.0	3.0	-
5 Mae Rim	2.2	7		1.4	1	2.3	1.4	0.0	1.2	-
6 Mae Kuang	1.4	5		1.0	1	1.6	0.4	0.0	0.8	-
8 Mae Lee	1.9	6		0.9	2	1.6	0.8	0.5	0.5	-
10 Ping part 3	3.0	10		1.7	2	2.3	1.1	3.0	0.0	-
13 Mae Had	2.4	8		1.8	2	2.0	1.6	0.1	0.6	-
Lower Sub-Basins				1.5	-	1.6	1.0	0.1	0.5	-
			weight:	1.0	1.0	1.0	1.0	1.0	1.0	1.0
15 Ping part 4	2.0	6		2.1	1	1.7	0.9	0.1	0.4	-
16 Huay Mae Thor	2.2	7		0.8	2	2.2	1.5	0.2	0.2	-
17 Klong Wang Chao	3.0	9		2.4	1	2.6	2.2	0.9	0.2	-
18 Klong Mae Raka	2.3	7		2.7	2	1.2	1.0	0.0	0.2	-
19 Klong Suan Mark	2.3	7		1.5	1	2.5	1.6	0.1	0.4	-
20 Lower Ping	1.6	5		1.1	1	1.0	0.8	0.1	0.9	-
Ping Basin				1.1	-	2.2	1.2	0.3	0.5	-

(a) Poverty

Reduction of rural poverty is a major theme of this project, as well as most major government development programs. And, poverty is frequently associated with activities leading to environmental deterioration. While average income is one measure of poverty, it would be much more insightful to have more disaggregated data according to smaller local units and/or sources of income. Data on income distribution would also add obvious depth to this assessment. The degree to which the value of subsistence production is captured by income data also needs to be clarified.

Moreover, poverty is also associated with various other issues. Rice deficits have commonly been used as an indicator of poverty in this region. Material indicators of capitalization and wealth have also been used in some studies, and a variety of newer generation indicators are being developed. Information on debt and loan defaults might provide insight into aspects of poverty that are increasingly entering public debate in Thailand. Most all of these indicators, however, require data that are not captured by current monitoring systems, or that are not available in disaggregated enough form to be useful for sub-basin-level calculations.

In its proposal to ONEP, Panya [2004] proposed that the percentage of agriculture that is irrigated be used as a socio-economic indicator. Their own data, however, appears to indicate that this variable has a strong correlation with average income levels, and thus adds little additional information related to poverty. Moreover, we have already chosen to use this data as one of the indicators associated with water use.

Thus, given these considerations and the strong limitations on immediately available data, we propose that:

Sub-Criterion 3.1. **Priority should be given to areas with relatively low incomes, and overall conditions indicative of economic and social difficulties.**

In order to assess Ping sub-basins according to this sub-criterion using readily available data, two indicators have been adapted from studies by Panya [2004] and CMU [2004].

Indicator 3.1.1: Low Income Score. This indicator provides a single value estimate of the relative level of sub-basin average income, calibrated to a 3-point scale corresponding to the range between highest and lowest average income levels. Thus, a value of 3.0 indicates the sub-basin has the lowest average income, whereas a value of zero is assigned to the sub-basin with the highest average income level. Calculation of sub-basin scores for this indicator are shown in Figure 17 using data from Panya Consultants. It is worth noting that these data estimate average per capita income in the 'wealthiest' sub-basin at just over US$ 1.00 per day. These very low estimates suggest that this data probably focuses on cash income only, and does not include the value of subsistence production.

Indicator 3.1.2: Economic & Social Weakness Score. This indicator provides a single value estimate of the relative level of overall economic and social weakness among sub-basins, based on assessments of data on labor, income, productivity and other considerations by a group of experts assembled for the CMU study of the Ping Basin for ONEP [CMU 2004]. According to the CMU report, the expert group considered data from a wide range of sources to assign a score that reflected the overall economic and social strength found in each sub-basin. Thus, calculation of the indicator used here reverses the value of the score assigned by the CMU expert group, thus resulting in an indicator of relative economic and social weakness, as shown in Figure 17. This is not a very satisfying indicator, however, for at least two reasons. First, there is inadequate discussion in the CMU report on data reviewed and the approach used to reach judgments and conclusions. Second, the resulting scores express such a limited range of variation it is not very useful for distinguishing among sub-basins.

Figure 17. Poverty Indicator Scoring for Ping Sub-Basins

Sub-Basin	Low Income Score: A total population (thous pers)	B total income (thous baht)	b/a per capita income (baht/pers)	3.1.1 Low Income Score**	Economic & Social Weakness Score: C econ-soc strength (CMU)	3.1.2 Econ/Soc Weakness Score***
1 Ping part 1	80	739,397	**9,269**	3.0	3	1
2 Mae Ngad	67	861,976	12,868	1.4	3	1
3 Mae Taeng	73	785,892	10,812	2.3	3	1
7 Mae Khan	106	1,364,536	12,868	1.4	2	2
9 Mae Klang	44	557,903	12,538	1.6	2	2
11 Mae Chaem upper	*	*	*	*	2	2
12 Mae Chaem lower	96	1,240,193	12,864	1.4	2	2
14 Mae Teun	58	639,742	11,099	2.2	2	2
Upper Sub-Basins	***524***	***6,189,639***	***11,812***	***1.9***		
4 Ping part 2	664	10,679,503	**16,093**	-	3	1
5 Mae Rim	85	1,090,705	12,868	1.4	3	1
6 Mae Kuang	291	4,031,909	13,856	1.0	3	1
8 Mae Lee	148	2,085,664	14,107	0.9	2	2
10 Ping part 3	21	252,920	12,129	1.7	2	2
13 Mae Had	45	541,019	12,099	1.8	2	2
Middle Sub-Basins	***1,253***	***18,681,719***	***14,912***	***0.5***		
15 Ping part 4	172	1,960,130	11,403	2.1	3	1
16 Huay Mae Thor	16	227,620	14,313	0.8	2	2
17 Klong Wang Chao	20	210,334	10,560	2.4	3	1
18 Klong Mae Raka	31	303,745	9,884	2.7	2	2
19 Klong Suan Mark	65	829,308	12,667	1.5	3	1
20 Lower Ping	378	5,104,147	13,498	1.1	3	1
Lower Sub-Basins	***682***	***8,635,285***	***12,661***	***1.5***		
Ping Basin	**2,459**	**33,506,642**	**13,627**	**1.1**		

* combined with lower Mae Chaem data
** calculated as ((<max. income> - <income>) / (<max. income> - <min. income>)) * 3
*** calculated as inverse of CMU strength score

It is worth noting that both of these indicators suggest there may be relatively limited variation among sub-basins at that level. If this is indeed true, then it may be that aggregations at the sub-basin level mask greater variation within the various sub-basins themselves. This will be an important issue for investigation as part of more intensive assessments within selected pilot sub-basins during the next stage of this project.

(b) Land use access and competition

This report has already touched at several points on different and often competing views of natural resource management that are emerging among different components of society. Important land use issues and conflicts are associated with legal and policy restrictions placed on land use in national parks, wildlife sanctuaries, class 1AB watersheds, and reserved forest lands that in aggregate account for 80 percent of the total land area of the Ping River Basin. How these land categories relate to each other are illustrated in Figure 18. The relative proportions of a sub-basin's land area located within each of these categories indicate the potential for issues associated with these restrictions on land use access and security. A rough indication of the relative extent, importance and distribution of these land use restriction zones can be seen in the GIS maps in Figure 19. These maps are constructed using boundary data recently obtained from the Department of National Parks, Wildlife and Plant Conservation provided by ONEP and Panya. Most data appear to be quite current, except that the set of most recently declared national parks, the final boundaries of which are still being negotiated locally, has not been included. As an example of new national parks in this category, the Mae Tho national park in Mae Chaem has been included using preliminary boundary data obtained from local officials and digitized by ICRAF. Many of these new parks are being overlaid on areas that include substantial numbers of local communities, so that local negotiations are often quite difficult and conflict is strong.

Figure 18. Categories Restricting Land Use Access

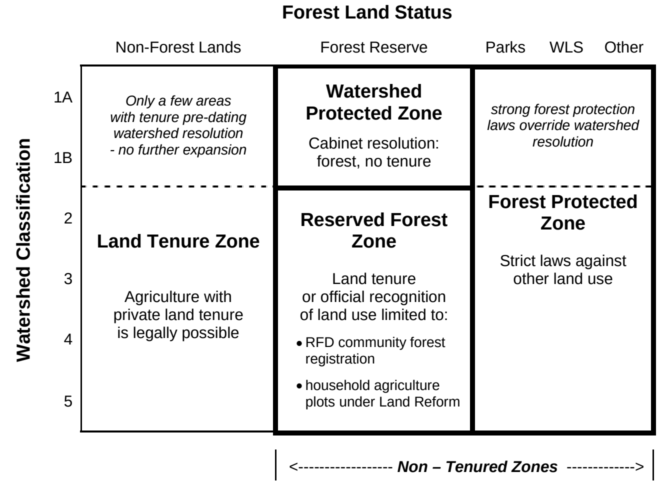
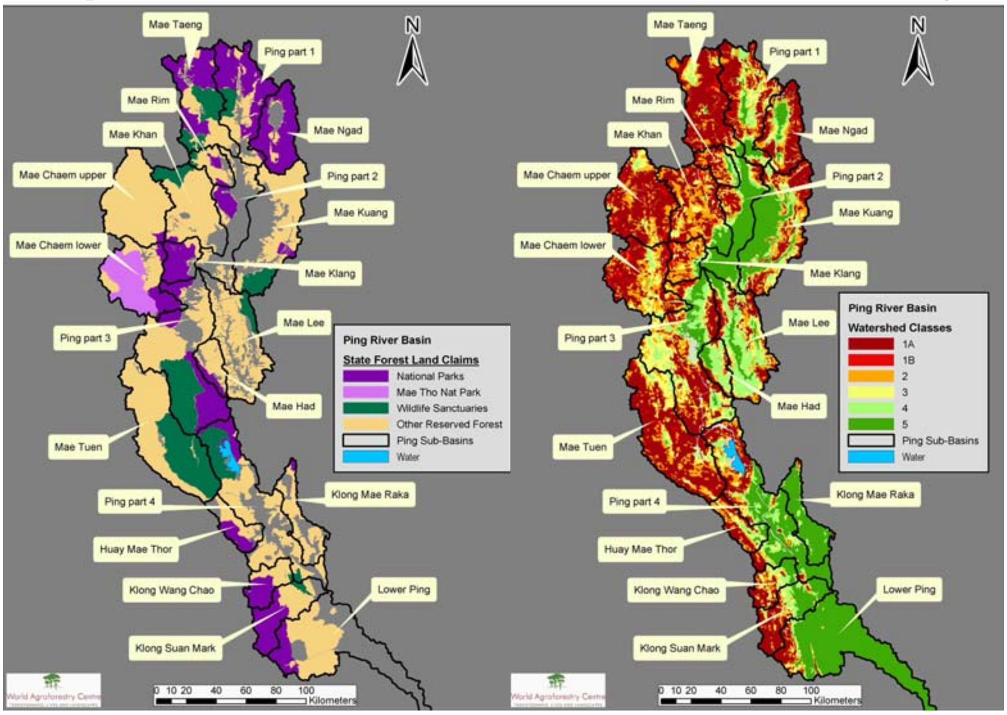


Figure 19. Spatial Distribution of Forest Land Use Restriction Zones in the Ping Basin



Contrasting views on what is 'appropriate' land use between national policy and local community levels is a major and still growing source of conflict in the Ping River Basin. One of the most important sources of conflict associated with land use restrictions imposed by government policies is the presence of agriculture in areas where policies proclaim it to be "inappropriate". This is seen as an especially important issue in areas that the national land use policy decision making process has declared to be protected forest (national parks and wildlife sanctuaries). It is also an issue in class 1AB watersheds outside of protected areas but now under 'preparation for protected area' status, and perhaps to a bit lesser extent in Reserved Forest areas in other watershed classes. These issues are strongest in upper sub-basins where, as we have already seen, these national policies seek to transform and very strongly constrain local land-based livelihoods of the majority of people. But they are also locally important in various middle and lower sub-basins where they affect significant and often relatively marginalized components of the population.

Thus, the specific sub-criterion related to land use access and competition is:

Sub-Criterion 3.2. **Priority should be given to areas where legal restrictions constrain local land-based livelihoods, and where agriculture is occurring in conflict with those restrictions. This priority should be highest for the upper sub-basin, but some presence would also be desirable in other sub-basins.**

In order to assess Ping sub-basins according to this sub-criterion, two indicators are developed. Both indicators require spatial data on the forest land use restriction zones described above.

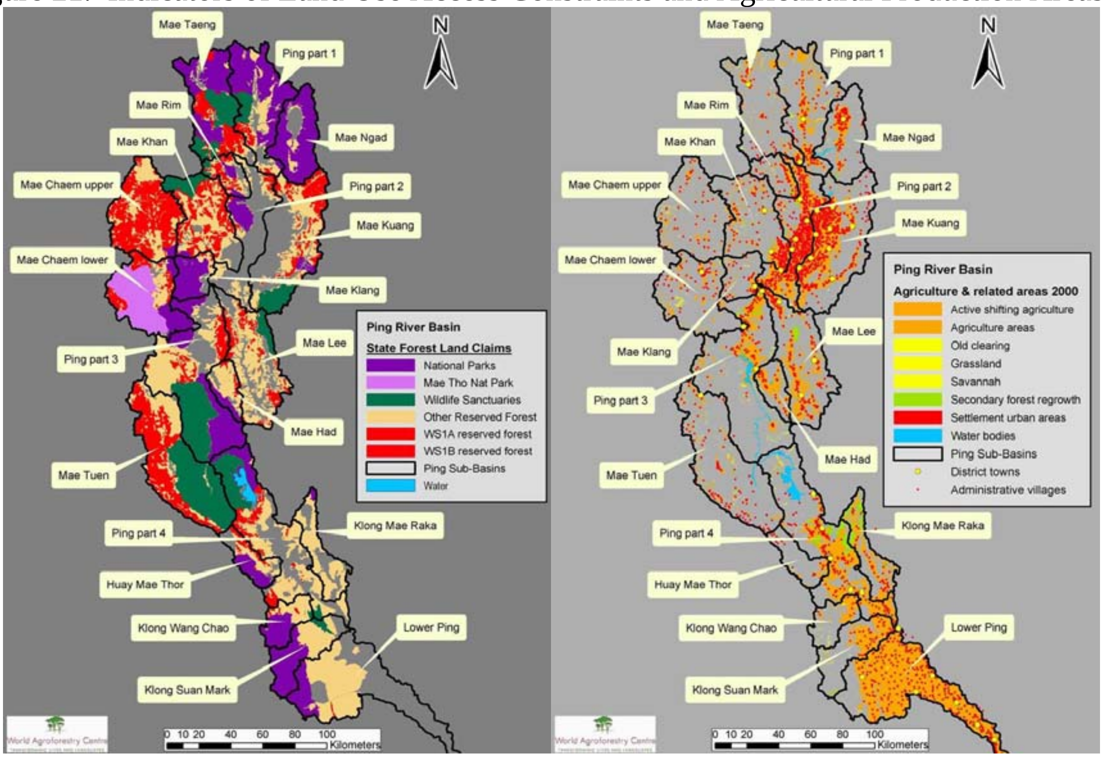
Indicator 3.2:1. Land Use Restriction Score. This indicator provides a single value estimate of the degree to which forest land use restrictions constrain land use in a given sub-basin. Proportions of the land area of a sub-basin classified in each type of restriction category are weighted according to the relative strength of restrictions applying to that category: National parks and wildlife sanctuaries (protected areas) are protected by strong laws and have a weight of 3. Class 1 watersheds outside national parks and wildlife sanctuaries are governed by cabinet resolutions and their temporary 'under preparation for protected area' status, so they have a value of 2. Areas of reserved forest not in either protected areas or class 1 watershed zones have a value of 1 because it is possible to request community forest recognition in these areas, some are already being considered for land reform, and land use restrictions are commonly perceived as less strenuous. Lands outside any of these forest zones are generally available for other types of land use, so they are assigned a weight of zero. Thus, at the extremes, an indicator value of 3.0 indicates all sub-basin land is under protected area status, whereas a value of zero indicates there are no forest land restrictions present.

Figure 20. Land Use Restriction Indicator Scoring for Ping Sub-Basins

		unit: square kilometers				unit: Percent				unit: Score					3.2.1
		Land Use Restriction Category				Percentage Distribution				Land Use Restriction Score					
		Tenure	Reserved	Watrshd	Protected	Tenure	Reserved	Watershed	Protected	Tenure	Reserved	Watershed	Protected	Total Point Score	Relative Land Use Restriction Score
Sub-Basin	Total	Non-forest	Other Reserve	1AB not park/wls	Nat Park WL Sanct	Non-forest	Other Reserved	1AB not park/wls	Nat Park WL Sanct	Relative Weight multiplied by % of land area					
										0.00	1.00	2.00	2.00		
1 Ping part 1	1,974	189	399	111	1,275	10	20	6	65	-	0.20	0.11	1.29	1.61	2.65
2 Mae Ngad	1,285	156	93	4	1,032	12	7	0	80	-	0.07	0.01	1.61	1.68	2.78
3 Mae Taeng	1,958	99	153	392	1,314	5	8	20	67	-	0.08	0.40	1.34	1.82	3.00
7 Mae Khan	1,833	214	690	660	269	12	38	36	15	-	0.38	0.72	0.29	1.39	2.29
9 Mae Klang	616	54	78	21	463	9	13	3	75	-	0.13	0.07	1.50	1.70	2.80
11 Mae Chaem upper	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12 Mae Chaem lower	3,896	57	859	1,667	1,311	1	22	43	34	-	0.22	0.86	0.67	1.75	2.88
14 Mae Teun	2,896	46	587	1,094	1,152	2	20	38	40	-	0.20	0.76	0.80	1.75	2.89
Upper Sub-Basins	***14,458***	***815***	***2,860***	***3,949***	***6,815***	***5.6***	***19.8***	***27.3***	***47.1***	***-***	***0.20***	***0.55***	***0.94***	***1.69***	***2.78***
4 Ping part 2	1,616	960	352	106	199	59	22	7	12	-	0.22	0.13	0.25	0.59	0.98
5 Mae Rim	508	67	161	147	134	13	32	29	26	-	0.32	0.58	0.53	1.42	2.34
6 Mae Kuang	2,734	996	803	576	352	36	29	21	13	-	0.29	0.42	0.26	0.97	1.60
8 Mae Lee	2,081	578	980	366	156	28	47	18	8	-	0.47	0.35	0.15	0.97	1.60
10 Ping part 3	3,452	429	922	298	1,696	12	27	9	49	-	0.27	0.17	0.98	1.42	2.34
13 Mae Had	520	56	287	55	123	11	55	11	24	-	0.55	0.21	0.47	1.23	2.03
Middle Sub-Basins	***10,911***	***3,085***	***3,504***	***1,547***	***2,660***	***28.3***	***32.1***	***14.2***	***24.4***	***-***	***0.32***	***0.28***	***0.49***	***1.09***	***1.80***
15 Ping part 4	2,983	702	1,071	339	680	24	36	11	23	-	0.36	0.23	0.46	1.04	1.72
16 Huay Mae Thor	644	119	180	114	231	19	28	18	36	-	0.28	0.36	0.72	1.35	2.23
17 Klong Wang Chao	649	4	259	32	353	1	40	5	54	-	0.40	0.10	1.09	1.59	2.62
18 Klong Mae Raka	902	282	587	6	27	31	65	1	3	-	0.65	0.01	0.06	0.72	1.19
19 Klong Suan Mark	1,132	93	391	4	644	8	35	0	57	-	0.35	0.01	1.14	1.49	2.46
20 Lower Ping	2,980	1,512	1,118	12	337	51	38	0	11	-	0.38	0.01	0.23	0.61	1.00
Lower Ping Basin	***9,289***	***2,712***	***3,606***	***508***	***2,271***	***29.2***	***38.8***	***5.5***	***24.5***	***-***	***0.39***	***0.11***	***0.49***	***0.99***	***1.63***
Ping Basin	**34,659**	**6,613**	**9,970**	**6,005**	**11,747**	**19**	**29**	**17**	**34**	**-**	**0.29**	**0.35**	**0.68**	**1.31**	**2.16**

Calculations of values for this indicator use data that originated in the Department of National Parks, Wildlife and Plant Conservation (DNP), which have been further processed by the consultant. Boundaries of forest reserves, national parks, wildlife sanctuaries and watershed classification were obtained in GIS shape file format from ONEP and Panya. They were then combined into a single shape file, together with the sub-basin boundaries used for this project, and areas were recalculated for all component polygons. The resulting data table then allows rather straightforward calculation of the Land Use Restriction Indicator Score, as indicated in Figure 20. A color coded map of this data is provided in the left side of Figure 21.

Figure 21. Indicators of Land Use Access Constraints and Agricultural Production Areas



This land use restriction indicator is an important measure of the overall restrictions that national policy is placing on local land-based livelihoods. The remaining important question related to land use access and competition, however, relates to the degree to which land-based livelihoods of local communities are currently or potentially in conflict with these increasingly strict restrictions. The map of spatial distribution of policy restrictions is paired in Figure 21 with a the map showing the distribution of village and urban settlements, as well as agricultural areas detected in the DNP's 2000 assessment of land use.

Data in the formats used to generate these maps allow us to develop at least a preliminary indicator of the degree to which agricultural dimensions of current local livelihood systems are in conflict, or will be in conflict with national conservation and land use restriction policies.

Indicator 3.2.2: Agriculture Conflict Score. This indicator provides a single value estimate of the degree to which agricultural land use in a sub-basin is currently in conflict with forest land use restrictions meant to constrain land use according to the restriction categories discussed above. Proportions of agricultural land area are weighted according to the strength of the type of restriction category where the conflict occurs. Thus, at the extremes, an indicator value of 3.0 indicates all agricultural land is located within protected areas, whereas a value of zero indicates all agriculture is outside restricted forest lands.

In order to provide data in the format required by these calculations, GIS shape file data processed for the land use restriction indicator were further combined with data on agricultural areas, as determined through interpretation of remote sensing data for the year 2000 by the Department of

Figure 22. Agricultural Conflict Indicator Scoring for Ping Sub-Basins

		unit: square kilometers				unit: Percent				unit: Score					3.2.2
		Agricultural areas located in				**Percentage Distribution**				**Agricultural Conflict Score**					
		Tenure	Reserved	Watrshd	Protected	Tenure	Reserved	Watershed	Protected	Tenure	Reserved	Watershed	Protected	Total Point Score	**Relative Agric Conflict Score**
Sub-Basin	***Total***	***Non-forest***	***Other Reserve***	***1AB not park/wls***	***Nat Park WL Sanct***	***Non-forest***	***Other Reserved***	***1AB not park/wls***	***Nat Park WL Sanct***	**Relative Weight multiplied by % of agric area**					
										0.00	**1.00**	**2.00**	**3.00**		
1 Ping part 1	501	173	189	5	134	35	38	1	27	-	0.38	0.02	0.80	1.20	2.24
2 Mae Ngad	264	151	70	1	43	57	26	0	16	-	0.26	0.00	0.49	0.76	1.41
3 Mae Taeng	269	85	54	36	94	32	20	13	35	-	0.20	0.27	1.05	1.52	2.83
7 Mae Khan	411	181	162	38	30	44	39	9	7	-	0.39	0.18	0.22	0.80	1.49
9 Mae Klang	96	46	8	0	42	48	8	0	44	-	0.08	0.01	1.32	1.41	2.64
11 Mae Chaem upper	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12 Mae Chaem lower	432	45	179	110	98	10	41	26	23	-	0.41	0.51	0.68	1.61	3.00
14 Mae Teun	190	29	57	67	37	16	30	35	19	-	0.30	0.70	0.58	1.58	2.96
Upper Sub-Basins	***2,163***	***710***	***718***	***257***	***478***	***32.8***	***33.2***	***11.9***	***22.1***	***-***	***0.33***	***0.24***	***0.66***	***1.23***	***2.30***
4 Ping part 2	1,005	821	153	6	26	82	15	1	3	-	0.15	0.01	0.08	0.24	0.45
5 Mae Rim	128	60	49	11	9	47	38	8	7	-	0.38	0.17	0.20	0.75	1.40
6 Mae Kuang	1,156	918	216	5	16	79	19	0	1	-	0.19	0.01	0.04	0.24	0.45
8 Mae Lee	697	412	269	5	12	59	39	1	2	-	0.39	0.01	0.05	0.45	0.84
10 Ping part 3	563	355	141	3	65	63	25	0	12	-	0.25	0.01	0.35	0.61	1.13
13 Mae Had	206	49	145	2	11	24	70	1	5	-	0.70	0.01	0.15	0.87	1.63
Middle Sub-Basins	***3,756***	***2,614***	***973***	***31***	***138***	***69.6***	***25.9***	***0.8***	***3.7***	***-***	***0.26***	***0.02***	***0.11***	***0.39***	***0.72***
15 Ping part 4	1,022	565	427	15	14	55	42	2	1	-	0.42	0.03	0.04	0.49	0.91
16 Huay Mae Thor	84	44	25	2	13	53	29	3	16	-	0.29	0.05	0.47	0.81	1.52
17 Klong Wang Chao	169	4	148	1	16	2	87	1	9	-	0.87	0.02	0.28	1.17	2.19
18 Klong Mae Raka	372	184	184	2	2	49	50	0	1	-	0.50	0.01	0.02	0.52	0.98
19 Klong Suan Mark	411	89	302	1	19	22	74	0	5	-	0.74	0.00	0.14	0.88	1.64
20 Lower Ping	2,501	1,442	1,054	1	3	58	42	0	0	-	0.42	0.00	0.00	0.43	0.80
Lower Sub-Basins	***4,557***	***2,328***	***2,140***	***22***	***67***	***51.1***	***47.0***	***0.5***	***1.5***	***-***	***0.47***	***0.01***	***0.04***	***0.52***	***0.98***
Ping Basin	**10,476**	**5,652**	**3,831**	**310**	**683**	**54**	**37**	**3**	**7**	**-**	**0.37**	**0.06**	**0.20**	**0.62**	**1.16**

National Parks, Wildlife and Plant Conservation, which was obtained from ONEP. As indicated in the legend of the map in Figure 21, this included areas they identified as ‘agricultural areas’, as well as areas they believed to be ‘active’ (*i.e.* currently cropped) fields in shifting cultivation systems. Resulting polygons were again recalculated, thereby generating a data table from which aggregations could be made in a format compatible with data columns required for calculations in Figure 22, resulting in a weighted composite indicator of areas where agriculture is in conflict with the land use policy mandates for these zones.

While this indicator is a useful preliminary estimate of these types of social conflict conditions, there are at least four limitations in this data that should be noted: (1) field verification (‘ground-truthing’) of this land use data has been quite limited; (2) various types of agroforestry practices that maintain substantial tree cover (*e.g. miang* agroforests or rotational forest fallow fields) are not detected as agriculture or secondary forest regrowth, especially in midland and highland zones; (3) local livelihoods in many areas, but especially in midland and highland zones, include substantial land-based components other than the currently cropped fields detected by remote sensing; and (4) land use claims by various interests – including lowland land speculators and tourism interests – are not detectable by this type of remote sensing. Thus, while this indicator is useful for distinguishing relative differences among Ping sub-basins, it should be viewed as a very conservative indicator of the absolute level of conflict between local livelihoods and policies restricting land use in national forestland zones.

In the longer term, considerations under a category such as this should expand to include agricultural crops or practices that are seen as “inappropriate” in ways that are not reflected in the above indicator. For example, certain types of tree crops and/or conservation farming practices are seen as the only “appropriate” type of land use for areas classified as watershed class 2 or 3. At this time, however, the consultant is not aware of any spatial datasets that are capable of distinguishing these types of crops or practices in a reliable and systematic manner. If such data could be obtained in the future, however, it could easily be crossed with the watershed classification spatial dataset to identify were ‘hotspots’ of inappropriate land use exist. A similar approach could be taken for other types of land use considered as “inappropriate” for various types of zones that have been or may be mandated by public policy at various levels. Development of datasets required to implement such an approach could help sub-basin management organizations move beyond the aggregated tables of generalized data that currently dominate discussion of such issues, to being able to identify exactly where and why such discrepancies exist.

(c) Ethnicity, settlement density and urbanization

Cultural diversity is an important characteristic that features in most descriptions of northern Thailand, including the Ping River Basin, and a very large portion of this diversity has long been contributed by mountain ethnic minority communities. Historically, the Thailand nation state has taken an approach that excluded most of these communities from direct involvement in mainstream society and its governance institutions, including assignment of citizenship and recognition of their land use systems. Responsibility for these communities was assigned to the Department of Public Welfare and other agencies under special 'highland development' policies. But during the last 15 years, and especially since approval of the 1997 national constitution and associated decentralization and devolution policies, there has been dramatic change in many areas of the Ping Basin. Most communities now have citizenship and official registration, and their communities are incorporated into new village and sub-district local governance mechanisms with status equal (at least in principle and in law) to that of any other citizen of Thailand.

While these changes are promising, there is still substantial division within northern Thai society between lowland society dominated by ethnic Thai communities in relatively densely settled valley floors and urbanizing areas, and mountain society where more sparsely settled by communities historically dominated by mountain minorities referenced by the single term *chao khao*. Various livelihood and land use activities of some mountain minorities are often, and increasingly, cited as an important issues and causes of environmental deterioration. Particular focus is directed toward highland communities who have transformed their agriculture to intensive commercial production of horticultural crops, often in response to opium crop substitution programs. A somewhat less, but still quite important target of lowland concern and 'development' programs are midland ethnic minority communities dependent on livelihoods that employ any form of shifting cultivation. Many of these midland communities are also seen as comprising a major component of the rural poor. Given the role of these communities as a special target of poverty and environmental concerns, as well as an important new voice (and vote), especially in upper sub-basins, they clearly need to be included as an important stakeholder in sub-basin management activities.

Yet another dimension of cultural diversity has been emerging in various major lowland areas of middle and lower sub-basins of the Ping River Basin, where relatively high density settlements are giving rise to processes of urbanization closely linked with national and international markets, information, ideas and world views. These areas are increasingly associated with population centers where commercial, service and industrial sectors are driving agricultural intensification, urbanization, economic growth and restructuring, and other powerful forces associated with 'modernization' and changing patterns of natural resource use and abuse, as discussed under section B.1.c., above. This is another important component of Ping River Basin society that cannot be excluded if pilot sub-basin management organizations are to have wider relevance.

Thus, since more than 60 percent of mountain ethnic minority populations are in upper sub-basins, whereas high settlement densities are primarily associated with middle and lower sub-basins:

Sub-Criterion 3.3. **The upper sub-basin should give priority to areas with strong upland ethnic minority presence, and other sub-basins should give priority to inclusion of densely settled areas.**

In order to assess Ping sub-basins according to this sub-criterion, two indicators are proposed as sufficient for the purposes of this project:

Indicator 3.3:1. Upland Ethnicity Score. This indicator provides a single value estimate of the degree to which issues associated with upland ethnic minority communities are likely to play an important role in sub-basin management activities. It is calculated by assigning a relative upland ethnicity weight to different ethnic components of the sub-basin population. For these purposes, the unitary notion of *chao khao* is replaced by grouping of ethnic components of the population on a basis similar to longstanding practices in Laos that associate ethnic groups with the zones where their cultures and livelihoods were primarily evolving (*Lao loum*, *Lao theung*, *Lao soung*), at least at the beginning of the current era of 'modernization', which in Thailand was about 1960. Thus, northern Thai and 'Haw' Chinese are combined in the group with lowland traditions, while ethnic Lua, Karen and Htin are combined into a midland traditions group. The highland traditions group includes other ethnic minorities, such as the Hmong, Lisu, Akha, Lahu and Yao. Estimates of the relative magnitude of populations of these groupings in each of the Ping sub-basins are used in the calculations in Figure 23.

Figure 23. Example of Upland Ethnicity Indicator Scoring for Ping Sub-Basins

		Population Ethnicity (unit: persons)			Percentage Distribution (unit: Percent)			Upland Ethnicity Score (3.3.1)				
	Traditions:	Lowland	Midland	Highland	Lowland	Midland	Highland	Lowland	Midland	Highland	Point Score	**Relative Upland Ethnicity Score**
Sub-Basin	***Total***	*Thai, Haw*	*Karen, Lua, Htin*	*Hmong, Lisu Akha, etc*	*Thai, Haw*	*Karen, Lua, Htin*	*Hmong, Lisu Akha, etc*	**Relative Weight** multiplied by % of persons				
								0.00	**2.00**	**3.00**		
1 Ping part 1	79,771	66,149	2,078	11,544	83	3	14	-	0.05	0.43	0.49	0.83
2 Mae Ngad	66,986	63,434	357	3,195	95	1	5	-	0.01	0.14	0.15	0.26
3 Mae Taeng	72,687	61,953	2,176	8,558	85	3	12	-	0.06	0.35	0.41	0.71
7 Mae Khan	106,041	90,871	11,993	3,177	86	11	3	-	0.23	0.09	0.32	0.54
9 Mae Klang	44,497	35,460	6,875	2,162	80	15	5	-	0.31	0.15	0.45	0.78
11 Mae Chaem upper	(with lower)	-	-	-								*
12 Mae Chaem lower	96,408	57,796	33,441	5,171	60	35	5	-	0.69	0.16	0.85	1.46
14 Mae Teun	57,642	36,132	19,641	1,869	63	34	3	-	0.68	0.10	0.78	1.33
Upper Sub-Basins	***524,032***	***411,795***	***76,561***	***35,676***	***79***	***15***	***7***	**-**	***0.29***	***0.20***	***0.50***	***0.85***
4 Ping part 2	663,600	657,151	-	6,449	99	-	1	-	-	0.03	0.03	0.05
5 Mae Rim	84,761	81,141	2,094	1,526								-
6 Mae Kuang	290,988	287,267	3,721	-	99	1	-	-	0.03	-	0.03	0.04
8 Mae Lee	147,846	125,246	22,600	-	85	15	-	-	0.31	-	0.31	0.52
10 Ping part 3	20,852	2,807	17,487	558	13	84	3	-	1.68	0.08	1.76	3.00
13 Mae Had	44,716	43,408	1,308	-	97	3	-	-	0.06	-	0.06	0.10
Middle Sub-Basins	***1,252,763***	***1,197,020***	***47,210***	***8,533***	***96***	***3.8***	***0.7***	**-**	***0.08***	***0.02***	***0.10***	***0.16***
15 Ping part 4	171,896	169,971	20	1,905	99	0	1	-	0.00	0.03	0.03	0.06
16 Huay Mae Thor	15,903	14,755	1,148	-	93	7	-	-	0.14	-	0.14	0.25
17 Klong Wang Chao	19,918	16,315	233	3,370	82	1	17	-	0.02	0.51	0.53	0.91
18 Klong Mae Raka	30,731	30,731	-	-	100	-	-	-	-	-	-	-
19 Klong Suan Mark	65,470	64,745	237	488	99	0	1	-	0.01	0.02	0.03	0.05
20 Lower Ping	378,141	371,449	666	6,026	98	0	2	-	0.00	0.05	0.05	0.09
Lower Sub-Basins	***682,059***	***667,966***	***2,304***	***11,789***	***98***	***0.3***	***1.7***	**-**	***0.01***	***0.05***	***0.06***	***0.10***
												-
Ping Basin	**2,458,854**	**2,276,781**	**126,075**	**55,998**	**93**	**5.1**	**2.3**	**-**	**0.10**	**0.07**	**0.17**	**0.29**

Although these groupings may at first glance appear to duplicate geographical altitude zone data that was used to group Ping sub-basins under criterion 1, they are fundamentally different in that they are based solely on people and their ethnicity. While it is likely there would have been a strong correlation with geographical altitude zones in the past, these correlations are weakening as lowland Thai communities are established in midland and highland zones, and as various midland and highland groups settle in other zones, sometimes as a result of government policies and programs, and sometimes at their own initiative.

Calculations in Figure 23 also employ weights for each of these three groupings, meant to indicate the relative intensity of their association in public debate and the policy arena with issues linked to natural resource management. Given the very high profile of ethnic groups with highland traditions in environmental and natural resource issues, a weight of 3 is assigned for these groups. Ethnic minority groups with midland traditions receive a weight of 2, whereas ethnic populations with lowland traditions receive a weight of zero. These weights can be adjusted according to consensus or expert opinion.

Since population data from regular mainstream sources in Thailand do not specify ethnicity, calculation of values for this indicator uses rough estimates constructed by the consultant by combining data from different sources. Since one essential component is disaggregated demographic data that includes ethnicity, ethnic minority populations have been estimated from a 1997 survey of highland communities in 20 provinces of Thailand [DPW 1998], which was made available in spreadsheet format by Panya and ONEP. Since this data includes ethnicity, village population and point coordinates locating each village, a GIS shape file was constructed, which was then clipped to the Ping River Basin and combined with sub-basin boundaries from ONEP. This allowed aggregation of population by ethnicity, but only for 'highland community' components of sub-basin populations. These data were then combined with sub-basin total population estimates from Panya, which are more recent, and the difference between the two totals was assumed to consist of lowland tradition ethnic groups not covered by the highland village survey. Given the two different sources and dates for each data set, this is very likely to be somewhat of an underestimate of the absolute numbers of mountain ethnic minorities. Since the methodology was consistent across all sub-basins, however, comparison of relative proportions across sub-basins should still be valid. Thus, this approach is deemed suitable for the purpose of relative sub-basin assessment at this stage of the project.

Discussions of ethnicity also provide a link with the cultural heritage of each ethnic group, as well as the common heritage of cultural diversity. Since these can relate to visions of preferred future land use and livelihood options, they may also be worthy of further study and learning. The report by CMU [2004] was able to draw on a range of qualitative, localized and often anecdotal data to put together a strong and very informative discussion of river life, culture and problems of primarily lowland Thai communities living in close proximity to main channels of the Ping River. Similar treatment for other groups in the basin could bring additional balance, and perhaps serve as background and resource material for consideration by pilot sub-basin management organizations. Indeed, it is precisely the directions of development and change that are occurring in various high density settlement areas of major lowland valleys that give rise to the second indicator under this sub-criterion.

Indicator 3.3.2: Population Density Score. This indicator provides a single value estimate of the relative population density of sub-basins in the Ping River Basin. Its calculation is straightforward, as indicated in Figure 24, based on the ratio between estimates of total population provided by Panya and total land area of each sub-basin as provided by ONEP. Ratio values for each sub-basin (persons per square kilometer) is converted to a 3-point scale of relative population density, wherein the sub-basin with highest population density is assigned a value of 3.0.

Relative sub-basin values of this indicator can also be compared visually with the distribution of administrative villages and municipal areas shown in the map on the right side of Figure 21. That figure also indicates the location of district towns, in which significant portions of local populations are concentrated. Although the lower Ping sub-basin has the second largest total population, it is distributed more widely among more dispersed settlements than is the case in middle sub-basins with high overall population densities. And in midland and highland areas of upper sub-basins, populations tend to be even more dispersed than indicated by the distribution of administrative villages, since in these areas administrative villages tend to be composed of multiple small settlements of the same or different ethnic groups. In any event, it is important to emphasize that high-density settlement and urban areas often have a range of important stakeholders in sub-basin management, (summarized in section B.1.c.), and there are usually multiple sectors that will need to be represented in an effective sub-basin management organization.

Figure 24. Population Density Indicator Scoring

3.3.2

	Population Density			
	People	Land	Population Density	Relative Population Density Score
Sub-Basin	*Population*	*Land Area*		
	persons	*sq km*	*per/sq km*	
1 Ping part 1	79,771	1,974	40.4	0.30
2 Mae Ngad	66,986	1,285	52.1	0.38
3 Mae Taeng	72,687	1,958	37.1	0.27
7 Mae Khan	106,041	1,833	57.8	0.42
9 Mae Klang	44,497	616	72.2	0.53
11 Mae Chaem upper	(with lower)	(with lower)		*
12 Mae Chaem lower	96,408	3,896	24.7	0.18
14 Mae Teun	57,642	2,896	19.9	0.15
Upper Sub-Basins	***524,032***	***14,458***	***36.2***	***0.26***
4 Ping part 2	663,600	1,616	410.5	3.00
5 Mae Rim	84,761	508	166.8	1.22
6 Mae Kuang	290,988	2,734	106.4	0.78
8 Mae Lee	147,846	2,081	71.1	0.52
10 Ping part 3	20,852	3,452	6.0	0.04
13 Mae Had	44,716	520	85.9	0.63
Middle Sub-Basins	***1,252,763***	***10,911***	***114.8***	***0.84***
15 Ping part 4	171,896	2,983	57.6	0.42
16 Huay Mae Thor	15,903	644	24.7	0.18
17 Klong Wang Chao	19,918	649	30.7	0.22
18 Klong Mae Raka	30,731	902	34.1	0.25
19 Klong Suan Mark	65,470	1,132	57.8	0.42
20 Lower Ping	378,141	2,980	126.9	0.93
Lower Sub-Basins	***682,059***	***9,289***	***73.4***	***0.54***
				-
Ping Basin	**2,458,854**	**34,659**	**70.9**	**0.52**

(d) Health

Public health is a major element of concern related to environmental management issues generally, and it features prominently in the logic underlying development of this project. In the context of the Ping River Basin, the currently most commonly perceived aspects of public health that might be improved through basin management would include those related to illness linked to water-borne diseases associated with sanitation related water pollution, respiratory illnesses associated with air pollution (including smoke), or illness due to toxic effects from chemicals increasingly used in agriculture and industry. Thus,

Sub-Criterion 3.4. **Priority should be given to sub-basins with relatively high levels of health problems associated with water or air pollution, or use of toxic chemicals.**

In order to assess Ping sub-basins according to this sub-criterion, a preliminary health problem indicator has been tentatively developed to work with any appropriate disaggregated data available to ONEP or Panya.

Indicator 3.4.1: Health Problem Score. This indicator would provide a single value depiction of the relative incidence of various environmentally-related illnesses. While exact composition of the indicator will depend on data availability, incidence of water-born diseases, respiratory infections, and pesticide poisoning are examples of possibilities used to construct the example score calculation table presented in Figure 25. The relative weights applied to different health problems are preliminary and tentative, and the table could be adjusted to fit any relevant data that may be available in an appropriate form.

Figure 25. Example of Health Problem Indicator Scoring for Ping Sub-Basins

		unit: persons			unit: cases / thousand persons (?)			unit: Score			3.4.1
		Illnesses Reported			Illness Rates			Health Problem Score			
		water/sanit	air	chemical	water/sanit	air	chemical	water/sanit	air	chemical	Health Problem Score
Sub-Basin	*Total*	*Gastro-intestinal*	*Respiratory*	*Chemical Poisoning*	*Gastro-intestinal*	*Respiratory*	*Chemical Poisoning*	Relative Weight multiplied by % of persons			
								2.00	1.00	3.00	
1 Ping part 1	79,771				-	-	-	-	-	-	-
2 Mae Ngad	66,986				-	-	-	-	-	-	-
3 Mae Taeng	72,687		Data not yet available		-	-	-	-	-	-	-
7 Mae Khan	106,041				-	-	-	-	-	-	-
9 Mae Klang	44,497				-	-	-	-	-	-	-
11 Mae Chaem upper	(with lower)										
12 Mae Chaem lower	96,408				-	-	-	-	-	-	-
14 Mae Teun	57,642				-	-	-	-	-	-	-
Upper Sub-Basins	*524,032*	-	-	-	-	-	-	-	-	-	-
4 Ping part 2	663,600				-	-	-	-	-	-	-
5 Mae Rim	84,761				-	-	-	-	-	-	-
6 Mae Kuang	290,988		Data not yet available		-	-	-	-	-	-	-
8 Mae Lee	147,846				-	-	-	-	-	-	-
10 Ping part 3	20,852				-	-	-	-	-	-	-
13 Mae Had	44,716				-	-	-	-	-	-	-
Middle Sub-Basins	*1,252,763*	-	-	-	-	-	-	-	-	-	-
15 Ping part 4	171,896				-	-	-	-	-	-	-
16 Huay Mae Thor	15,903				-	-	-	-	-	-	-
17 Klong Wang Chao	19,918		Data not yet available		-	-	-	-	-	-	-
18 Klong Mae Raka	30,731				-	-	-	-	-	-	-
19 Klong Suan Mark	65,470				-	-	-	-	-	-	-
20 Lower Ping	378,141				-	-	-	-	-	-	-
Lower Sub-Basins	*682,059*	-	-	-	-	-	-	-	-	-	-
Ping Basin	2,458,854	-	-	-	-	-	-	-	-	-	-

(e) Additional socio-economic data

A vast range of additional socio-economic, cultural and historical data could conceivably be added to the list of sub-criteria and indicators listed in this section. As an example, ONEP staff have suggested data related to crime and drugs. While these and other aspects are issues that could quite possibly be important for various sub-basin management organizations, the watershed consultant does not view them as practical for inclusion in sub-basin selection criteria at this stage. The list of sub-criteria and indicators is already perhaps too long, and various elements are already pushing the envelope of data readily available in an appropriate form. Moreover, variation of many of these factors among locations within a sub-basin is likely to be as great or greater than variation among sub-basins, as already suggested by data used in poverty indicators in this report.

Many are also likely to be correlated with differences in levels of urbanization, prominence of lowland or upland areas, or diversity of ethnic groups, which are factors that other sub-criteria and indicators are already seeking to capture.

Thus, it would appear more appropriate at this stage to view such issues as topics for further exploration through more detailed assessments to be conducted in each selected pilot sub-basin, as well as for discussion with and by emergent sub-basin management organizations in the context of their relevance for consideration and activities under specific conditions and at specific locations.

During discussions when the first draft of this report was presented to ONEP staff, the consultant suggested that one potentially interesting and useful source of socio-economic data might be available from Kho Cho Cho Song Kho data under the biennial village survey conducted through the Ministry of Interior's Community Development Department, if that data could be linked with georeferenced point locations for each administrative village. This would then allow the data to be combined with polygon shape files such as sub-basin boundaries, so that aggregations of village level data could be assessed at a sub-basin level. As this report was being finalized, ONEP staff provided the consultant with a version of Kho Cho Cho Song Kho data from the 2003 survey for villages in the Ping River basin that had been linked to ONEP's shape file of administrative village locations. Although the consultant has been making progress in working with this data, incorporation of additional findings from that data into this report has not been possible, due to the complexity of the large database file, the need to make various other revisions to this report suggested by ONEP reviewers, demands from other work, and the short time available before the revised version of this report had to be submitted. The consultant plans to continue working with this data, however, and hopes to include relevant findings into subsequent reports under this project, with emphasis on selected pilot sub-basins and information potentially relevant for future project expansion.

(4) Local capacity and administrative complexity

While it is clearly important to have representation of conditions under which a reasonable range of natural resource and socio-economic issues are likely to be key elements of pilot sub-basin management activities, it is also important to consider elements affecting the likelihood of significant progress being made under the project. We should also consider how other sub-basins will view the relevance of project activities in terms of the capacity of their local governments to provide essential support for sub-basin activities. Thus,

Criterion 4. **Selected sub-basins should represent a reasonable mix of local organizational capacities, but avoid areas where excessive administrative complexity may prevent adequate testing of model approaches within the project timeframe.**

In order to apply this criterion, two more specific sub-criteria are proposed to assess conditions associated with each key issue included in this criterion: Sub-criteria and indicators are summarized in Figure 24, where overall scores are relative within sub-basin groupings and relative weights are all set to 1.0.

(a) Local organizational capacity

Two components of the organizational capacity of local institutional actors depicted generally in Figure 8 are likely to have a substantial effect on the outcome of this project. Of key importance will be the degree to which very local watershed and/or natural resource management networks have begun to emerge within a given sub-basin. Progress is likely to be most rapid where such networks have emerged as a result of local initiative, and have reached the point where they are seeking to build alliances that can allow them to work at a wider level. If other conditions of such sub-basins are relevant, progress in such areas could provide a powerful demonstration effect for areas where such networks are not yet active. Since the longer term viability and sustainability of multi-level networking efforts depends on linkage with local governments, whether with TAOs through the "prachakhom window" or through other mechanisms, it is also important that pilot

Figure 26. Organizational and Administrative Indicator Scoring

Sub-Basin	4. Overall Local Org Capacity & Complexity: Score	4. Overall Local Org Capacity & Complexity: weighted total		4.1. Capacity: 4.1.1. Loc Govt Capacity Score	4.1. Capacity: 4.1.2. Network Experience Score	4.2. Compexity: 4.2.1. Admin Simplicity Score
			source:	onep, DOLA	Need data	Panya, ONEP
Upper Sub-Basins				***1.1***	-	***2.6***
			weight:	*1.0*	*1.0*	*1.0*
1 Ping part 1	**2.4**	4		1.6	-	2.5
2 Mae Ngad	**2.1**	4		0.8	-	2.8
3 Mae Taeng	**2.0**	3		0.9	-	2.4
7 Mae Khan	**2.4**	4		1.7	-	2.2
9 Mae Klang	**3.0**	5		2.0	-	3.0
11 Mae Chaem upper	*****	*		*	-	2.9
12 Mae Chaem lower	**2.2**	4		1.0	-	2.6
14 Mae Teun	**2.0**	3		0.7	-	2.7
Middle Sub-Basins				***1.6***	-	***1.8***
			weight:	*1.0*	*1.0*	*1.0*
4 Ping part 2	**2.3**	3		3.0	-	0.0
5 Mae Rim	**2.8**	4		0.9	-	2.7
6 Mae Kuang	**2.2**	3		2.1	-	0.6
8 Mae Lee	**2.8**	4		1.1	-	2.5
10 Ping part 3	**2.4**	3		0.9	-	2.2
13 Mae Had	**3.0**	4		0.9	-	3.0
Lower Sub-Basins				***1.4***	-	***2.4***
			weight:	*1.0*	*1.0*	*1.0*
15 Ping part 4	**2.3**	3		1.3	-	1.8
16 Huay Mae Thor	**2.8**	4		0.8	-	3.0
17 Klong Wang Chao	**2.7**	4		0.9	-	2.9
18 Klong Mae Raka	**2.5**	3		0.8	-	2.7
19 Klong Suan Mark	**3.0**	4		1.4	-	2.8
20 Lower Ping	**2.2**	3		1.8	-	1.2
Ping Basin				**1.3**	**-**	**2.1**

project experience includes sites where capacity of local governments are currently at both low and relatively higher levels. Thus,

<u>*Sub-Criterion 4.1.*</u> **Priority should be given to sub-basins where local resource management-related networks are already emerging, and especially to those where efforts to federate at larger watershed levels have begun. A mix of low and high capacities of supporting local (sub-district) government should be included in the overall set of selected sub-basins.**

In order to assess Ping sub-basins according to this sub-criterion, two indicators have been developed to capture a few key characteristics.

<u>**Indicator 4.1.1: Local Government Capacity Score**</u>. This indicator provides a value that reflects the overall composite capacity of local government units in a sub-basin, as characterized by their status as a municipality (*tessaban*) or their TAO rating assigned and monitored by units of the Ministry of Interior (MOI) responsible for monitoring and supporting TAO development.

MOI assigns a rating to all TAO's in the country, on a scale of 1 to 5, based largely on their overall annual budget; Class 1 TAO's have the largest annual budget. The overall annual budget of a TAO reflects its ability to collect local taxes, which in turn reflects a combination of the economic activity and land values of areas under their jurisdiction, as well as the ability of the TAO to levy and collect local taxes. The classification level of the TAO also reflects the number and type of permanent staff positions that the TAO has available to it, which directly affects its ability to handle issues and activities within its mandate. Thus, persistently low TAO ratings reflect some combination of a low level of economic activity, ineffective local leadership, and/or conditions that undermine TAO ability to raise local funds, such as the inability of TAO's in upper tributary watersheds to collect land taxes in areas zoned to any type of forest land status.

In order to implement this approach, lists of TAO ratings for 2002 were obtained from the MOI's Department of Provincial Administration website [http:\\www.dopa.go.th/local/abt.htm], and GIS shape files of TAO and municipality boundaries for the Ping Basin were obtained from ONEP.

TAO ratings were manually inserted into the database of the TAO boundary files, which was then combined with shape files of municipality boundaries and sub-basin boundaries. This resulted in a database file that could yield data on the areas covered by TAO under each of the rating levels, as well as municipalities. Suitably aggregated data was inserted into appropriate columns of the calculation table in Figure 27, and weights were assigned to each of the category columns. Since requirements for establishment of municipalities (*tambon, muang* or *nakhon*) are all already quite high, and their responsibilities are even greater than class 1 TAOs, they were assigned a weight of 3.0. Class 1 to 5 TAOs were assigned weights intended to reflect the declining capacity of each category. Thus, the resulting score yields a depiction of the overall proportion of local government capacity across the entire landscape of the sub-basin.

While this area-based approach appears particularly relevant in relation to natural resource management, another alternative would be to conduct similar types of data processing and calculations using demographic data on tessaban and TAOs to obtain a people-based approach.

Figure 27. Area-Based Indicator Scoring for Local Government Capacity

unit: square kilometers | unit: Percent | 4.1.1

		Local Government Classification						Percentage Distribution						Area-Based Local Gov't Capacity Score							
		Munic	elected sub-district government					Munic	elected sub-district govt					Munic	1	2	3	4	5	Point	Relative
Sub-Basin	***Total Area***	***Tessaban***	***TAO Classification Level*** ***1***	***2***	***3***	***4***	***5***	***Tssbn***	***TAO Classification Level*** ***1***	***2***	***3***	***4***	***5***	**Relative Weight of capacity by multiplied by % of land area**						Score	**Capacity Score**
	sq km													**3.00**	**2.50**	**2.00**	**1.50**	**0.75**	**0.25**		
1 Ping part 1	1,974	42	-	-	14	921	997	2	-	-	1	47	51	0.06	-	-	0.01	0.35	0.13	0.55	1.58
2 Mae Ngad	1,285	6	-	-	-	0	1,278	0.5	-	-	-	0	100	0.01	-	-	-	0.00	0.25	0.26	0.76
3 Mae Taeng	1,958	16	-	-	-	146	1,795	1	-	-	-	7	92	0.03	-	-	-	0.06	0.23	0.31	0.89
7 Mae Khan	1,833	139	-	-	-	438	1,257	8	-	-	-	24	69	0.23	-	-	-	0.18	0.17	0.58	1.66
9 Mae Klang	616	18	-	-	29	376	193	3	-	-	5	61	31	0.09	-	-	0.07	0.46	0.08	0.70	2.00
11 Mae Chaem upper	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12 Mae Chaem lower	3,896	102	-	-	-	261	3,532	3	-	-	-	7	91	0.08	-	-	-	0.05	0.23	0.36	1.02
14 Mae Teun	2,896	3	-	-	-	-	2,893	0.1	-	-	-	-	100	0.00	-	-	-	-	0.25	0.25	0.73
Upper Sub-Basins	***14,458***	***327***	***-***	***-***	***43***	***2,142***	***11,946***	***2***	***-***	***-***	***0.3***	***15***	***83***	*0.07*	*-*	*-*	*0.00*	*0.11*	*0.21*	***0.39***	***1.12***
4 Ping part 2	1,617	168	90	21	277	467	594	10	6	1	17	29	37	0.31	0.14	0.03	0.26	0.22	0.09	1.04	3.00
5 Mae Rim	508	-	-	-	-	58	450	-	-	-	-	11	89	-	-	-	-	0.09	0.22	0.31	0.88
6 Mae Kuang	2,734	296	32	2	198	401	1,805	11	1	0.1	7	15	66	0.32	0.03	0.00	0.11	0.11	0.17	0.74	2.13
8 Mae Lee	2,081	36	-	-	0	393	1,651	2	-	-	0	19	79	0.05	-	-	0.00	0.14	0.20	0.39	1.13
10 Ping part 3	3,452	27	-	-	1	299	3,125	1	-	-	0	9	91	0.02	-	-	0.00	0.06	0.23	0.31	0.91
13 Mae Had	520	8	-	-	-	14	498	1	-	-	-	3	96	0.04	-	-	-	0.02	0.24	0.30	0.87
Middle Sub-Basins	***10,911***	***534***	***121***	***23***	***477***	***1,632***	***8,124***	***5***	***1***	***0***	***4***	***15***	***74***	*0.15*	*0.03*	*0.00*	*0.07*	*0.11*	*0.19*	***0.54***	***1.56***
15 Ping part 4	2,983	108	-	-	174	189	2,512	4	-	-	6	6	84	0.11	-	-	0.09	0.05	0.21	0.45	1.31
16 Huay Mae Thor	644	-	-	-	-	34	610	-	-	-	-	5	95	-	-	-	-	0.04	0.24	0.28	0.80
17 Klong Wang Chao	649	-	-	-	-	80	569	-	-	-	-	12	88	-	-	-	-	0.09	0.22	0.31	0.90
18 Klong Mae Raka	902	-	-	-	6	9	887	-	-	-	1	1	98	-	-	-	0.01	0.01	0.25	0.26	0.76
19 Klong Suan Mark	1,132	4	-	-	-	477	651	0.3	-	-	-	42	58	0.01	-	-	-	0.32	0.14	0.47	1.35
20 Lower Ping	2,980	197	-	-	-	1,215	1,568	7	-	-	-	41	53	0.20	-	-	-	0.31	0.13	0.64	1.83
Lower Sub-Basins	***9,289***	***309***	***-***	***-***	***180***	***2,004***	***6,796***	***3***	***-***	***-***	***2***	***22***	***73***	*0.10*	*-*	*-*	*0.03*	*0.16*	*0.18*	***0.47***	***1.36***
Ping Basin	**34,659**	**1,170**	**121**	**23**	**700**	**5,778**	**26,866**	**3**	**0.3**	**0.1**	**2**	**17**	**78**	0.10	0.01	0.00	0.03	0.13	0.19	**0.46**	**1.33**

<u>Indicator 4.1.2: Network Experience Scale</u>. This indicator provides a simple score value that reflects an extremely coarse characterization of the overall status of local network development in sub-basins related to watershed and natural resource management, and/or other types of activity seen as providing relevant experience for development of sub-basin management organizations.

As there is no known source of systematic basin-wide data on such issues, this indicator needs to be based on gross estimates. Thus, an extremely simple scoring system is proposed as follows:

0 = no relevant local networks are known to exist
1 = a few local networks have begun, but they have little experience thus far
2 = fairly experienced local networks exist, and are beginning to interact with each other
3 = experienced local networks exist, and have begun building alliance at sub-basin level

No further calculations would be required before entering scores into the table in Figure 28.

Examples of sub-basins that might deserve a rating of 3 on this scale might include:

- Mae Kuang and Mae Tha, where local watershed management networks are seen as strong, they have taken collective action in the past through alliances, and management committees are being formed at levels of Mae Kuang and Mae Tha watersheds

Figure 28. Area-Based Indicator Scoring for Local Government Capacity

unit: Score

Sub-Basin	Local Network Experience Score
1 Ping part 1	3
2 Mae Ngad	-
3 Mae Taeng	-
7 Mae Khan	-
9 Mae Klang	-
11 Mae Chaem upper	3
12 Mae Chaem lower	3
14 Mae Teun	-
Upper Ping Basin Ave	
4 Ping part 2	-
5 Mae Rim	-
6 Mae Kuang	3
8 Mae Lee	-
10 Ping part 3	-
13 Mae Had	-
Middle Ping Basin Ave	
15 Ping part 4	-
16 Huay Mae Thor	-
17 Klong Wang Chao	-
18 Klong Mae Raka	-
19 Klong Suan Mark	-
20 Lower Ping	-
Lower Ping Basin Ave	
Ping Basin Ave	

Needs ratings according to simple scale:

0 = no relevant local networks are known to exist

1 = a few local networks have begun, but they have little experience thus far

2 = fairly experienced local networks exist, and are beginning to interact with each other

3 = experienced local networks exist, and have begun efforts to build an alliance at sub-basin scale

- Mae Chaem (upper & lower combined), where 24 local watershed and forest conservation networks have joined efforts to form a sub-basin level alliance for coordination and higher-level collective action through a sub-basin management committee.
- Mae Ping 1, where forest conservation and small watershed networks are joining with village doctors and others to build a broader joint network that approaches sub-basin level

As this information is known to the consultant either through direct personal experience or through personal social networks, the existence of additional examples is highly probable. The consultant proposes that ONEP and Panya use their extensive relationships with individuals, organizations and governmental units around the Ping Basin to gather simple information at this level on as many Ping sub-basins as possible. The resulting information could be presented for consideration and discussion during the upcoming Water Forum, which would also be an opportunity for leaders from various Ping sub-basins to provide further information and input. Further effort to collect such information would be useful not only for pilot sub-basin selection purposes, but also to help build a catalog of experience that is building in the Ping Basin. This experience could be a valuable resource, both for management ‘model’ development in pilot sub-basins, and for adaptation and refinement of the approach in other sub-basins during the subsequent expansion phase.

In this regard, it would also be very useful to try to build a catalogue of information on efforts and activities conducted by NGOs and government agencies to provide various types of support for local networks and emerging alliances or federations of networks. Although such information is not proposed as a specific sub-basin selection sub-criterion or indicator, such experience could also provide important learning experience and human resources for building and refining the overall multi-level Ping Basin management system.

(b) Administrative complexity

Given the very short project time frame, it seems wise to try to avoid sub-basins where mis-matches between administrative and watershed boundaries result in a complex set of administrative units that would require major coordination efforts before the project could progress. Thus,

Sub-Criterion 4.2. **Priority should be given to sub-basins with relatively lower requirements for coordination across administrative units.**

In order to assess Ping sub-basins according to this sub-criterion, an indicator has been developed to capture and synthesize key information.

Indicator 4.2.1: Administrative Simplicity Score. This indicator provides a single value that depicts the overall proliferation of administrative units in a sub-basin, and provides for relative weights that can reflect levels of difficulty and time delay in coordination among multiple units of the same general type. The overall score is on a scale of 3 relative to other sub-basins. Thus, a score of 3.0 indicates the sub-basin has the greatest administrative simplicity among Ping sub-basins, whereas lower scores indicate proportionately greater administrative complexity.

Calculation involves a two-step process, as reflected in the calculation table shown in Figure 26. The first step is to simply catalog the various relevant administrative units for each sub-basin according to the column heading categories in the left side of the table. The types of units considered follow from the general types of units depicted in Figure 8. The second step is then to assign weights according to the simplicity (or ease) of coordination with and among that type of unit. For example, preliminary tentative weights already in the table reflect the hypothesis that it is relatively difficult to coordinate among provinces, and least difficult to coordinate among local forestry units. Broader experience, especially at local levels, should be drawn upon to ascertain whether such hypotheses are valid or not, and how the weighting regime could be further refined.

Figure 29. Administrative Simplicity Indicator Scoring for Ping Sub-Basins

unit: number of admin units | unit: Score | 4.2.1

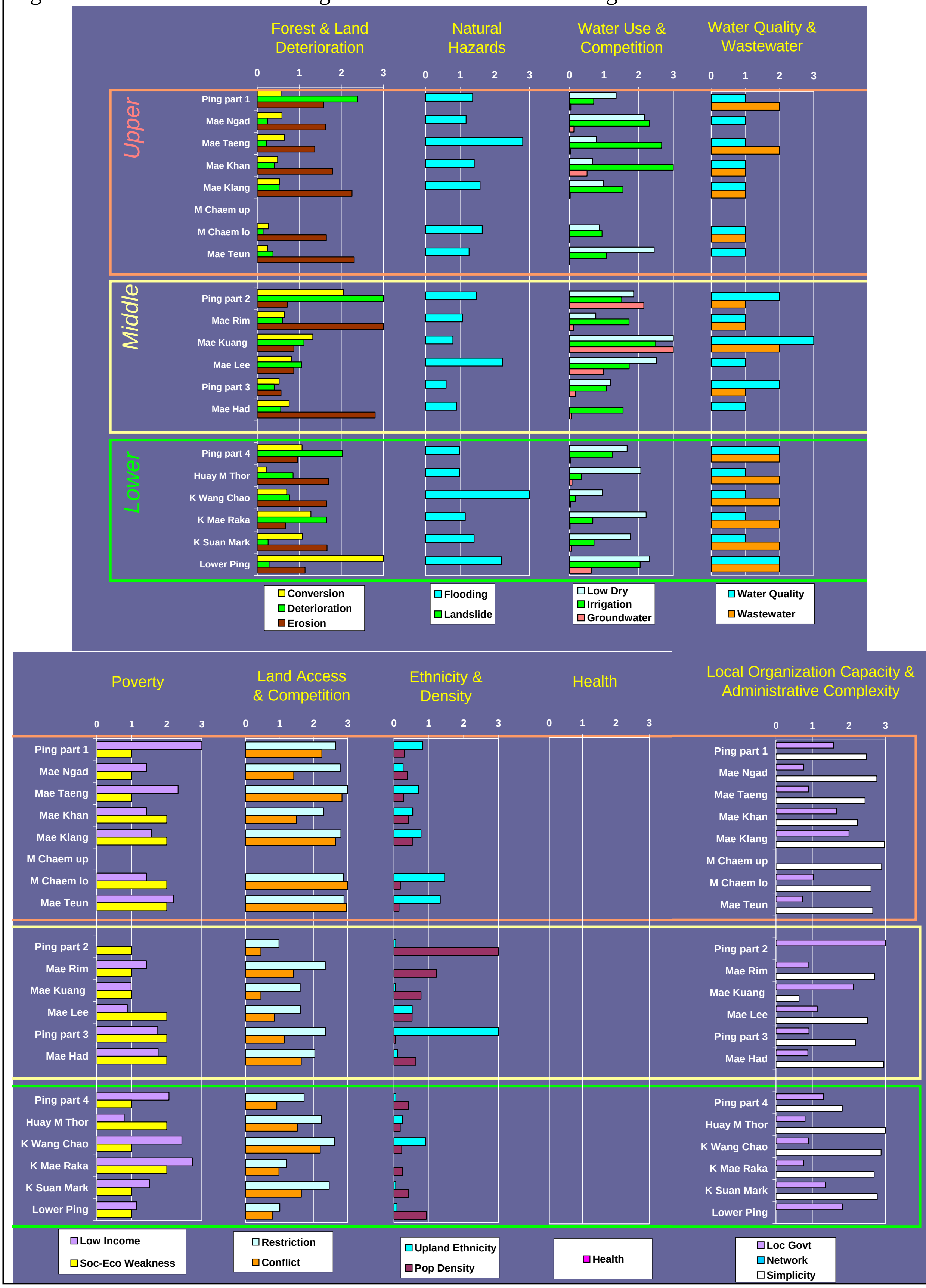
	Administrative Units						Administrative Simplicity Score						
	DOLA		Loval Govt		MoNRE		Province	District	Loc Govt	Watershed	Conserv	Weighted	Admin
							Relative Coord. Difficulty Weight multiplied by number of units					Complexity	Simplicity
Sub-Basin	***Province***	***Districts***	***Tambon***	***Munic***	***Watrshd units***	***Parks & WLS***						Total	Score**
							3.0	**2.5**	**2.0**	**1.0**	**1.5**		
1 Ping part 1	1	5	13	3	3	4	3.0	12.5	26.0	3.0	6.0	50.5	2.5
2 Mae Ngad	1	2	11	1	2	1	3.0	5.0	22.0	2.0	1.5	33.5	2.8
3 Mae Taeng	1	3	14	1	8	4	3.0	7.5	28.0	8.0	6.0	52.5	2.4
7 Mae Khan	1	5	19	3	8	2	3.0	12.5	38.0	8.0	3.0	64.5	2.2
9 Mae Klang	1	1	5	1	3	2	3.0	2.5	10.0	3.0	3.0	21.5	3.0
11 Mae Chaem upper	1	1	5	-	9	1	3.0	2.5	10.0	9.0	1.5	26.0	2.9
12 Mae Chaem lower	1	3	9	2	10	3	3.0	7.5	18.0	10.0	4.5	43.0	2.6
14 Mae Teun	2	2	9	1	8	2	6.0	5.0	18.0	8.0	3.0	40.0	2.7
Upper Ping Basin Ave	***1.1***	***3***	***11***	***2***	***6***	***2***	***3.4***	***6.9***	***21.3***	***6.4***	***3.6***	***41.4***	***2.6***
4 Ping part 2	2	13	76	13	3	1	6.0	32.5	152.0	3.0	1.5	195.0	-
5 Mae Rim	1	3	9	-	4	3	3.0	7.5	18.0	4.0	4.5	37.0	2.7
6 Mae Kuang	1	10	63	13	1	2	3.0	25.0	126.0	1.0	3.0	158.0	0.6
8 Mae Lee	1	5	16	4	-	1	3.0	12.5	32.0	-	1.5	49.0	2.5
10 Ping part 3	3	7	17	2	3	3	9.0	17.5	34.0	3.0	4.5	68.0	2.2
13 Mae Had	2	2	5	1	-	1	6.0	5.0	10.0	-	1.5	22.5	3.0
Middle Ping Basin Ave	***1.7***	***7***	***31***	***6***	***2***	***2***	***5.0***	***16.7***	***62.0***	***1.8***	***2.8***	***88.3***	***1.8***
15 Ping part 4	2	7	30	2	1	3	6.0	17.5	60.0	1.0	4.5	89.0	1.8
16 Huay Mae Thor	1	2	4	1	1	2	3.0	5.0	8.0	1.0	3.0	20.0	3.0
17 Klong Wang Chao	2	4	4	-	-	2	6.0	10.0	8.0	-	3.0	27.0	2.9
18 Klong Mae Raka	2	5	9	-	-	1	6.0	12.5	18.0	-	1.5	38.0	2.7
19 Klong Suan Mark	1	3	9	1	-	3	3.0	7.5	18.0	-	4.5	33.0	2.8
20 Lower Ping	2	7	49	8	-	2	6.0	17.5	98.0	-	3.0	124.5	1.2
Lower Ping Basin Ave	***1.7***	***5***	***18***	***2***	***0.3***	***2***	***5.0***	***11.7***	***35.0***	***0.3***	***3.3***	***55.3***	***2.4***
Ping Basin Ave	**1.5**	**5**	**19**		**3**	**2**	**4.4**	**11.3**	**37.6**	**3.2**	**3.2**	**59.6**	**2.1**

** calculated as [(<max total>-<total>) / (<max total>-<min total>)] *3

(5) Putting it all together

As indicated in previous sections of this report, the consultant has been able to obtain data to quantify all but three of the indicators proposed in this report. The results of score calculations before application of relative weights among indicators are summarized by bar charts in Figure 30.

Figure 34. Bar Charts of Unweighted Indicator Scores for Ping Sub-Basin



To the extent that these criteria and indicators are seen as useful, the project consultant team can include them in their proposal for a pair of candidate sub-basins for each of the lower, middle and upper sub-basin groupings. In order to help facilitate such considerations, this section summarizes all indicator calculations and presents an example of how to use provisions for deriving weighted overall values for each sub-basin.

It is important to note that Figures 10, 16 and 26 are summary tables for each of the sets of sub-criteria and indicators associated with a major guiding criterion. Results of calculations for each individual indicator for which data is currently available have been entered into the summary table for their overall guiding criterion. These tables contain provision for transparent methods of assigning two additional types of weights:

- In deriving overall values for each criterion, relative weights can be applied to different sub-criteria and each of their indicators, in order to reflect different levels of importance or priority they are seen to have in the decision-making process. As indicated in those tables, weights are all set to the default value of 1.0, which implies an equal weight for each.
- Summary tables include separate lines for these weights under each of the sub-basin groupings (lower, middle, and upper). Since above discussions of each indicator suggest that it may well be appropriate to assign higher priority to some sub-criteria or indicators under conditions specific to one sub-basin grouping or another, this provision allows different weighting regimes for each sub-basin grouping.

Again, these weightings can be used as a transparent method for reflecting expert opinion, they can be derived through stakeholder consensus, and/or they can be used to conduct a simple sensitivity analysis on indicator or sub-criteria aggregations. In any event, the weightings are optional, and if they are not seen as useful or necessary, or if they appear to over-complicate matters, they can simply be ignored.

To bring a final step toward closure in applying this set of criteria and indicators, Figure 31 introduces an overall summary table that summarizes the overall values derived in the data tables for each of the major guiding criteria. This table again has provision for assigning different weights for each of the major criteria, and weighting regimes can be different for each of the sub-

Figure 31. Overall Summary of Weighted Indicator Scoring for Ping Sub-Basins

	Summary Overall Weighted Scores		1. Grouping Lowland Zone Bias Score		2. Overall Natural Resource Issues		3. Overall Social & Economic Issues		4. Overall Local Org Capacity & Complexity	
Sub-Basin	Score	weighted total		*source:*	Score	weighted total	Score	weighted total	Score	weighted total
Upper Sub-Basins			***1.88***							
				weight:		2.00		3.00		1.00
1 Ping part 1	**3.00**	91	2.24		**3.0**	16	**2.7**	19	**2.4**	4
2 Mae Ngad	**2.18**	66	2.27		**2.3**	12	**1.9**	13	**2.1**	4
3 Mae Taeng	**2.89**	88	1.59		**2.7**	14	**2.7**	19	**2.0**	3
7 Mae Khan	**2.35**	72	1.95		**2.5**	13	**2.0**	14	**2.4**	4
9 Mae Klang	**2.78**	85	1.87		**2.5**	13	**2.6**	18	**3.0**	5
11 Mae Chaem upper	*	*	1.43		*	*	*	*	*	*
12 Mae Chaem lower	**2.69**	82	1.88		**1.8**	10	**2.8**	20	**2.2**	4
14 Mae Teun	**2.93**	89	1.93		**2.2**	12	**3.0**	21	**2.0**	3
Middle Sub-Basins			***2.54***							
				weight:		2.00		3.00		1.00
4 Ping part 2	**2.82**	78	2.80		**2.4**	23	**2.1**	8	**3.0**	6
5 Mae Rim	**2.23**	62	2.32		**1.4**	14	**2.5**	10	**2.2**	4
6 Mae Kuang	**3.00**	83	2.63		**3.0**	29	**1.6**	7	**2.4**	5
8 Mae Lee	**2.27**	63	2.59		**1.8**	17	**1.9**	8	**2.4**	5
10 Ping part 3	**2.32**	64	2.33		**1.2**	12	**3.0**	12	**2.0**	4
13 Mae Had	**2.05**	57	2.73		**1.1**	10	**2.6**	11	**2.4**	5
Lower Sub-Basins			***2.80***							
				weight:		2.00		3.00		1.00
15 Ping part 4	**2.71**	64	2.81		**2.3**	17	**2.2**	9	**2.4**	4
16 Huay Mae Thor	**2.27**	54	2.54		**1.7**	13	**2.0**	8	**2.5**	5
17 Klong Wang Chao	**2.77**	66	2.53		**1.7**	12	**3.0**	12	**2.6**	5
18 Klong Mae Raka	**2.69**	64	2.99		**1.9**	15	**2.5**	10	**2.3**	4
19 Klong Suan Mark	**2.51**	59	2.55		**1.8**	13	**2.2**	9	**3.0**	5
20 Lower Ping	**3.00**	71	2.94		**3.0**	23	**1.8**	7	**2.7**	5
Ping Basin			**2.33**							

basin groupings. In this case weights have been assigned to give greatest weight to socio-economic issues (3.0), followed by natural resource issues (2.0), and local organization (1.0).

While this table applies the same weighting regime across all sub-basin groupings, the values for each individual criterion are derived through calculations that have used weighting regimes that reflect differences among sub-basin groups. These weight assignments are pursuant to reasoning presented for each sub-criterion and indicator in previous sections of this report, and are presented in the following tables as an example of how the weighting system can be implemented.

Figure 32. Natural Resource Issues Weighted Indicator Scoring for Ping Sub-Basins

	2. Overall Natural Resource Issues			2.1. Degradation			2.2. Hazards		2.3. Water Use			2.4 Water Quality	
				2.1.1.	2.1.2.	2.1.3.	2.2.1.	2.2.2.	2.3.1.	2.3.2.	2.3.3.	2.4.1.	2.4.2.
				Forest Conversion Score	Forest Deterior Score	Soil Erosion Score	Flooding Risk Score	Landslide Risk Score	Agric Irrigation Score	Groundwater Use Score	Low Dry Season Flow Score	Water Quality Problem Score	Wastewater Problem Score
Sub-Basin	Score	weighted total	***source:***	CMU data	CMU data	Panya data	Panya	Need data	Panya data	Panya data	Panya data	Panya	CMU
Upper Sub-Basins				***0.4***	***0.5***	***1.8***		***-***	***1.8***	***0.1***	***1.4***		
			weight:	*2.0*	*2.0*	*2.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*
1 Ping part 1	**3.0**	16		0.6	2.4	1.6	1.4	-	0.7	0.0	1.4	1	2
2 Mae Ngad	**2.3**	12		0.6	0.3	1.6	1.2	-	2.3	0.1	2.2	1	0
3 Mae Taeng	**2.7**	14		0.7	0.2	1.4	2.8	-	2.7	0.0	0.8	1	2
7 Mae Khan	**2.5**	13		0.5	0.4	1.8	1.4	-	3.0	0.5	0.7	1	1
9 Mae Klang	**2.5**	13		0.5	0.5	2.3	1.6	-	1.5	0.0	1.0	1	1
11 Mae Chaem upper	*****	*		*	*	*	*	-	*	*	*	*	*
12 Mae Chaem lower	**1.8**	10		0.3	0.1	1.6	1.6	-	0.9	0.0	0.9	1	1
14 Mae Teun	**2.2**	12		0.2	0.4	2.3	1.3	-	1.1	0.0	2.4	1	0
Middle Sub-Basins				***1.0***	***0.9***	***1.0***		***-***	***1.9***	***1.3***	***1.8***		
			weight:	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*2.0*	*2.0*	*2.0*	*2.0*	*1.0*
4 Ping part 2	**2.4**	23		2.0	3.0	0.7	1.5	-	1.5	2.2	1.9	2	1
5 Mae Rim	**1.4**	14		0.6	0.6	3.0	1.1	-	1.7	0.1	0.8	1	1
6 Mae Kuang	**3.0**	29		1.3	1.1	0.9	0.8	-	2.5	3.0	3.0	3	2
8 Mae Lee	**1.8**	17		0.8	1.1	0.9	2.2	-	1.7	1.0	2.5	1	0
10 Ping part 3	**1.2**	12		0.5	0.4	0.6	0.6	-	1.1	0.2	1.2	2	1
13 Mae Had	**1.1**	10		0.8	0.6	2.8	0.9	-	1.6	0.1	0.0	1	0
Lower Sub-Basins				***1.6***	***1.2***	***1.2***	***1.7***	***-***	***1.6***	***0.4***	***1.9***		
			weight:	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*2.0*	*2.0*	*2.0*	*2.0*	*1.0*
15 Ping part 4	**2.3**	17		1.1	2.0	1.0	1.0	-	1.2	0.0	1.7	2	2
16 Huay Mae Thor	**1.7**	13		0.2	0.9	1.7	1.0	-	0.3	0.1	2.1	1	2
17 Klong Wang Chao	**1.7**	12		0.7	0.8	1.7	3.0	-	0.2	0.0	0.9	1	2
18 Klong Mae Raka	**1.9**	15		1.3	1.7	0.7	1.1	-	0.7	0.0	2.2	1	2
19 Klong Suan Mark	**1.8**	13		1.1	0.3	1.7	1.4	-	0.7	0.1	1.8	1	2
20 Lower Ping	**3.0**	23		3.0	0.3	1.1	2.2	-	2.0	0.6	2.3	2	2
Ping Basin				**0.9**	**0.7**	**1.4**	**1.5**	**-**	**1.7**	**0.6**	**1.6**	**-**	

Weighted indicator scoring calculations for the natural resource issue criterion are shown in Figure 32. Values displayed in columns under each indicator are the same values obtained in calculation tables for each of those indicators presented in previous sections. Thus, the differential weighting regime used is entirely reflected by values entered into cells with green background color in this table. This application is quite simple, and is based on two notions: (1) Since land and forest degradation indicators are seen as especially critical in upper sub-basins, a weight of 2.0 has been assigned to appropriate cells. (2) As water use and water quality indicators are seen as having especially high importance in middle and lower sub-basins, a weight of 2.0 has been assigned to those cells to reflect these priorities.

In the case of socio-economic issues, weighted calculations are shown in Figure 33. Three major considerations were used in applying weights: (1) Given the importance of poverty to this project, a weight of 2.0 was applied to the low income score for all 3 sub-basin groups. (2) Given the special importance of land use access and competition in upper sub-basins, a weight of 2.0 was assigned to indicators of land use restrictions and agricultural conflict for the upper basin grouping. (3) Roles and representation of upland ethnic groups is very important in upper sub-basins, whereas inclusion of urbanizing population centers is especially important in middle and lower sub-basins – thus, weights of 2.0 were assigned to appropriate cells of indicators under sub-criterion 3.3.

Weighted calculations of the local organization criterion are presented in Figure 34, where weights are assigned following two lines of consideration: (1) Local government capacity was assigned a weight of 2.0 in middle and lower sub-basins because strong local government would be an advantage in seeking to establish a sub-basin management organization as quickly as possible under conditions that often involve substantial numbers of people and some rather complex social

Figure 33. Socio-Economic Issues Weighted Indicator Scoring for Ping Sub-Basins

	3. Overall Social & Economic Issues			3.1. Poverty		3.2. Competition		3.3. Minorities & Urban		3.4. Health
				3.1.1.	3.1.2.	3.2.1	3.2.2	3.3.1	3.3.2	3.3.1.
				Low Income Score	Econ & Social Weakness Score	Land Use Restriction Score	Agricultural Conflict Score	Upland Ethnicity Score	Population Density Score	Health Problem Score
Sub-Basin	**Score**	weighted total	*source:*	Panya data	CMU data	Panya/onep	Panya/onep	ONEP, Panya	Panya	Needs data
Upper Sub-Basins				***1.9***	***-***	***2.8***	***2.3***	***0.8***	***0.3***	***-***
			weight:	*2.0*	*1.0*	*2.0*	*2.0*	*2.0*	*1.0*	*1.0*
1 Ping part 1	**2.7**	19		3.0	1	2.6	2.2	0.8	0.3	-
2 Mae Ngad	**1.9**	13		1.4	1	2.8	1.4	0.3	0.4	-
3 Mae Taeng	**2.7**	19		2.3	1	3.0	2.8	0.7	0.3	-
7 Mae Khan	**2.0**	14		1.4	2	2.3	1.5	0.5	0.4	-
9 Mae Klang	**2.6**	18		1.6	2	2.8	2.6	0.8	0.5	-
11 Mae Chaem upper	**0.0**			*	2	*	*	*	*	-
12 Mae Chaem lower	**2.8**	20		1.4	2	2.9	3.0	1.5	0.2	-
14 Mae Teun	**3.0**	21		2.2	2	2.9	3.0	1.3	0.1	-
Middle Sub-Basins				***0.5***	***-***	***1.8***	***0.7***	***0.2***	***0.8***	***-***
			weight:	*2.0*	*1.0*	*1.0*	*1.0*	*1.0*	*2.0*	*1.0*
4 Ping part 2	**2.1**	8		0.0	1	1.0	0.4	0.0	3.0	-
5 Mae Rim	**2.5**	10		1.4	1	2.3	1.4	0.0	1.2	-
6 Mae Kuang	**1.6**	7		1.0	1	1.6	0.4	0.0	0.8	-
8 Mae Lee	**1.9**	8		0.9	2	1.6	0.8	0.5	0.5	-
10 Ping part 3	**3.0**	12		1.7	2	2.3	1.1	3.0	0.0	-
13 Mae Had	**2.6**	11		1.8	2	2.0	1.6	0.1	0.6	-
Lower Sub-Basins				***1.5***	***-***	***1.6***	***1.0***	***0.1***	***0.5***	***-***
			weight:	*2.0*	*1.0*	*1.0*	*1.0*	*1.0*	*2.0*	*1.0*
15 Ping part 4	**2.2**	9		2.1	1	1.7	0.9	0.1	0.4	-
16 Huay Mae Thor	**2.0**	8		0.8	2	2.2	1.5	0.2	0.2	-
17 Klong Wang Chao	**3.0**	12		2.4	1	2.6	2.2	0.9	0.2	-
18 Klong Mae Raka	**2.5**	10		2.7	2	1.2	1.0	0.0	0.2	-
19 Klong Suan Mark	**2.2**	9		1.5	1	2.5	1.6	0.1	0.4	-
20 Lower Ping	**1.8**	7		1.1	1	1.0	0.8	0.1	0.9	-
Ping Basin				**1.1**	**-**	**2.2**	**1.2**	**0.3**	**0.5**	**-**

situations. For upper sub-basins this weight was left at 1.0 because work with relatively low capacity local governments will be necessary in order to provide a context that is reasonably representative of upper sub-basins, where such conditions are normal. (2) A weight of 3.0 is assigned to the network experience indicator in all sub-basin groupings, because of its potential importance in providing organizational building blocks for sub-basin management organizations. Thus, it is seen to be quite unfortunate that this is a purely symbolic gesture because even such simple data is not available for enough sub-basins for this indicator to be implemented at this time.

Figure 34. Local Organization Weighted Indicator Scoring for Ping Sub-Basins

	4. Overall Local Org Capacity & Complexity			4.1. Capacity		4.2. Compexity
				4.1.1.	4.1.2.	4.2.1.
				Loc Govt Capacity Score	Network Experience Score	Admin Simplicity Score
Sub-Basin	**Score**	weighted total	*source:*	onep, DOLA	Need data	Panya, ONEP
Upper Sub-Basins				***1.1***	***-***	***2.6***
			weight:	*1.0*	*3.0*	*1.0*
1 Ping part 1	**2.4**	4		1.6	-	2.5
2 Mae Ngad	**2.1**	4		0.8	-	2.8
3 Mae Taeng	**2.0**	3		0.9	-	2.4
7 Mae Khan	**2.4**	4		1.7	-	2.2
9 Mae Klang	**3.0**	5		2.0	-	3.0
11 Mae Chaem upper	*****	*		*	-	2.9
12 Mae Chaem lower	**2.2**	4		1.0	-	2.6
14 Mae Teun	**2.0**	3		0.7	-	2.7
Middle Sub-Basins				***1.6***	***-***	***1.8***
			weight:	*2.0*	*3.0*	*1.0*
4 Ping part 2	**3.0**	6		3.0	-	0.0
5 Mae Rim	**2.2**	4		0.9	-	2.7
6 Mae Kuang	**2.4**	5		2.1	-	0.6
8 Mae Lee	**2.4**	5		1.1	-	2.5
10 Ping part 3	**2.0**	4		0.9	-	2.2
13 Mae Had	**2.4**	5		0.9	-	3.0
Lower Sub-Basins				***1.4***	***-***	***2.4***
			weight:	*2.0*	*3.0*	*1.0*
15 Ping part 4	**2.4**	4		1.3	-	1.8
16 Huay Mae Thor	**2.5**	5		0.8	-	3.0
17 Klong Wang Chao	**2.6**	5		0.9	-	2.9
18 Klong Mae Raka	**2.3**	4		0.8	-	2.7
19 Klong Suan Mark	**3.0**	5		1.4	-	2.8
20 Lower Ping	**2.7**	5		1.8	-	1.2
Ping Basin				**1.3**	**-**	**2.1**

The “bottom line” results of applying these weights to the quantitative indicators proposed in this report can be seen in the summary overall weighted scores shown in the left column of the table in Figure 31. The highest score (3.0) for each sub-basin grouping is highlighted in bright yellow, and the second highest score in light yellow. Similar relative values for each of the major criteria are listed in other columns.

Thus, under these weighting regimes, the leading candidate sub-basins are:

- ***Lower sub-basins***: Lower Ping, followed by Klong Wang Chao and Ping part 4
- ***Middle sub-basins***: Mae Kuang, followed by Ping part 2 and Ping part 3
- ***Upper sub-basins***: Ping part 1, followed by Mae Tuen and Mae Taeng

As Mae Kuang and Ping part 1 are known to have significant network experience, the list of leading candidates appears to be quite robust.

C. Data and Information Requirements for Applying Selection Criteria

Data required to assess each of the indicators proposed in previous sections of this report are shown in Figure 35, along with sources from which they could be obtained. Fortunately, as the table indicates, data for all but three of the indicators have been provided by ONEP, Panya, ICRAF, CMU report [2004] and Ministry of Interior web sites. The only significant shortcoming of these data is that many data cannot be disaggregated for upper and lower Mae Chaem sub-basins due to the non-standard nature of this division of the physical catchment. Requirements for which data have not yet become available are indicated in orange color.

Figure 35. Data Requirements for Assessing Criteria and Indicators

	Group		Natural Resource Issues										Soc-Econ Issues							Loc Capacity		
	land	peo	degrade			hazard		water use			pollute		poverty		compete		eth/urb		hlth	LGv	net	cplx
	1.1.0	1.2.0	2.1.1	2.1.2	2.1.3	2.2.1	2.2.2	2.3.1	2.3.2	2.3.3	2.4.1	2.4.2	3.1.1	3.1.2	3.2.1	3.2.2	3.3.1	3.3.2	3.4.1	4.1.1	4.1.2	4.2.1
Ping sub-basin boundaries	onep		onep										onep							onep		
Forest land boundaries																						
National Parks (1 new)															panya							
Wildlife Sanctuaries															panya							
Watershed Classes															onep							
Forest Reserves															panya							
Land & land use coverages																						
elevation	icraf																					
landslide risk							ldd															
Agriculture land use																onep						
Administrative unit boundaries																						
Province																						onep
District																						onep
TAO area																				onep		onep
capacity class																				moi		
Municipality (w/population)		onep																		onep		onep
Agency units locations/domains																						
forestry units																						panya
water units																						??
Village point locations																						
admin village locations (no eth/pop)		onep															onep					
hilltirbe survey villages (97 pop)		panya															panya					
Health unit areas																			??			
water-born disease incidence																			??			
respiratory infection incidence																			??			
chemical poisoning incidence																			??			
Network experience																					??	
Tabular natural resource data																						
Agriculture - irrigated								panya														
Agriculture - all								panya														
Forest - healthy			CMU																			
Forest - deteriorated			CMU																			
Scrub & grassland			CMU																			
Water resource data																						
Qmin						panya																
Qmax						panya																
Qmean						panya																
streamflow - annual										panya												
streamflow - wet season										panya												
groundwater - potential									panya													
groundwater - use									panya													
soil erosion					panya																	
Water quality score											panya											
wastewater problem												CMU										
population													panya									
Income per capita													panya									
econ & social strength														CMU								

D. Participation & Transparency in Pilot Sub-Basin Selection: Water Forum

As I understand it, the Water Forum is planned as the primary vehicle for providing a platform for more public participation in the process of pilot sub-basin selection. These are to be large one-day events where many local leaders from each Ping sub-basin are being invited to participate. Thus, given the scale and short duration of this event-oriented process, there are at least five essential component phases of Water Forum-related activity that require some rather careful consideration:

(1) Preparation of proposed processes and considerations

Preparations for the Water Forum include consideration of proposed criteria and indicators discussed in this report and/or proposed by Panya consultants, collection and processing of relevant data, and hopefully nomination of at least two suggested candidate sub-basins for each of the lower, middle and upper sub-basin groupings in the Ping Basin. We should also collaborate in developing an approach for clearly articulating the reason for, and the nature of activities conducted to prepare for the Forum, the informing (not predeterming) role of quantitative criteria and indicators, and the role of the Forum itself. This appears to be in line with basic processes proposed by Panya staff and concurred to by this consultant.

(2) Communication of proposed processes and considerations

After articulating the overall purpose of this project and its pilot sub-basin approach, the next objective of activities at the Forum itself should be to clearly and effectively communicate our perceptions of the pilot sub-basin selection process, and our approach to using systematic criteria and indicators as a decision-making aid. Visual aids that should be able to help facilitate this communication process could include: (a) large poster-size printouts of clearly color coded spatial data layers used to evaluate indicators; and (b) large printouts of data calculation tables, such as those shown in this report, or perhaps more simplified versions that still communicate essential features of the assessment process. Ideally these visual aids should be placed where they can be easily viewed during discussions and referenced by speakers, rather than off in a corner where they can only be seen during coffee breaks. Smaller copies can be included in handout briefing books. Time should also be budgeted to field questions of clarification from forum participants.

(3) Solicitation of feedback, additional information and alternative points of view

The next objective should be to genuinely solicit feedback on our approach to sub-basin selection, the nature and utility (or not) of the criteria and indicators employed, and sources, adequacy, and accuracy of data used in this process. Caution sometimes needs to be taken to prevent such events from degenerating into a soapbox for long diatribes from various disenchanted and/or egocentric folks who love microphones. Indeed, depending on the size of the gathering and nature of the participants, it may be more useful to break into smaller discussion groups than to try to gain feedback through large plenary sessions, although time and logistic considerations may be additional constraints on this approach. If smaller discussion groups are used, each should have some relatively clear objectives that they try to achieve, and facilitators should try to see that participation is as inclusive as possible. The process should also place emphasis on soliciting additional information that could help further strengthen assessments (such as additional information about local network experience, for example).

And, there should also be adequate “space” for alternative points of view – especially if they can offer constructive proposals for how to alter or improve the sub-basin selection approach. For example, with some gatherings it would not be inconceivable that an effective and innovative leader might propose a far more intuitive approach to sub-basin selection that could rapidly gain broader support from Ping Basin stakeholders than the more analytical approach taken by people such as ourselves. Moreover, there may be a brilliant line of argument about why one of the sub-basins not on our candidate list should be selected.

(4) Clarification and discussion of any points of disagreement

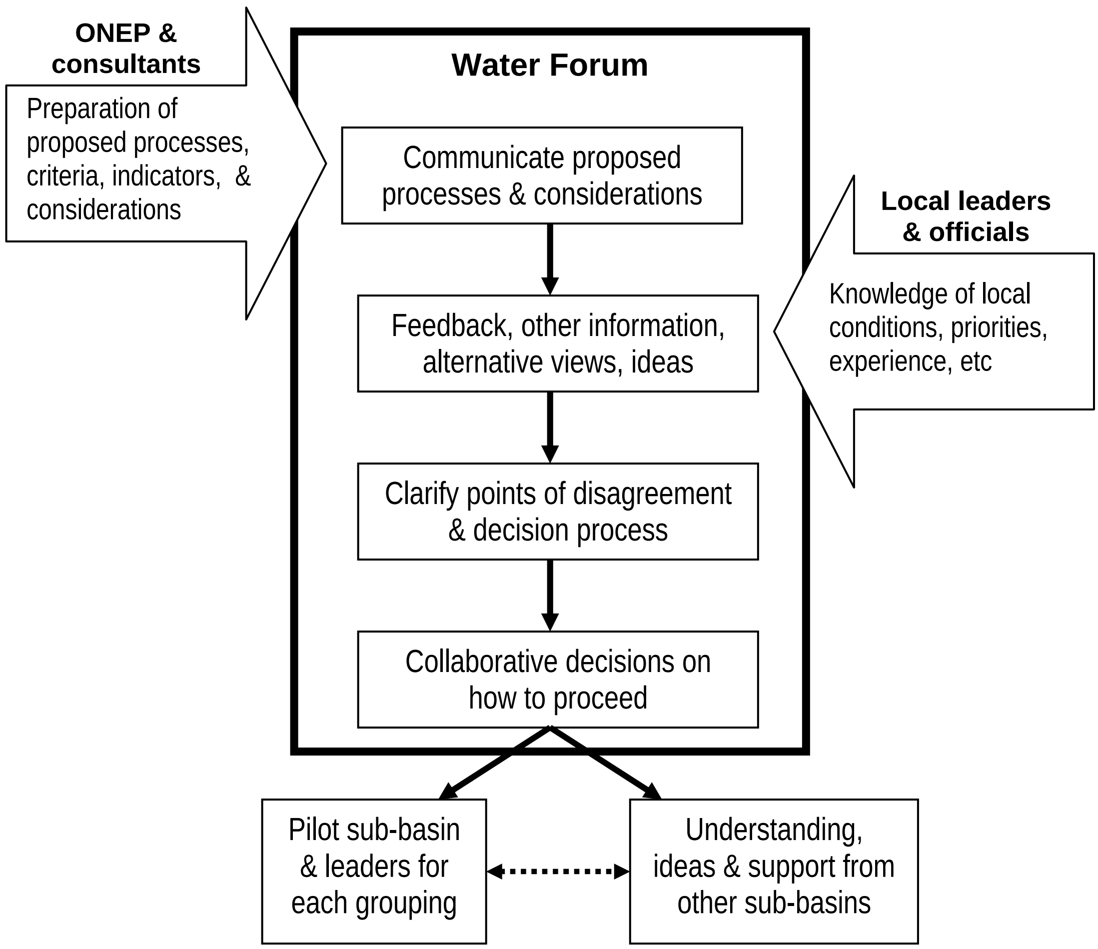
As a result of these discussions and deliberations, there may be particular interpretations or points of disagreement that warrant further clarification and/or at least limited discussion across the broader group of participants. This phase is important for setting the stage for decisions to be made about sub-basin selection and future actions, so it is important to defuse any trends toward either cynicism or major confrontation, even if some factions just have to agree to disagree with each other.

(5) Collaborative decisions on how to proceed

The first and most obvious objective of this phase is to reach a decision on sub-basin selection. If possible, it would clearly be best if there is at least a substantial enough majority consensus that a final decision can be made "on the spot" at the Forum itself. If further considerations must be submitted to people in distant places beyond the Ping Basin before a final decision can be made at some future date, it will substantially detract from the perception (even if not from the reality) of participation in and ownership of the decision-making process, and possibly the project itself.

The second very important objective here should be to try to mobilize widespread support for the pilot sub-basin project, even among people in sub-basins that are not selected. Some of these areas are likely to have substantial relevant experience that could be a valuable resource for pilot areas. Moreover, all sub-basins should be encouraged to continue or start building networks and other types of activities that can provide a foundation for rapid progress during the subsequent expansion phase of Ping Basin management activities. Indeed, the use of newsletters, web pages or other approaches to communicating progress and issues at pilot sub-basins as the project progresses may be a valuable investment to help build momentum for spin-offs and expansion of project activities.

Figure 36. Participatory sub-basin selection process



E. Further Work Plan

This final section focuses on the nature and timing of the major remaining tasks under this consultancy, as defined under the scope of services of the terms of reference shown in the first section of this report.

(1) Developing a participatory management model to test and adapt in pilot sub-basins

It is anticipated that this work will be conducted in close collaboration with the selected consulting team from Panya Consultants, as well as any relevant ONEP staff who are willing and available to participate, as part of an overall activity 'bundle' consisting of three closely related components:

- **Detailed assessment of selected sub-basins** ('micro-watersheds'). As we have seen from discussions in earlier sections of this report, the range of broad data currently available on sub-basins in the Ping River Basin is informative, but still suffers from numerous limitations. Thus, it is imperative that pilot activities within selected sub-basins begin with more detailed assessments of conditions, stakeholders, issues, tensions, conflicts, capacity and experience within those sub-basins. The range of stakeholders and associated issues broadly summarized in B(1)(c) of this report needs to be more clearly identified for the specific setting of each sub-basin. Given the general differences among lower, middle and upper sub-basin groupings indicated by the broad data in Figure 7, and explored in developing criteria and indicators, we can anticipate that there may be clusters of stakeholders and issues that differ among the three pilot sub-basins. Assuming that selected sub-basins provide a reasonable sample of each of these groups, then characteristics of the three sub-basins should help provide a reasonable range of conditions for further developing and testing the effectiveness and robustness of the project approach.

  In their proposal to ONEP, Panya Consultants suggests that these assessments should include detailed inventories for environmental and health conditions, household surveys, and perception surveys, in order to determine important linkages among use of natural resources, environment and poverty. Participatory environment and poverty assessments would be conducted by a multidisciplinary team, including local representatives and key informants, in order to more clearly understand local conditions. I concur in this approach, and would be pleased to work closely with the Panya team as they develop, implement, and analyze these assessments. These assessments could also provide a good opportunity to more fully explore the relevance of several issues where little broader sub-basin data was readily available for our rapid sub-basin selection assessment, including poverty, health, and issues related to waste disposal, crime and drugs raised by ONEP staff.

- **Establishment of sub-basin associations**. The Panya proposal also suggests that participatory efforts to establish sub-basin associations or boards be conducted in parallel with detailed sub-basin assessments. I concur regarding both the importance and timing of these efforts. As this will presumably form the organizational core and base for action-oriented implementation operations within each sub-basin, there is considerable urgency for it to begin as quickly as possible. At the same time, however, it will also be very important to quickly develop a relatively clear picture of the range of major and minor stakeholders in each sub-basin, in order to ensure that strategically important stakeholders are not excluded. In terms of registration with a relevant government agency, this is probably a good first step. But I also hope that the terms of that registration would be flexible enough to allow the association/board to develop its plans based on local needs that emerge from detailed assessments and participatory processes, rather than be dominated or pre-determined by the perspective or mandates of that particular agency.

  Moreover, these efforts need to work with and build on relevant existing initiatives within the sub-basin. And, especially if the selected sub-basin has not yet developed networking relationships at or near the sub-basin level, there may be useful experience in other sub-basins that could help contribute to these deliberations and efforts. In this regard, I would hope that the preliminary cataloguing of current experience with local networking activities – as discussed in connection with indicator 4.1.2. and the Water Forum, above – might help identify important sources of experience across the Ping Basin that could be an important resource for the project.

- **Development of a participatory sub-basin management 'model'**. The third part in this trilogy of start-up activities focuses on articulating an overall 'model' for participatory sub-basin management. One of the major challenges for this activity will be to formulate a 'model' approach that will be general (and robust) enough to be relevant for the range of conditions present in sub-basins of the Ping (and hopefully elsewhere in Thailand), while at the same time specific enough to provide some real articulation and practical guidance. Given the nature of this project, we know that its participatory processes need to be inclusive, as well as viable in the context of institutional hierarchies and social realities within which it must operate. And, it must be able to effectively interface with local governments and relevant agencies, as well as with villages and any relevant NGOs and more local and less formal networks operating within the sub-basin. Moreover, it must be able to maintain responsibility, transparency and accountability in its decision-making, monitoring and financial management processes, and hopefully build a reputation based on effectiveness, integrity and equity. This is, of course, a tall set of orders, and no model structure can assure all of these outcomes. What we will seek to do, however, is to build on literature, local knowledge, and experience in Thailand to articulate a general participatory and organizational 'model' that provides as many appropriate considerations, interfaces and incentives as possible, along with guidance and suggestions for approaches for adapting it to specific local conditions.

  We anticipate that this process will be interacting closely with the two above activities, including the participatory processes embedded within them. This will allow us to collaborate with a range of real actors and stakeholders from the range of pilot sites, from which we hope to bring an inductive synthesis line of reasoning to interact with more deductive reasoning associated with more general concepts and theory. It should also allow us to jointly evolve a 'model' that focuses on the core commonalities across efforts in the three pilot sub-basins where the 'model' will be tested. And, we hope a growing information system for the Ping River Basin (see also the appendix on additional recommendations) will help us further anticipate and refine the robustness and adaptability of our 'model' approach.

Given the interdependencies of these three activities, I hope that ONEP and the Panya Consultants team concur with me on the need for collaboration and interaction among them. In anticipation of this agreement, I have adjusted proposed dates for submission of my reports to correspond with the new workplan submitted to ONEP by Panya Consultants.

(2) Developing a pilot project action plan

As suggested in the Panya proposal, the above three lines of activity would feed into development of a sound action plan, which must proceed under the leadership of sub-basin associations or boards, in consultation with local institutions and key supporting government agencies. Objectives targeted by the action plan will focus on improved livelihood, health and environment outcomes in the sub-basin. Moreover, the action plan must provide means for ensuring participatory processes, sound financial management mechanisms, and monitoring and assessing progress.

I interpret my role in this process as a member of the overall project team working with sub-basin leaders to develop and articulate action plans for each sub-basin. I anticipate that my contributions would emphasize aspects that could help ensure adequate testing of the 'model' approach, as well as efforts to help assure foundations are in place for cross-site synthesis and learning from the pilot project. This would include, but not necessarily be limited to suggestions on mechanisms for inclusive participation (including the action plan development process itself), negotiation tools, financing mechanisms, monitoring systems and indicators, transparency, and accountability, as well as capacity building activities and tools relevant to participatory watershed management processes.

Thus, I anticipate that these contributions would be made as part of an iterative process of interaction with other members of the project consultant team and key leaders in the sub-basin areas, which would then be described in the final report under this consultancy. The action plan itself would, of course, be a product developed under the leadership of sub-basin boards, with supporting organizations, government organizations and project consultants involved in supporting roles.

(3) Guidance and advice for developing pilot project toolkits

The project envisions a set of 'toolkits' for use by communities, organizations, and institutions in the Ping River basin. Approaches, methods and techniques are to be grouped and presented as guidance notes for (a) technical toolkits, (b) organizational toolkits, and (c) awareness and education toolkits. In their proposal to ONEP, Panya Consultants also anticipated preparation of a participatory watershed management manual for facilitators and trainers as an output of this project.

Development of guidance notes for project 'toolkits' is to occur in parallel with development of sub-basin action plans, and should obviously be matched to provide support for implementation of action plans. The approach is again based on teamwork under the project, and my contributions are to provide guidance and advice during this process. Experience during this process will be integrated into my final report under this consultancy.

(4) Submission of interim and final reports

The terms of reference for this consultancy (see first section of this report) specify submission of three major outputs in the form of reports. Due to various delays in project start-up associated with selecting and finalizing agreements with the selected consulting firm for this project (Panya Consultants), the agreed timetable for submission of these reports has been modified. Moreover, given the linkages among the above activities, and the need for a teamwork approach, the following new dates are proposed to fit with the workplan developed by Panya Consultants, as indicated in Figure 28. Thus, proposed report submissions are as follows:

(a) Inception Report: *submitted 8 February 2005*

This is the report contained above, the main focus of which is on identification of practical criteria for selection of the three pilot sub-basins for this project..

(b) Interim Report: *proposed due date: 31 May 2005*

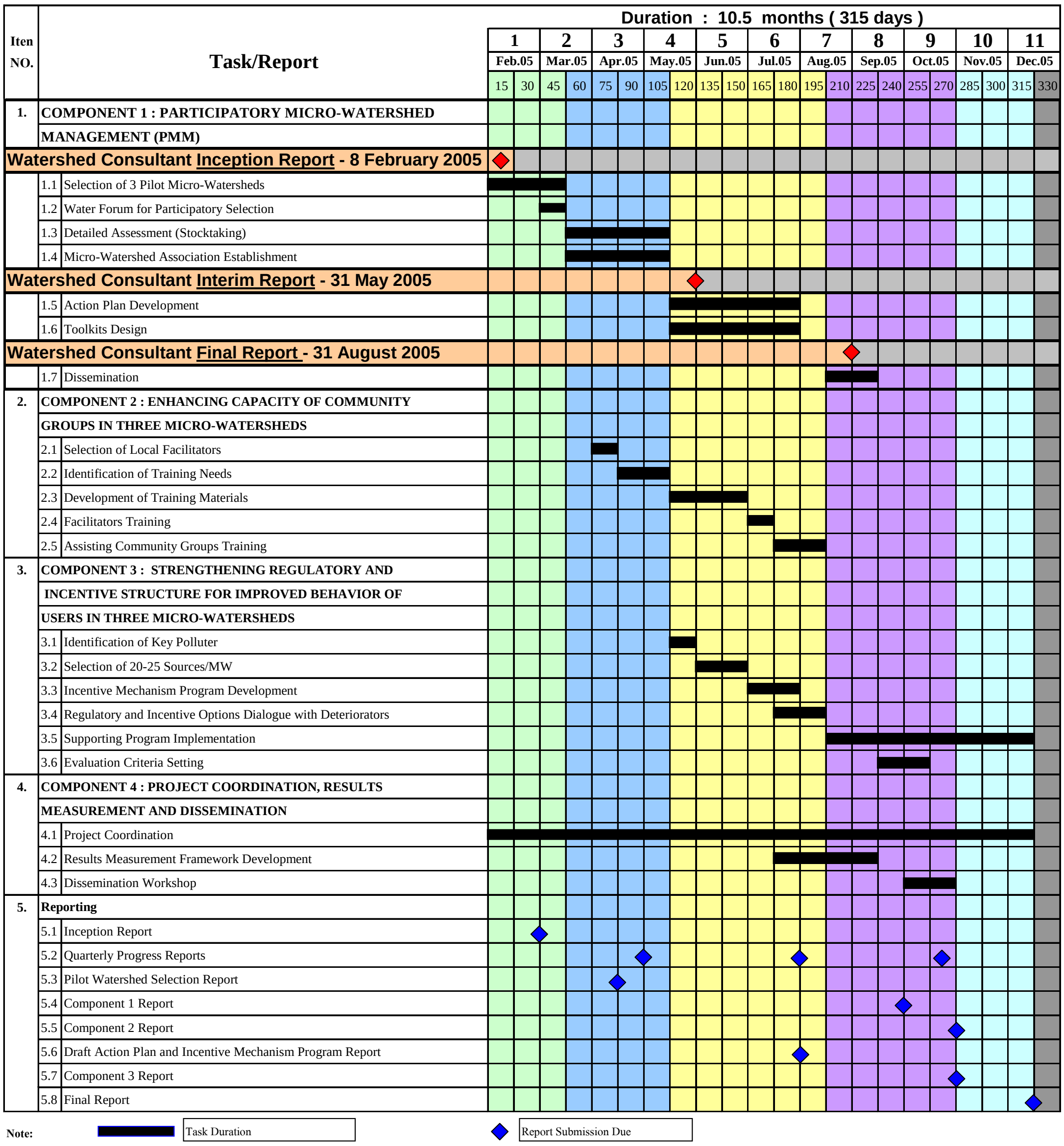
The main focus of this report will be on articulation of the participatory sub-basin management 'model' to be applied, tested, and most likely adapted and refined under this project. Since the 'model' approach needs to be developed in tandem with detailed sub-basin assessments and establishment of sub-basin associations or boards, timing for submission of this report is proposed to coincide with the end of the period during which all three of these activities are scheduled to occur under the workplan of Panya Consultants.

(c) Final Report: *proposed due date: 31 Aug 2005*

This report will integrate the two previous reports with information on development of the implementation action plan and development of tool kit guidance notes. As these activities will also employ a teamwork approach, proposed timing for the submission of this report is shortly after conclusion of the period scheduled for these activities under the workplan submitted to ONEP by Panya Consultants.

Figure 28. Watershed Consultant Reports & Panya Consultants Workplan

Panya's Work Plan for Participatory Watershed Management for Ping River Basin Project (FM-PO-001)



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[2] A range of additional references will be added in the expanded overview section in the final report of this consultancy (see footnote 1 for further explanation).

APPENDIX 1. Observations and Additional Recommendations

During the course of the first phase of this consultancy, the consultant has made various observations that merit some mention in the context of this report. He has also formulated a few recommendations that may extend a bit beyond the scope of the TOR. Some minor points related to data and a few other issues have been mentioned at appropriate points in the main text of this report.

This appendix seeks to summarize most of these observations, and forward some recommendations that center on the need for a Ping Basin management information system to support the types of organizations and activities envisioned by this project. The following discussion is divided into four sections related to sub-basin delineation, the pilot sub-basin approach, data characteristics and availability, and needs for a Ping basin management data system that this project could help assist.

(1) Sub-basin delineation

While sub-basin delineation has been an important initial clarification for operations under this project, there is still a need for ONEP to collaborate with other agencies of the Ministry of Natural Resources and Environment, as well as other relevant government agencies, to reach agreement on a common sub-basin delineation scheme for the Ping River Basin (and in the future other river basins). This is necessary in order to: (a) achieve common understandings that are essential for building participatory management organizations within the sub-basins, and (b) for coordinating communication with and support from the range of government agencies (as well as other public and private organizations and institutions) that will be associated with integrated basin management in both the immediate and longer-term future.

Two additional issues that have arisen in relation to sub-basin delineation in the Ping Basin are also worth mentioning here:

- The division of Mae Chaem into two sub-basins appears to be based on fairly obscure reasoning, and it may threaten to undermine already emerging networks seeking to improve natural resource management at the wider Mae Chaem level. After discussions with local watershed network leaders in Mae Chaem, this I have already submitted to ONEP my concerns about this apparently quite arbitrary division of Mae Chaem into two sub-basins (it seems to be based on the existence of a gauging station), the apparent lack of local participation in this decision process, and some of the likely impacts of this decision. The ONEP watershed group has responded that if local institutions in Mae Chaem prefer, they could organize to manage the two official sub-basins as the single natural sub-basin that it is. This still begs the question, however, about why and how the division was done in the first place.
- Review of data used in formulating this report reveals that the nature of the Ping part 3 sub-basin is somewhat of an anomaly. The manner in which boundaries of this sub-basin have been delineated results in a sub-basin that combines areas with strong “middle sub-basin” characteristics together with other areas that display very strong “upper sub-basin” characteristics. If any sub-basin were to be a candidate for division into two management units, this sub-basin would be a candidate for serious consideration. On the other hand, it might also present an opportunity during the expansion phase of Ping Basin activities to work with a sub-basin that really needs to draw on the experience of both middle and upper sub-basin groupings. If successful, it could even serve as a “model” for how these groupings can most constructively interact with each other to manage issues and resources in the larger Ping Basin context.

(2) The pilot sub-basin approach

It is becoming increasingly apparent that it may be unfortunate that a pilot sub-basin oriented project like this was not able to be launched about 2 or 3 years earlier. During this period of time there has been much discussion and activity that has occurred in many sub-basins related to these new Ping River Basin activities. The consultant is aware of many details of such discussions and activities in the context of the Mae Chaem sub-basin where he has been working, but it is now clear that parallel activities have been occurring in many sub-basins – and especially in those that make up the middle and upper sub-basin groupings. Serious networking and planning activities have been conducted at local and sub-basin levels, and substantial communication has be made with representatives of national agencies and basin planning projects such as those reported by Panya [2003] and CMU [2004].

Thus, for many local leaders who have been active in these processes, it is difficult for them to understand why there is a need to select pilot sub-basins at this time. Many express the view that it would be much better to allocate even modest amounts of resources for them to begin implementing activities they have already been planning in each sub-basin, but for which promised support from government sources has not yet been forthcoming. Moreover, many say that further delay only undermines the credibility both of the Ping River Basin management efforts, and of the local leaders themselves who have invested much time and effort to help mobilize participation by members of local communities that are now becoming increasing skeptical that anything will happen.

Such views underscore the quite urgent necessity to make it clear to all the sub-basins of the Ping River Basin that selection of the three pilot sub-watersheds does NOT mean that those not selected will receive no support for efforts to build participatory management organizations within their sub-basins. In order to make this clear to local leaders and emerging watershed management networks, there needs to be a clear statement by ONEP, the Ministry, and/or higher levels of government regarding their continuing commitment to building the multi-level Ping River Basin management organization. It needs to clearly state that all sub-basins will be involved in this effort, and that anything they can do to help achieve significant positive results in the pilot sub-basins will help accelerate the rate at which broader, more inclusive efforts can be planned and implemented.

(3) Data characteristics, quality and availability

Since much of the work under the first phase of this consultancy has dealt with identifying, accessing and analyzing data, a number of observations have been made about data characteristics, quality and availability, including the following:

Biophysical Data

- Forest cover & land use. There are considerably more weaknesses in data on forest cover and "deforestation" than many people are aware of. Moreover, categories used in interpreting remote sensing data on forest cover and land use have seldom been seriously questioned for their relevance and utility in providing information of a character and format that really meets the information needs of local managers and management organizations. One would hope that the emerging sub-basin management organizations supported under this project could become an active party in discussions aimed at improving the interpretation and use of such data.

- Natural hazards. It was very unfortunate that LDD landslide risk maps could not be obtained in a GIS format in time for analyses in this report. However, since spatially-explicit information on landslide and flash flood risks are highly likely to be very important and useful for sub-basin management organizations, efforts to obtain and further analyze data such as represented in the LDD maps should be an important line of activity supported by ONEP.

- Soil erosion. The type of data used in this report and many other assessments are really very gross and rough estimates of total soil movement across macro-landscapes. Such soil movement is related to natural terrain and soil characteristics, as well as human-related factors such as land use patterns. And seldom is anything mentioned about the fact that pristine natural landscapes still have varying rates of soil erosion, or that much of the soil that may erode from a particular spot actually accumulates at other points in the landscape before reaching streams or irrigation canals. Indeed, the alluvial valley lowlands where irrigated paddy production are centered would not exist without soil erosion and movement processes. The main issue in these debates should be the degree to which land use practices accelerate soil erosion and movement processes to the detriment of ecosystem health and productivity for human benefit. Most relevant data is based on very local plot-level studies, and very crude methods are used to translate that to landscape levels. Since sub-basin management will require understanding and management at landscape levels, research, monitoring and development work related to soil erosion – and many other factors – will need to be taken to a higher level of sophistication if it is to make contributions that extend beyond rhetoric.

- Water use. Data on water use are really quite limited, and appear not to capture many components that are of high and increasing importance, especially in areas beyond medium to large scale irrigation project service area. Improved research, monitoring, and possibly modeling are tools that need to be explored with some sense of urgency given the importance of the natural resource management and social conflict issues related to water use.

- Water quality. While data used to estimate values for both indicators in Figure 15 are subject to very substantial limitations, more revealing data on water quality is very limited, and this may well be all that is available for a rapid assessment of all Ping sub-basins using secondary data sources at this time. We hope that in the future ONEP will be able to help facilitate development of more systematic and comprehensive datasets on water quality and wastewater monitoring, and that these efforts can be extended to include other aspects of pollution, such as various types of smoke pollution, as well as problems related to solid waste disposal.

Socio-economic Data

- Poverty. Both indicators of poverty used in this report suggest there may be relatively limited variation among sub-basins at that level. If this is indeed true, then it may be that aggregations at the sub-basin level mask greater variation within the various sub-basins themselves. Or, it may be that the data used is simply inadequate to characterize the nature of poverty and its distribution. These will be important issues for investigation as part of more intensive assessments within selected pilot sub-basins during the next stage of this project.

- Land use restrictions and competition. In the longer term, considerations under a category such as this should expand to include agricultural crops or practices that are seen as "inappropriate" in ways that are not reflected in the above indicator. For example, certain types of tree crops and/or conservation farming practices are seen as the only "appropriate" type of land use for areas classified as watershed class 2 or 3. At this time, however, the consultant is not aware of any spatial datasets that are capable of distinguishing these types of crops or practices in a reliable and systematic manner. If such data could be obtained in the future, however, it could easily be crossed with the watershed classification spatial dataset to identify were 'hotspots' of inappropriate land use exist. A similar approach could be taken for other types of land use considered as "inappropriate" for various types of zones that have been or may be mandated by public policy at various levels. Development of datasets required to implement such an approach could help sub-basin management organizations move beyond the aggregated tables of generalized data that currently dominate discussion of such issues, to being able to identify exactly where and why such discrepancies exist.

- Public Health. It is most unfortunate that suitable data could not be accessed in time for use in calculating indicator 3.3.1 proposed in this report. Efforts to identify and access such data should continue, however, since this type of information would be very useful for sub-basin management organizations both in pilot sub-basins, and in other sub-basins.

- Additional socio-economic data. A vast range of additional socio-economic, cultural and historical data could conceivably be added to the list of sub-criteria and indicators listed in this section. As one example, ONEP staff have suggested data related to crime and drugs. While these and other aspects are issues that could quite possibly be important for various sub-basin management organizations, the watershed consultant does not view them as practical for inclusion in sub-basin selection criteria at this stage. The list of sub-criteria and indicators is already perhaps too long, and various elements are already pushing the envelope of data readily available in an appropriate form.

  Moreover, variation of many of these factors among locations within a sub-basin is likely to be as great or greater than variation among sub-basins, as already suggested by data used in poverty indicators in this report. Many are also likely to be correlated with differences in levels of urbanization, prominence of lowland or upland areas, or diversity of ethnic groups, which are factors that other sub-criteria and indicators are already seeking to capture. Empirical data that could help bring insights into such issues would be valuable for analysts and managers working in several sectors at various levels.

  Thus, it would appear more appropriate at this stage to view such issues as topics for further exploration through more detailed assessments to be conducted in each selected pilot sub-basin, as well as for discussion with and by emergent sub-basin management organizations in the context of their relevance for consideration and activities under specific conditions and at specific locations.

- KCC2K. During discussions when the first draft of this report was presented to ONEP staff, the consultant suggested that one potentially interesting and useful source of socio-economic data might be available from Kho Cho Cho Song Kho data under the biennial village survey conducted through the Ministry of Interior's Community Development Department, if that data could be linked with georeferenced point locations for each administrative village. This would then allow the data to be combined with polygon shape files such as sub-basin boundaries, so that aggregations of village level data could be assessed at a sub-basin level. As this report was being finalized, ONEP staff provided the consultant with a version of Kho Cho Cho Song Kho data from the 2003 survey for villages in the Ping River basin that had been linked to ONEP's shape file of administrative village locations. Although the consultant has been making progress in working with this data, incorporation of additional findings from that data into this report has not been possible, due to the complexity of the large database file, the need to make various other revisions to this report suggested by ONEP reviewers, demands from other work, and the short time available before the revised version of this report had to be submitted. The consultant plans to continue working with this data, however, and hopes to include relevant findings into subsequent reports under this project, with emphasis on selected pilot sub-basins and information potentially relevant for future project expansion.

Local organization data

- Network experience. The consultant proposes that ONEP and Panya use their extensive relationships with individuals, organizations and governmental units around the Ping Basin to gather simple information on network experience in as many Ping sub-basins as possible. The resulting information could be presented for consideration and discussion during the upcoming Water Forum, which would also be an opportunity for leaders from various Ping sub-basins to provide further information and input. Further effort to collect such information would be useful not only for pilot sub-basin selection purposes, but also to help build a catalog of experience that is building in the Ping Basin. This experience could be a valuable resource, both for management 'model' development in pilot sub-basins, and for adaptation and refinement of the approach in other sub-basins during the subsequent expansion phase.

In this regard, it would also be very useful to try to build a catalogue of information on efforts and activities conducted by NGOs and government agencies to provide various types of support for local networks and emerging alliances or federations of networks. Although such information is not proposed as a specific sub-basin selection sub-criterion or indicator, such experience could also provide important learning experience and human resources for building and refining the overall multi-level Ping Basin management system.

(4) Need for a Ping basin management data system, and potential project contributions

It is apparent that there have already been numerous efforts to gather background materials, survey, and assess information on the Ping basin. This includes efforts conducted with direction and support from at least three department-level agencies within the Ministry of Natural Resources and Environment (MoNRE): Office of Natural Resource and Environmental Policy and Planning (ONEP), Department of Water Resources (DWR), and Department of Environmental Quality Promotion (DEQP). Related activities have also been conducted by forestry units within MoNRE, as well as by the Royal Irrigation Department and probably other agencies in the Ministry of Agriculture and Cooperatives and other Ministries.

It is not yet clear, however, that there have been any systematic efforts to collate these materials, put them in a coherent and useable form and format, and make them accessible to people directly involved in developing the Basin program -- and especially to those within the basin who will be directly responsible for basin management activities over the longer-term. Indeed, I have not seen any information regarding efforts to assess management-related information needs at basin, sub-basin or more local levels, or any suggestions or plans for how a multi-level information management system can be located, established and developed to meet such needs. If such efforts exist, relevant information should be made available to consultants.

Development of a multi-level basin information management system is a very important component that will be essential (1) for building effective participatory management organizations and mechanisms ("models") under this pilot project; (2) for expanding efforts to other sub-basins, and especially (3) for supporting the longer term viability of the participatory management organizations envisioned for the Ping River Basin. It would be a quite sad and inefficient use of resources if information compiled on the Ping River Basin does not contribute to meeting this important need.

Thus, this project should assure that all efforts to collect and assess data consider how they can best contribute to meeting information needs of emerging sub-basin management organizations. Indeed, the project should do to as much as possible to contribute to building an information management system for the basin and sub-basins that can be accessible by and useful for these organizations. ONEP could make a very significant overall contribution by coordinating (even collaborating) with other MoNRE lead agencies under this project to (a) establish an overall framework and at least a database of meta-data on information that is collected and compiled, and (b) help identify suitable institutional and physical location(s) within the Ping River Basin where a useful data system can be housed, maintained and accessed by basin and sub-basin management organizations. As the project aims to help achieve development of real participatory mechanisms under the spirit of the 1997 Constitution, most all of this data and information should be placed in the public domain (except, perhaps, data associated with a genuine national security concern).

Some suggestions regarding how this project could help address these issues and needs as it proceeds through the various planned stages of its implementation include:

(a) Rapid assessment for sub-basin selection. Given the extreme time constraint on this activity, it must of necessity be limited to information that is readily available from secondary sources. Fortunately, Panya Consultants and ONEP have already compiled substantial databases, with much of it in a spatial (GIS) format. These databases appear to be most quantitative and spatially explicit in terms of biophysical conditions, higher-level administrative units, and some types of specific government agency activities. Unfortunately, sub-basin delineation schemes for various data vary somewhat, so that recalculations will need to be made to bring all available sub-basin data into conformance with the project's ONEP sub-basin scheme. Even if this is only partially achievable in time for the sub-basin selection process, efforts to complete this compilation should continue, and additional data should be added as it is obtained. In any event, all sub-basin data from secondary sources collected as part of this activity should be assembled and made easily accessible.

(b) Detailed assessments of pilot sub-basins. From an information management system point of view, the assessment phase should be seen as a pilot effort to help begin determining the needs and availabilities of information believed to be important at the sub-basin and/or more local levels of participatory management. Various initial surveys and associated activities are apparently planned to help obtain data and information at this level. This information needs to be systematically compiled and made available to (and accessible by) relevant local organizations, as well as project consultants and officials. This can help provide 'baseline' data useful for assessing progress during the project. And, since activities are expected to continue into the future, and serve as a model for other sub-basins, the information content, format and priorities need to be assessed and refined for future application. It has been a very common experience of past development projects that initial surveys yielded substantial information that was never used and eventually discarded, while many potentially useful types of information were never collected or compiled. This project should strive to contribute to more systematic learning that can help assure a more efficient and effective process for the Ping Basin.

(c) Establishing and developing "model" sub-basin management organizations. Training and associated activities being planned for this phase of the project will presumably need to draw on data and information derived from initial sub-basin surveys, broader secondary sources, and probably additional sources of information that are likely to emerge as this process unfolds; some may draw on local knowledge and experience, or other forms of information less commonly seen in agency programs. It is very likely that of the information available, some elements will prove to be more relevant and useful than others; it is also likely that needs may emerge for data or information not available from these sources. The project should make a concerted effort to document its experience in this regard, so that future sub-basin efforts can benefit from this learning process. This can also help inform efforts to further develop basin-wide datasets.

(d) Building basin system for extrapolation. Near or shortly after the completion of this project, a new set of activities will presumably be needed to suggest how learning and experience in the pilot sub-basins can be used to expand support for development of sub-basin management organizations in other Ping sub-basins. Thus, basin-wide data and information will again become an important tool for understanding how conditions in other sub-basins may be similar or different in important ways that can affect the nature, direction, and priorities of these efforts. If the above activities have been conducted in a reasonably coherent and effective manner, much of this information should already be available. And if gaps were beginning to be identified during pilot project implementation, progress should already be underway to fill them.

(e) Building system for long-term management. If we assume that this pilot project and subsequent efforts to develop sub-basin management organizations are reasonably successful, then the resulting multi-level set of management organizations will have continuing data and information needs, as they seek to guide and support sustainable basin management efforts as conditions continue to change in the future.

Moreover, efforts to build an effective information management system for Ping river basin and sub-basin management organizations should actively seek to engage and link themselves with related efforts beyond the domain of the Ministry of Natural Resources and Environment. For example, the Thailand Research Fund (TRF) is supporting efforts at Chiang Mai University led by Dr. Methi Ekasingh to develop pilot user friendly information management and decision support systems for Chiang Mai and Lamphun provinces, which is essentially the upper portion of the Ping River Basin. This system uses a simple Thai language menu driven interface that allows users to set their boundaries at province, district, or sub-district levels, or alternatively at river basin, sub-basin, or local sub-watershed level. The system provides a range of spatial and pseudo-spatial data, and is open for new data layers to be added. Decision support tools are modular and the design makes it easy to add additional tools as they are developed. Moreover, this appears to be an important prototype for an information management system that can begin to reduce problems associated with incompatible data from different agencies and other sources, and can provide users at all levels with access to information that is frequently not available to them. Pilot systems are scheduled for release for use in Chiang Mai and Lamphun provinces during implementation of this project.

Clarifying Interlude:

As part of the feedback I received from ONEP regarding the outline of this report, there was a request for me to clarify my operational definitions of the terms transparency and participation. I hope the following will suffice.

- Transparency. In the context of this consultancy, I perceive transparency as referring to clear and open articulation of all reasoning and the data (and its source) upon which it is based. As one type of example, in proposing new sub-basin selection criteria and indicators, this report demonstrates very considerable effort to clearly and fully articulate the logic underlying all criteria, sub-criteria and indicators, the methods by which sub-basin assessments have been or are to be calculated, and the sources of data used or needed to conduct the calculations. More obscure 'expert opinion' approaches have been avoided, except for a few cases where absence of readily available sources of alternative data resulted in the inclusion of indicators derived by previous studies using expert assessments. Where relative weighting of indicators may be appropriate, I have opted for a clearly indicated method of applying relative weights that is open to scrutiny and can be adjusted according to expert opinion or through stakeholder consensus, in a manner that is open for all to see and judge for themselves. The value I place on transparency also makes me uncomfortable with decision-making processes that do not reveal their logic and data, and may thus invite suspicions about bias or hidden agendas. Relevant examples include expansion of protected forest areas and division of Mae Chaem into two sub-basins.

- Participation. In the context of 'participatory watershed management' I perceive participation as a synonym for collaboration. Thus, its heart lies in true collaboration among equals – each may have their own ideas, knowledge, concerns, duties, authority, etc., but interaction proceeds on an essentially peer-to-peer basis. The core of participatory watershed management, then, revolves around processes of mutual respect, communication, negotiation, learning and innovation that seek to attain and continually refine outcomes that aim to maximize mutual perceptions of equity and justice among stakeholders – including consideration of larger society and future generations – as conditions continue to evolve and change through time. This type of participation is very difficult, if not impossible without transparency of information and reasoning relevant to the interaction that is referred to as 'participatory'. Thus, I am uncomfortable with processes that claim to be participatory when they entail important decisions made by one party, who then simply informs or seeks to cynically manipulate the other party.

Moreover, I see these concepts – together with the concept of accountability – as closely intertwined and essential for the fundamental functioning of both high quality science and democratic processes. Thus, I was not surprised to hear very frequent reference to these terms during discussion and debate that swirled around development of the 1997 national constitution. I clearly recognize, however, that these are my own personally held beliefs and values, and I am not seeking to force such views on anyone else. I only wish to clarify how I am using these terms, and that I intend to continue conducting my work according to these principles. Unless I am advised otherwise, I will assume that this does not cause problems.

APPENDIX 2. Larger Format Calculation & Data Tables

The author recognizes that some people may find it difficult to read the small print in some of the more complex calculation and data tables presented various figures of this report.

Thus, this appendix contains larger format versions of most calculation and data tables. To help the reader locate the appropriate table, they are listed in the following tables and then presented in numerical sequence.

Figure 5. Calculation of the Lowland Zone Area Bias Score for Ping Sub-Basins

			Area Distribution (unit: square kilometers)					Percentage Distribution (unit: Percent)			Area Bias Score (unit: Score 1.1.)			
			Lowland		Midland	Highland		Lowland	Midland	Highland	Lowland	Midland	Highland	Lowland Zone Bias Score
Sub-Basin	*Share of Ping Basin*	*Total*	*<300 m*	*300 - 600m*	*600 - 1,000m*	*1,000 - 1,600m*	*> 1,600 m*	*<600m*	*600 - 1,000m*	*>1,000m*	Relative Weight multiplied by % of area			
	percent	*sq. km.*						**>50%**		**>20%**	**3.00**	**2.00**	**1.00**	
11 Mae Chaem upper	5.9	2,061	-	34	827	1,150	51	2	40	**58**	0.05	0.80	0.58	1.434
3 Mae Taeng	5.6	1,958	-	129	902	893	34	7	46	**47**	0.20	0.92	0.47	1.592
9 Mae Klang	1.8	616	33	145	177	227	34	29	29	**42**	0.87	0.57	0.42	1.866
12 Mae Chaem lower	5.3	1,834	21	320	938	531	23	19	51	**30**	0.56	1.02	0.30	1.884
14 Mae Teun (CM+Tak)	8.4	2,896	74	608	1,343	852	19	24	46	**30**	0.71	0.93	0.30	1.934
7 Mae Khan	5.3	1,833	10	417	894	496	16	23	49	**28**	0.70	0.98	0.28	1.954
1 Ping part 1	5.7	1,974	-	795	857	308	13	40	43	16	1.21	0.87	0.16	2.240
2 Mae Ngad	3.7	1,285	-	560	516	208	1	44	40	16	1.31	0.80	0.16	2.273
"upper sub-basins"	*42*	*14,458*	*138*	*3,009*	*6,453*	*4,666*	*192*	*22*	*45*	*34*	*0.65*	*0.89*	*0.34*	*1.882*
5 Mae Rim	1.5	508	7	225	206	71	0	45	41	14	1.36	0.81	0.14	2.315
10 Ping part 3 (CM+Tak)	10.0	3,452	511	1,033	1,511	395	1	45	44	11	1.34	0.88	0.11	2.332
8 Mae Lee	6.0	2,081	34	1,221	789	37	-	**60**	38	2	1.81	0.76	0.02	2.585
6 Mae Kuang (w/M.Tha)	7.9	2,734	307	1,583	670	167	8	**69**	24	6	2.07	0.49	0.06	2.627
13 Mae Had	1.5	520	55	331	126	8	-	**74**	24	2	2.22	0.48	0.02	2.725
4 Ping part 2 (w/M.Aow)	4.7	1,616	454	918	165	79	1	**85**	10	5	2.55	0.20	0.05	2.799
"middle sub-basins"	*31*	*10,911*	*1,367*	*5,310*	*3,467*	*757*	*10*	*61*	*32*	*7*	*1.84*	*0.64*	*0.07*	*2.542*
Upper Ping Basin	***73***	***25,370***	***1,506***	***8,319***	***9,920***	***5,423***	***202***	***38.7***	***39.1***	***22.2***	***1.16***	***0.78***	***0.22***	***2.166***
17 Klong Wang Chao	1.9	649	217	178	204	47	2	**61**	31	8	1.83	0.63	0.08	2.532
16 Huay Mae Thor	1.9	644	173	191	264	17	-	**56**	41	3	1.69	0.82	0.03	2.539
19 Klong Suan Mark	3.3	1,132	582	180	227	132	11	**67**	20	13	2.02	0.40	0.13	2.546
15 Ping part 4	8.6	2,983	1,856	614	447	67	0	**83**	15	2	2.48	0.30	0.02	2.805
20 Lower Ping	8.6	2,980	2,664	156	141	18	-	**95**	5	1	2.84	0.09	0.01	2.940
18 Klong Mae Raka	2.6	902	852	42	8	-	-	**99**	1	-	2.97	0.02	-	2.992
Lower Ping Basin	***27***	***9,289***	***6,343***	***1,361***	***1,290***	***282***	***14***	***82.9***	***13.9***	***3.2***	***2.49***	***0.28***	***0.03***	***2.798***
Ping Basin	**100**	**34,659**	**7,849**	**9,680**	**11,210**	**5,704**	**216**	**51**	**32**	**17**	**1.52**	**0.65**	**0.17**	**2.335**

Figure 7. Sub-Basin Shares of Major Ping River Basin Characteristics

	Terrain	Land		People, Settlement, Income						Cropped Area		Forest Cover Area			State Forest Zone Area			Soil Loss	Water		River
Sub-Basin	Lowland Bias	TOTAL AREA	URBAN AREA	POP Density	TOTAL PEOPLE	UPLAND MINORITY	URBAN PEOPLE	NO. OF INDUST	OVERALL INCOME	TOTAL AGRIC	IRRIG AGRIC	SCRUB FOREST	DEGRAD FOREST	TOTAL FOREST	FOREST LANDS	PROTECT FOREST	WS 1AB ZONE	TOTAL EROSION	ANNUAL RUNOFF	DRY SEAS RUNOFF	STREAM LEVEL
unit:	score	% total	% total	per/km2	% total	% total	% total	% total	% total	% total	% total	% total	% total	% total	% total	% total	% total	% total	% total	% total	score
11 Mae Chaem upper**	1.43	6	1	**	**	**	0	0	**	1	**	0	1	8	7	0	11	**	**	**	2
3 Mae Taeng	1.59	6	3	37	3	6	1	1	2	4	7	0	2	7	7	11	11	6	7	8	2
9 Mae Klang	1.87	2	1	72	2	5	2	2	2	1	1	3	1	2	2	4	2	3	3	3	2
12 Mae Chaem lower**	1.88	5	1	25	4	21	0	0	4	2	2	1	2	7	6	11	8	13	13	16	2
14 Mae Teun	1.93	8	1	18	2	12	0	0	2	3	2	0	7	12	10	10	14	15	11	9	2
7 Mae Khan	1.95	5	5	59	4	8	4	2	4	3	5	9	2	6	6	2	6	7	5	6	2
1 Ping part 1	2.24	6	3	40	3	7	1	0	2	4	1	1	21	5	6	11	7	7	6	6	3
2 Mae Ngad	2.27	4	3	52	3	2	1	0	3	2	4	1	2	4	4	9	5	4	4	4	2
Upper Sub-Basins	***1.88***	***42***	***15***	*36*	***21***	***62***	***9***	***6***	***18***	***20***	***22***	***16***	***39***	***52***	***49***	***58***	***64***	***55***	***49***	***52***	
5 Mae Rim	2.32	1	2	153	3	2	2	2	3	1	1	0	2	2	2	1	2	4	3	4	2
10 Ping part 3	2.33	10	5	23	3	10	1	0	1	4	0	20	3	12	11	14	8	4	5	5	3
8 Mae Lee	2.59	6	6	71	6	12	1	1	6	5	6	17	6	6	5	1	3	4	3	2	2
6 Mae Kuang	2.63	8	20	108	12	2	7	9	12	10	13	13	9	6	6	3	5	5	9	6	2
13 Mae Had	2.73	2	1	84	2	1	1	0	2	1	3	1	1	2	2	1	1	3	4	5	2
4 Ping part 2	2.80	5	26	404	25	4	40	29	32	8	7	8	8	2	2	2	2	2	4	4	3
Middle Sub-Basins	***2.54***	***31***	***60***	*117*	***51***	***31***	***52***	***41***	***56***	***29***	***30***	***58***	***29***	***29***	***28***	***23***	***22***	***22***	***26***	***25***	
17 Klong Wang Chao	2.53	2	0	31	1	2	0	1	1	2	0	0	3	2	2	3	2	2	2	2	2
16 Huay Mae Thor	2.54	2	0	25	1	1	1	1	1	0	0	0	3	2	2	2	2	2	1	1	2
19 Klong Suan Mark	2.55	3	1	60	3	0	0	2	2	4	2	0	1	3	4	5	3	4	4	4	2
15 Ping part 4	2.81	9	8	57	7	1	6	8	6	8	6	20	19	7	7	6	5	6	6	6	3
20 Lower Ping	2.94	9	14	121	15	4	30	40	15	32	38	2	0	2	5	3	2	7	10	8	3
18 Klong Mae Raka	2.99	3	1	31	1	0	2	1	1	4	2	4	5	2	2	0	0	1	2	2	2
Lower Sub-Basins	***2.80***	***27***	***25***	*72*	***28***	***8***	***39***	***53***	***26***	***50***	***48***	***26***	***32***	***19***	***23***	***19***	***14***	***23***	***25***	***23***	
Ping Basin	**2.33**	**100**	**100**	*70*	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	

** These data for Mae Chaem cannot yet be split into upper and lower sub-basins – overall data listed under lower Mae Chaem

Figure 10. Natural Resource Indicator Scoring for Ping Sub-Basins

	2. Overall Natural Resource Issues			**2.1. Degradation**			**2.2. Hazards**		**2.3. Water Use**			**2.4 Water Quality**	
				2.1.1.	**2.1.2.**	**2.1.3.**	**2.2.1.**	**2.2.2.**	**2.3.1.**	**2.3.2.**	**2.3.3.**	**2.4.1.**	**2.4.2.**
				Forest Conversion Score	Forest Deterior Score	Soil Erosion Score	Flooding Risk Score	Landslide Risk Score	Agric Irrigation Score	Groundwater Use Score	Low Dry Season Flow Score	Water Quality Problem Score	Wastewater Problem Score
Sub-Basin	**Score**	weighted total	*source:*	CMU data	CMU data	Panya data	Panya	Need data	Panya data	Panya data	Panya data	Panya	CMU
Upper Sub-Basins				***0.4***	***0.5***	***1.8***		-	***1.8***	***0.1***	***1.4***		
			weight:	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*
1 Ping part 1	**2.9**	11		0.6	2.4	1.6	1.4	-	0.7	0.0	1.4	1	2
2 Mae Ngad	**2.4**	9		0.6	0.3	1.6	1.2	-	2.3	0.1	2.2	1	0
3 Mae Taeng	**3.0**	12		0.7	0.2	1.4	2.8	-	2.7	0.0	0.8	1	2
7 Mae Khan	**2.7**	10		0.5	0.4	1.8	1.4	-	3.0	0.5	0.7	1	1
9 Mae Klang	**2.5**	9		0.5	0.5	2.3	1.6	-	1.5	0.0	1.0	1	1
11 Mae Chaem upper	*	*		*	*	*	*	-	*	*	*	*	*
12 Mae Chaem lower	**2.0**	8		0.3	0.1	1.6	1.6	-	0.9	0.0	0.9	1	1
14 Mae Teun	**2.3**	9		0.2	0.4	2.3	1.3	-	1.1	0.0	2.4	1	0
Middle Sub-Basins				***1.0***	***0.9***	***1.0***		-	***1.9***	***1.3***	***1.8***		
			weight:	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*
4 Ping part 2	**2.7**	16		2.0	3.0	0.7	1.5	-	1.5	2.2	1.9	2	1
5 Mae Rim	**1.7**	10		0.6	0.6	3.0	1.1	-	1.7	0.1	0.8	1	1
6 Mae Kuang	**3.0**	18		1.3	1.1	0.9	0.8	-	2.5	3.0	3.0	3	2
8 Mae Lee	**1.9**	11		0.8	1.1	0.9	2.2	-	1.7	1.0	2.5	1	0
10 Ping part 3	**1.3**	8		0.5	0.4	0.6	0.6	-	1.1	0.2	1.2	2	1
13 Mae Had	**1.3**	8		0.8	0.6	2.8	0.9	-	1.6	0.1	0.0	1	0
Lower Sub-Basins				***1.6***	***1.2***	***1.2***	***1.7***	-	***1.6***	***0.4***	***1.9***		
			weight:	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*
15 Ping part 4	**2.3**	12		1.1	2.0	1.0	1.0	-	1.2	0.0	1.7	2	2
16 Huay Mae Thor	**1.8**	9		0.2	0.9	1.7	1.0	-	0.3	0.1	2.1	1	2
17 Klong Wang Chao	**2.0**	10		0.7	0.8	1.7	3.0	-	0.2	0.0	0.9	1	2
18 Klong Mae Raka	**2.1**	11		1.3	1.7	0.7	1.1	-	0.7	0.0	2.2	1	2
19 Klong Suan Mark	**1.9**	10		1.1	0.3	1.7	1.4	-	0.7	0.1	1.8	1	2
20 Lower Ping	**3.0**	16		3.0	0.3	1.1	2.2	-	2.0	0.6	2.3	2	2
Ping Basin				**0.9**	**0.7**	**1.4**	**1.5**	**-**	**1.7**	**0.6**	**1.6**	**-**	

Figure 11. Forest & Land Degradation Indicator Scores for Ping Sub-Basins

	Land & Cover Areas				Soil	Ratios		Rate	Nat Res Degradation Scores		
									2.1.1	2.1.2	2.1.3
	A	B	C	D	E	Forest	Forest	Soil	Forest	Forest	Soil
Sub-Basin	***Total Area***	***Good Forest***	***Deteriorated Forest***	***Scrub & Grass***	***Soil Erosion***	***Conversion*** (a-b-c-d)/a	***Deterioration*** (c+d)/b	***Erosion*** e/a	***Conversion Score****	***Deterioration Score****	***Erosion Score*****
	km2	km^2	km^2	km^2	tons/year			ton km^{-2} yr^{-1}			
1 Ping part 1	1,978	1,263	392	6	5,698,469	0.16	0.31	2,881	0.56	2.39	1.58
2 Mae Ngad	1,281	1,032	28	6	3,799,979	0.17	0.03	2,968	0.59	0.25	1.63
3 Mae Taeng	1,954	1,548	45		4,873,823	0.19	0.03	2,494	0.65	0.22	1.37
7 Mae Khan	1,808	1,479	36	43	5,912,140	0.14	0.05	3,269	0.49	0.41	1.79
9 Mae Klang	615	489	19	15	2,527,393	0.15	0.07	4,112	0.53	0.52	2.25
11 Mae Chaem upper	*	*	*	*	*	*	*	*	*	*	*
12 Mae Chaem lower	3,896	3,531	61	4	11,672,216	0.08	0.02	2,996	0.27	0.14	1.64
14 Mae Teun	3,147	2,787	136	1	13,222,372	0.07	0.05	4,202	0.25	0.37	2.30
Upper Sub-Basins	***14,678***	***12,130***	***716***	***74***	*47,706,392*	***0.12***	***0.07***	***3,250***	***0.42***	***0.50***	***1.78***
4 Ping part 2	1,505	451	141	37	1,956,664	0.58	**0.39**	1,300	2.05	3.00	0.71
5 Mae Rim	556	420	33		3,041,530	0.18	0.08	**5,475**	0.65	0.60	3.00
6 Mae Kuang	2,688	1,464	156	58	4,277,070	0.38	0.15	1,591	1.32	1.11	0.87
8 Mae Lee	2,082	1,407	118	77	3,299,319	0.23	0.14	1,585	0.81	1.05	0.87
10 Ping part 3	3,317	2,683	53	90	3,425,324	0.15	0.05	1,033	0.52	0.40	0.57
13 Mae Had	531	388	22	6	2,713,823	0.22	0.07	5,113	0.76	0.56	2.80
Middle Sub-Basins	***10,678***	***6,813***	***524***	***268***	*18,713,730*	***0.29***	***0.12***	***1,753***	***1.01***	***0.88***	***0.96***
15 Ping part 4	3,026	1,666	354	90	5,318,599	0.30	0.27	1,757	1.06	2.03	0.96
16 Huay Mae Thor	645	542	61		1,998,545	0.06	0.11	3,099	0.23	0.85	1.70
17 Klong Wang Chao	648	471	47		1,952,736	0.20	0.10	3,016	0.70	0.77	1.65
18 Klong Mae Raka	989	518	93	19	1,216,566	0.36	0.22	1,230	1.27	1.65	0.67
19 Klong Suan Mark	1,086	730	25	-	3,287,910	0.31	0.03	3,027	1.07	0.26	1.66
20 Lower Ping	3,135	442	8	8	6,497,799	**0.85**	0.04	2,073	3.00	0.28	1.14
Lower Sub-Basins	***9,529***	***4,369***	***589***	***118***	*20,272,155*	***0.47***	***0.16***	***2,127***	***1.64***	***1.23***	***1.17***
Ping Basin	**34,885**	**23,312**	**1,829**	**459**	86,692,277	**0.27**	**0.10**	**2,485**	**0.94**	**0.75**	**1.36**

* calculated as (ratio / (max ratio value)) * 3

** calculated as (rate / (max rate)) * 3

Figure 13. Natural Hazard Indicator Scoring for Ping Sub-Basins

Sub-Basin	Channel Flood Risk Score A Q_{ave} a. ave	B Q_{max} b. high	C Q_{min} c. low	(b-c)/a ratio	2.2.1 Flood Risk Score	Total	Area Distribution (unit: square kilometers) Landslide Risk Level: Low or very low	medium	high	Percentage Distribution (unit: Percent) Landslide Risk Level: Low or very low	medium	high	Landslide Risk Score (unit: Score) Relative Weight multiplied by % of area: Low 0.00	Medium 1.50	High 3.00	2.2.2 Landslide Risk Score
1 Ping part 1	209	451	69	1.8	1.36	1,974				-	-	-	-	-	-	-
2 Mae Ngad	277	563	126	1.6	1.17	1,285	Data not yet available			-	-	-	-	-	-	-
3 Mae Taeng	194	782	51	3.8	2.81	1,958				-	-	-	-	-	-	-
7 Mae Khan	201	441	63	1.9	1.40	1,833				-	-	-	-	-	-	-
9 Mae Klang	179	451	72	2.1	1.57	616				-	-	-	-	-	-	-
11 Mae Chaem upper	*	*	*	*	*	-				-	-	-	-	-	-	-
12 Mae Chaem lower	443	1,093	121	2.2	1.63	3,896				-	-	-	-	-	-	-
14 Mae Teun	249	520	101	1.7	1.25	2,896				-	-	-	-	-	-	-
Upper Sub-Basins						***14,458***	-	-	-	-	-	-	-	-	-	-
4 Ping part 2	174	398	56	2.0	1.46	1,616				-	-	-	-	-	-	-
5 Mae Rim	71	135	33	1.4	1.07	508	Data not yet available									
6 Mae Kuang	185	281	85	1.1	0.79	2,734				-	-	-	-	-	-	-
8 Mae Lee	170	530	23	3.0	2.22	2,081				-	-	-	-	-	-	-
10 Ping part 3	178	184	43	0.8	0.59	3,452				-	-	-	-	-	-	-
13 Mae Had	197	308	72	1.2	0.89	520				-	-	-	-	-	-	-
Middle Sub-Basins						***10,911***	-	-	-	-	-	-	-	-	-	-
15 Ping part 4	561	994	253	1.3	0.98	2,983				-	-	-	-	-	-	-
16 Huay Mae Thor	138	244	62	1.3	0.98	644	Data not yet available			-	-	-	-	-	-	-
17 Klong Wang Chao	224	916	14	4.0	3.00	649				-	-	-	-	-	-	-
18 Klong Mae Raka	147	305	79	1.5	1.14	902				-	-	-	-	-	-	-
19 Klong Suan Mark	303	611	40	1.9	1.40	1,132				-	-	-	-	-	-	-
20 Lower Ping	879	2,715	127	2.9	2.19	2,980				-	-	-	-	-	-	-
Lower Sub-Basins	***314***	***787***	***85***	***2.2***	***1.66***	***9,289***	-	-	-	-	-	-	-	-	-	-
Ping Basin	**237**	**557**	**73**	**2.0**	**1.52**	**34,659**	-	-	-	-	-	-	-	-	-	-

Figure 14. Water Use and Competition Indicator Scoring for Ping Sub-Basins

	Irrigated Agriculture Score (2.3.1)				Groundwater Use Score (2.3.2)				Low Dry Season Stream Flow Score (2.3.3)			
	A	B	C		D	E	F		G	H	I	
Sub-Basin	***Agriculture Area***	***Irrigated Area***	***Irrig/Agric Ratio***	***Irrigated Agric Score*****	***Groundwater Potential***	***Used***	***Used/Pot Ratio***	***Ground-water use Score*****	***Annual Flow***	***Wet Season Flow***	***Wet/Annual Ratio***	***Low Dry Seas Flow Score******
	km^2	*km^2*	*b/a*		*mill m^3*	*mill m^3*	*e/d*		*mill m^3*	*mill m^3*	*h/g*	
1 Ping part 1	273	56	0.21	0.70	5	0	0.07	0.04	501	371	0.74	1.35
2 Mae Ngad	207	140	0.68	2.31	5	1	0.22	0.13	365	287	0.79	2.17
3 Mae Taeng	351	275	0.78	2.66	6	0	0.05	0.03	642	455	0.71	0.78
7 Mae Khan	234	206	0.88	3.00	15	13	0.85	0.51	431	303	0.70	0.67
9 Mae Klang	116	53	0.45	1.55	7	0	0.04	0.03	259	186	0.72	0.99
11 Mae Chaem upper	*	*	*	*	*	*	*	*	*	*	*	*
12 Mae Chaem lower	304	84	0.28	0.94	20	1	0.03	0.02	1,214	867	0.71	0.87
14 Mae Teun	203	64	0.32	1.07	4	0	0.01	0.00	1,034	830	0.80	2.44
Upper Sub-Basins	***1,687***	***879***	***0.52***	***1.77***	***63***	***16***	***0.25***	***0.15***	***4,445***	***3,298***	***0.74***	***1.37***
4 Ping part 2	612	272	0.44	1.51	18	66	3.59	2.15	354	272	0.77	1.85
5 Mae Rim	94	48	0.51	1.72	4	1	0.19	0.11	265	188	0.71	0.76
6 Mae Kuang	706	517	0.73	2.49	9	43	5.00	3.00	790	659	0.83	3.00
8 Mae Lee	458	232	0.51	1.73	13	21	1.64	0.98	228	184	0.81	2.52
10 Ping part 3	40	13	0.32	1.07	8	2	0.28	0.17	410	300	0.73	1.18
13 Mae Had	242	110	0.46	1.55	9	1	0.10	0.06	323	215	0.67	-
Middle Sub-Basins	***2,152***	***1,192***	***0.55***	***1.88***	***61***	***134***	***2.19***	***1.31***	***2,370***	***1,817***	***0.77***	***1.81***
15 Ping part 4	643	236	0.37	1.25	18	1	0.06	0.04	521	395	0.76	1.67
16 Huay Mae Thor	38	4	0.10	0.34	1	0	0.12	0.07	126	98	0.78	2.06
17 Klong Wang Chao	122	6	0.05	0.17	2	0	0.05	0.03	169	122	0.72	0.95
18 Klong Mae Raka	301	60	0.20	0.68	11	0	0.03	0.02	161	127	0.79	2.22
19 Klong Suan Mark	312	65	0.21	0.71	5	1	0.11	0.06	368	281	0.76	1.76
20 Lower Ping	2,534	1,522	0.60	2.04	55	57	1.05	0.63	883	702	0.79	2.31
Lower Sub-Basins	***3,949***	***1,893***	***0.48***	***1.63***	***91***	***60***	***0.66***	***0.39***	***2,229***	***1,725***	***0.77***	***1.95***
Ping Basin	**7,788**	**3,963**	**0.51**	**1.73**	**215**	**209**	**0.97**	**0.58**	**9,044**	**6,841**	**0.76**	**1.63**

* combined with lower Mae Chaem data

** calculated as (<ratio> / <max ratio>) * 3

*** calculated as ((<ratio> - <min. ratio>) / (<max. ratio> - <min. ratio>)) * 3

Figure 15. Water Quality Indicator Scoring for Ping Sub-Basins

	2.4.1	2.4.2
	Water Quality	
Sub-Basin	**Water Quality Problem Score**	**Wastewater Problem Score**
	< Panya >	< CMU >
1 Ping part 1	1	2
2 Mae Ngad	1	0
3 Mae Taeng	1	2
7 Mae Khan	1	1
9 Mae Klang	1	1
11 Mae Chaem upper	1	1
12 Mae Chaem lower	1	1
14 Mae Teun	1	0
Upper Sub-Basins		
4 Ping part 2	2	1
5 Mae Rim	1	1
6 Mae Kuang	3	2
8 Mae Lee	1	0
10 Ping part 3	2	1
13 Mae Had	1	0
Middle Sub-Basins		
15 Ping part 4	2	2
16 Huay Mae Thor	1	2
17 Klong Wang Chao	1	2
18 Klong Mae Raka	1	2
19 Klong Suan Mark	1	2
20 Lower Ping	2	2
Lower Sub-Basins		
Ping Basin		

Figure 16. Socio-Economic Indicator Scoring for Ping Sub-Basins

	3. Overall Social & Economic Issues			**3.1. Poverty**		**3.2. Competition**		**3.3. Minorities & Urban**		**3.4. Health**
				3.1.1.	**3.1.2.**	**3.2.1**	**3.2.2**	**3.3.1**	**3.3.2**	**3.3.1.**
				Low Income Score	Econ & Social Weakness Score	Land Use Restriction Score	Agricultural Conflict Score	Upland Ethnicity Score	Population Density Score	Health Problem Score
Sub-Basin	**Score**	weighted total	***source:***	Panya data	CMU data	Panya/onep	Panya/onep	ONEP, Panya	Panya	Needs data
Upper Sub-Basins				***1.9***	***-***	***2.8***	***2.3***	***0.8***	***0.3***	***-***
			weight:	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*
1 Ping part 1	**2.6**	10		3.0	1	2.6	2.2	0.8	0.3	-
2 Mae Ngad	**1.9**	7		1.4	1	2.8	1.4	0.3	0.4	-
3 Mae Taeng	**2.6**	10		2.3	1	3.0	2.8	0.7	0.3	-
7 Mae Khan	**2.1**	8		1.4	2	2.3	1.5	0.5	0.4	-
9 Mae Klang	**2.7**	10		1.6	2	2.8	2.6	0.8	0.5	-
11 Mae Chaem upper	**0.0**			*	2	*	*	*	*	-
12 Mae Chaem lower	**2.8**	11		1.4	2	2.9	3.0	1.5	0.2	-
14 Mae Teun	**3.0**	12		2.2	2	2.9	3.0	1.3	0.1	-
Middle Sub-Basins				***0.5***	***-***	***1.8***	***0.7***	***0.2***	***0.8***	***-***
			weight:	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*
4 Ping part 2	**1.6**	5		0.0	1	1.0	0.4	0.0	3.0	-
5 Mae Rim	**2.2**	7		1.4	1	2.3	1.4	0.0	1.2	-
6 Mae Kuang	**1.4**	5		1.0	1	1.6	0.4	0.0	0.8	-
8 Mae Lee	**1.9**	6		0.9	2	1.6	0.8	0.5	0.5	-
10 Ping part 3	**3.0**	10		1.7	2	2.3	1.1	3.0	0.0	-
13 Mae Had	**2.4**	8		1.8	2	2.0	1.6	0.1	0.6	-
Lower Sub-Basins				***1.5***	***-***	***1.6***	***1.0***	***0.1***	***0.5***	***-***
			weight:	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*
15 Ping part 4	**2.0**	6		2.1	1	1.7	0.9	0.1	0.4	-
16 Huay Mae Thor	**2.2**	7		0.8	2	2.2	1.5	0.2	0.2	-
17 Klong Wang Chao	**3.0**	9		2.4	1	2.6	2.2	0.9	0.2	-
18 Klong Mae Raka	**2.3**	7		2.7	2	1.2	1.0	0.0	0.2	-
19 Klong Suan Mark	**2.3**	7		1.5	1	2.5	1.6	0.1	0.4	-
20 Lower Ping	**1.6**	5		1.1	1	1.0	0.8	0.1	0.9	-
Ping Basin				**1.1**	**-**	**2.2**	**1.2**	**0.3**	**0.5**	**-**

Figure 17. Poverty Indicator Scoring for Ping Sub-Basins

				3.1.1		3.1.2
	Low Income Score				**Economic & Social Weakness Score**	
	A	B	b/a	***Low***	C	***Econ/Soc***
Sub-Basin	***total population***	***total income***	***per capita income***	***Income Score*****	***econ-soc strength***	***Weakness Score******
	thous pers	*thous baht*	*baht/pers*		*CMU*	
1 Ping part 1	80	739,397	**9,269**	3.0	3	1
2 Mae Ngad	67	861,976	12,868	1.4	3	1
3 Mae Taeng	73	785,892	10,812	2.3	3	1
7 Mae Khan	106	1,364,536	12,868	1.4	2	2
9 Mae Klang	44	557,903	12,538	1.6	2	2
11 Mae Chaem upper	*	*	*	*	2	2
12 Mae Chaem lower	96	1,240,193	12,864	1.4	2	2
14 Mae Teun	58	639,742	11,099	2.2	2	2
Upper Sub-Basins	***524***	***6,189,639***	***11,812***	***1.9***		
4 Ping part 2	664	10,679,503	**16,093**	-	3	1
5 Mae Rim	85	1,090,705	12,868	1.4	3	1
6 Mae Kuang	291	4,031,909	13,856	1.0	3	1
8 Mae Lee	148	2,085,664	14,107	0.9	2	2
10 Ping part 3	21	252,920	12,129	1.7	2	2
13 Mae Had	45	541,019	12,099	1.8	2	2
Middle Sub-Basins	***1,253***	***18,681,719***	***14,912***	***0.5***		
15 Ping part 4	172	1,960,130	11,403	2.1	3	1
16 Huay Mae Thor	16	227,620	14,313	0.8	2	2
17 Klong Wang Chao	20	210,334	10,560	2.4	3	1
18 Klong Mae Raka	31	303,745	9,884	2.7	2	2
19 Klong Suan Mark	65	829,308	12,667	1.5	3	1
20 Lower Ping	378	5,104,147	13,498	1.1	3	1
Lower Sub-Basins	***682***	***8,635,285***	***12,661***	***1.5***		
Ping Basin	**2,459**	**33,506,642**	**13,627**	**1.1**		

* combined with lower Mae Chaem data

** calculated as ((<max. income> - <income>) / (<max. income> - <min. income>)) * 3

*** calculated as inverse of CMU strength score

Figure 20. Land Use Restriction Indicator Scoring for Ping Sub-Basins

		Land Use Restriction Category (unit: square kilometers)				Percentage Distribution (unit: Percent)				Land Use Restriction Score (unit: Score)					3.2.1
		Tenure	Reserved	Watrshd	Protected	Tenure	Reserved	Watershed	Protected	Tenure	Reserved	Watershed	Protected	Total	Relative
Sub-Basin	***Total***	***Non-forest***	***Other Reserve***	***1AB not park/wls***	***Nat Park WL Sanct***	***Non-forest***	***Other Reserved***	***1AB not park/wls***	***Nat Park WL Sanct***	**Relative Weight** multiplied by % of land area				Point Score	Land Use Restriction Score
										0.00	**1.00**	**2.00**	**2.00**		
1 Ping part 1	1,974	189	399	111	1,275	10	20	6	65	-	0.20	0.11	1.29	1.61	2.65
2 Mae Ngad	1,285	156	93	4	1,032	12	7	0	80	-	0.07	0.01	1.61	1.68	2.78
3 Mae Taeng	1,958	99	153	392	1,314	5	8	20	67	-	0.08	0.40	1.34	1.82	3.00
7 Mae Khan	1,833	214	690	660	269	12	38	36	15	-	0.38	0.72	0.29	1.39	2.29
9 Mae Klang	616	54	78	21	463	9	13	3	75	-	0.13	0.07	1.50	1.70	2.80
11 Mae Chaem upper	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12 Mae Chaem lower	3,896	57	859	1,667	1,311	1	22	43	34	-	0.22	0.86	0.67	1.75	2.88
14 Mae Teun	2,896	46	587	1,094	1,152	2	20	38	40	-	0.20	0.76	0.80	1.75	2.89
Upper Sub-Basins	***14,458***	***815***	***2,860***	***3,949***	***6,815***	***5.6***	***19.8***	***27.3***	***47.1***	***-***	***0.20***	***0.55***	***0.94***	***1.69***	***2.78***
4 Ping part 2	1,616	960	352	106	199	59	22	7	12	-	0.22	0.13	0.25	0.59	0.98
5 Mae Rim	508	67	161	147	134	13	32	29	26	-	0.32	0.58	0.53	1.42	2.34
6 Mae Kuang	2,734	996	803	576	352	36	29	21	13	-	0.29	0.42	0.26	0.97	1.60
8 Mae Lee	2,081	578	980	366	156	28	47	18	8	-	0.47	0.35	0.15	0.97	1.60
10 Ping part 3	3,452	429	922	298	1,696	12	27	9	49	-	0.27	0.17	0.98	1.42	2.34
13 Mae Had	520	56	287	55	123	11	55	11	24	-	0.55	0.21	0.47	1.23	2.03
Middle Sub-Basins	***10,911***	***3,085***	***3,504***	***1,547***	***2,660***	***28.3***	***32.1***	***14.2***	***24.4***	***-***	***0.32***	***0.28***	***0.49***	***1.09***	***1.80***
15 Ping part 4	2,983	702	1,071	339	680	24	36	11	23	-	0.36	0.23	0.46	1.04	1.72
16 Huay Mae Thor	644	119	180	114	231	19	28	18	36	-	0.28	0.36	0.72	1.35	2.23
17 Klong Wang Chao	649	4	259	32	353	1	40	5	54	-	0.40	0.10	1.09	1.59	2.62
18 Klong Mae Raka	902	282	587	6	27	31	65	1	3	-	0.65	0.01	0.06	0.72	1.19
19 Klong Suan Mark	1,132	93	391	4	644	8	35	0	57	-	0.35	0.01	1.14	1.49	2.46
20 Lower Ping	2,980	1,512	1,118	12	337	51	38	0	11	-	0.38	0.01	0.23	0.61	1.00
Lower Ping Basin	***9,289***	***2,712***	***3,606***	***508***	***2,271***	***29.2***	***38.8***	***5.5***	***24.5***	***-***	***0.39***	***0.11***	***0.49***	***0.99***	***1.63***
Ping Basin	**34,659**	**6,613**	**9,970**	**6,005**	**11,747**	**19**	**29**	**17**	**34**	**-**	**0.29**	**0.35**	**0.68**	**1.31**	**2.16**

Figure 22. Agricultural Conflict Indicator Scoring for Ping Sub-Basins

		unit: square kilometers				unit: Percent				unit: Score					3.2.2
		Agricultural areas located in				Percentage Distribution				Agricultural Conflict Score					
		Tenure	Reserved	Watrshd	Protected	Tenure	Reserved	Watershed	Protected	Tenure	Reserved	Watershed	Protected	Total Point Score	Relative Agric Conflict Score
Sub-Basin	***Total***	***Non-forest***	***Other Reserve***	***1AB not park/wls***	***Nat Park WL Sanct***	***Non-forest***	***Other Reserved***	***1AB not park/wls***	***Nat Park WL Sanct***	**Relative Weight multiplied by % of agric area**					
										0.00	**1.00**	**2.00**	**3.00**		
1 Ping part 1	501	173	189	5	134	35	38	1	27	-	0.38	0.02	0.80	1.20	2.24
2 Mae Ngad	264	151	70	1	43	57	26	0	16	-	0.26	0.00	0.49	0.76	1.41
3 Mae Taeng	269	85	54	36	94	32	20	13	35	-	0.20	0.27	1.05	1.52	2.83
7 Mae Khan	411	181	162	38	30	44	39	9	7	-	0.39	0.18	0.22	0.80	1.49
9 Mae Klang	96	46	8	0	42	48	8	0	44	-	0.08	0.01	1.32	1.41	2.64
11 Mae Chaem upper	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12 Mae Chaem lower	432	45	179	110	98	10	41	26	23	-	0.41	0.51	0.68	1.61	3.00
14 Mae Teun	190	29	57	67	37	16	30	35	19	-	0.30	0.70	0.58	1.58	2.96
Upper Sub-Basins	***2,163***	***710***	***718***	***257***	***478***	***32.8***	***33.2***	***11.9***	***22.1***	***-***	***0.33***	***0.24***	***0.66***	***1.23***	***2.30***
4 Ping part 2	1,005	821	153	6	26	82	15	1	3	-	0.15	0.01	0.08	0.24	0.45
5 Mae Rim	128	60	49	11	9	47	38	8	7	-	0.38	0.17	0.20	0.75	1.40
6 Mae Kuang	1,156	918	216	5	16	79	19	0	1	-	0.19	0.01	0.04	0.24	0.45
8 Mae Lee	697	412	269	5	12	59	39	1	2	-	0.39	0.01	0.05	0.45	0.84
10 Ping part 3	563	355	141	3	65	63	25	0	12	-	0.25	0.01	0.35	0.61	1.13
13 Mae Had	206	49	145	2	11	24	70	1	5	-	0.70	0.01	0.15	0.87	1.63
Middle Sub-Basins	***3,756***	***2,614***	***973***	***31***	***138***	***69.6***	***25.9***	***0.8***	***3.7***	***-***	***0.26***	***0.02***	***0.11***	***0.39***	***0.72***
15 Ping part 4	1,022	565	427	15	14	55	42	2	1	-	0.42	0.03	0.04	0.49	0.91
16 Huay Mae Thor	84	44	25	2	13	53	29	3	16	-	0.29	0.05	0.47	0.81	1.52
17 Klong Wang Chao	169	4	148	1	16	2	87	1	9	-	0.87	0.02	0.28	1.17	2.19
18 Klong Mae Raka	372	184	184	2	2	49	50	0	1	-	0.50	0.01	0.02	0.52	0.98
19 Klong Suan Mark	411	89	302	1	19	22	74	0	5	-	0.74	0.00	0.14	0.88	1.64
20 Lower Ping	2,501	1,442	1,054	1	3	58	42	0	0	-	0.42	0.00	0.00	0.43	0.80
Lower Sub-Basins	***4,557***	***2,328***	***2,140***	***22***	***67***	***51.1***	***47.0***	***0.5***	***1.5***	***-***	***0.47***	***0.01***	***0.04***	***0.52***	***0.98***
Ping Basin	**10,476**	**5,652**	**3,831**	**310**	**683**	**54**	**37**	**3**	**7**	**-**	**0.37**	**0.06**	**0.20**	**0.62**	**1.16**

Figure 23. Example of Upland Ethnicity Indicator Scoring for Ping Sub-Basins

		Population Ethnicity (unit: persons)			Percentage Distribution (unit: Percent)			Upland Ethnicity Score				3.3.1
	Traditions:	Lowland	Midland	Highland	Lowland	Midland	Highland	Lowland	Midland	Highland	Point Score	**Relative Upland Ethnicity Score**
Sub-Basin	***Total***	*Thai, Haw*	*Karen, Lua, Htin*	*Hmong, Lisu Akha, etc*	*Thai, Haw*	*Karen, Lua, Htin*	*Hmong, Lisu Akha, etc*	**Relative Weight** multiplied by % of persons				
								0.00	**2.00**	**3.00**		
1 Ping part 1	79,771	66,149	2,078	11,544	83	3	14	-	0.05	0.43	0.49	0.83
2 Mae Ngad	66,986	63,434	357	3,195	95	1	5	-	0.01	0.14	0.15	0.26
3 Mae Taeng	72,687	61,953	2,176	8,558	85	3	12	-	0.06	0.35	0.41	0.71
7 Mae Khan	106,041	90,871	11,993	3,177	86	11	3	-	0.23	0.09	0.32	0.54
9 Mae Klang	44,497	35,460	6,875	2,162	80	15	5	-	0.31	0.15	0.45	0.78
11 Mae Chaem upper	(with lower)	-	-	-								*
12 Mae Chaem lower	96,408	57,796	33,441	5,171	60	35	5	-	0.69	0.16	0.85	1.46
14 Mae Teun	57,642	36,132	19,641	1,869	63	34	3	-	0.68	0.10	0.78	1.33
Upper Sub-Basins	***524,032***	***411,795***	***76,561***	***35,676***	***79***	***15***	***7***	***-***	***0.29***	***0.20***	***0.50***	***0.85***
4 Ping part 2	663,600	657,151	-	6,449	99	-	1	-	-	0.03	0.03	0.05
5 Mae Rim	84,761	81,141	2,094	1,526								-
6 Mae Kuang	290,988	287,267	3,721	-	99	1	-	-	0.03	-	0.03	0.04
8 Mae Lee	147,846	125,246	22,600	-	85	15	-	-	0.31	-	0.31	0.52
10 Ping part 3	20,852	2,807	17,487	558	13	84	3	-	1.68	0.08	1.76	3.00
13 Mae Had	44,716	43,408	1,308	-	97	3	-	-	0.06	-	0.06	0.10
Middle Sub-Basins	***1,252,763***	***1,197,020***	***47,210***	***8,533***	***96***	***3.8***	***0.7***	***-***	***0.08***	***0.02***	***0.10***	***0.16***
15 Ping part 4	171,896	169,971	20	1,905	99	0	1	-	0.00	0.03	0.03	0.06
16 Huay Mae Thor	15,903	14,755	1,148	-	93	7	-	-	0.14	-	0.14	0.25
17 Klong Wang Chao	19,918	16,315	233	3,370	82	1	17	-	0.02	0.51	0.53	0.91
18 Klong Mae Raka	30,731	30,731	-	-	100	-	-	-	-	-	-	-
19 Klong Suan Mark	65,470	64,745	237	488	99	0	1	-	0.01	0.02	0.03	0.05
20 Lower Ping	378,141	371,449	666	6,026	98	0	2	-	0.00	0.05	0.05	0.09
Lower Sub-Basins	***682,059***	***667,966***	***2,304***	***11,789***	***98***	***0.3***	***1.7***	***-***	***0.01***	***0.05***	***0.06***	***0.10***
												-
Ping Basin	**2,458,854**	**2,276,781**	**126,075**	**55,998**	**93**	**5.1**	**2.3**	**-**	**0.10**	**0.07**	**0.17**	**0.29**

3.3.2

	Population Density			
	People	Land	Population Density	Relative Population Density Score
Sub-Basin	*Population*	*Land Area*		
	persons	*sq km*	*per/sq km*	
1 Ping part 1	79,771	1,974	40.4	0.30
2 Mae Ngad	66,986	1,285	52.1	0.38
3 Mae Taeng	72,687	1,958	37.1	0.27
7 Mae Khan	106,041	1,833	57.8	0.42
9 Mae Klang	44,497	616	72.2	0.53
11 Mae Chaem upper	(with lower)	(with lower)		*
12 Mae Chaem lower	96,408	3,896	24.7	0.18
14 Mae Teun	57,642	2,896	19.9	0.15
Upper Sub-Basins	***524,032***	***14,458***	***36.2***	***0.26***
4 Ping part 2	663,600	1,616	410.5	3.00
5 Mae Rim	84,761	508	166.8	1.22
6 Mae Kuang	290,988	2,734	106.4	0.78
8 Mae Lee	147,846	2,081	71.1	0.52
10 Ping part 3	20,852	3,452	6.0	0.04
13 Mae Had	44,716	520	85.9	0.63
Middle Sub-Basins	***1,252,763***	***10,911***	***114.8***	***0.84***
15 Ping part 4	171,896	2,983	57.6	0.42
16 Huay Mae Thor	15,903	644	24.7	0.18
17 Klong Wang Chao	19,918	649	30.7	0.22
18 Klong Mae Raka	30,731	902	34.1	0.25
19 Klong Suan Mark	65,470	1,132	57.8	0.42
20 Lower Ping	378,141	2,980	126.9	0.93
Lower Sub-Basins	***682,059***	***9,289***	***73.4***	***0.54***
				-
Ping Basin	**2,458,854**	**34,659**	**70.9**	**0.52**

Figure 25. Example of Health Problem Indicator Scoring for Ping Sub-Basins

		unit: persons			unit: cases / thousand persons (?)			unit: Score			3.4.1
		Illnesses Reported			**Illness Rates**			**Health Problem Score**			
		water/sanit	air	chemical	water/sanit	air	chemical	water/sanit	air	chemical	**Health Problem Score**
Sub-Basin	***Total***	***Gastro-intestinal***	***Respiratory***	***Chemical Poisoning***	***Gastro-intestinal***	***Respiratory***	***Chemical Poisoning***	**Relative Weight multiplied by % of persons**			
								2.00	**1.00**	**3.00**	
1 Ping part 1	79,771				-	-	-	-	-	-	-
2 Mae Ngad	66,986		Data not yet available		-	-	-	-	-	-	-
3 Mae Taeng	72,687				-	-	-	-	-	-	-
7 Mae Khan	106,041				-	-	-	-	-	-	-
9 Mae Klang	44,497				-	-	-	-	-	-	-
11 Mae Chaem upper	(with lower)										
12 Mae Chaem lower	96,408				-	-	-	-	-	-	-
14 Mae Teun	57,642				-	-	-	-	-	-	-
Upper Sub-Basins	***524,032***	-	-	-	-	-	-	-	-	-	-
4 Ping part 2	663,600				-	-	-	-	-	-	-
5 Mae Rim	84,761		Data not yet available		-	-	-	-	-	-	-
6 Mae Kuang	290,988				-	-	-	-	-	-	-
8 Mae Lee	147,846				-	-	-	-	-	-	-
10 Ping part 3	20,852				-	-	-	-	-	-	-
13 Mae Had	44,716				-	-	-	-	-	-	-
Middle Sub-Basins	***1,252,763***	-	-	-	-	-	-	-	-	-	-
15 Ping part 4	171,896				-	-	-	-	-	-	-
16 Huay Mae Thor	15,903		Data not yet available		-	-	-	-	-	-	-
17 Klong Wang Chao	19,918				-	-	-	-	-	-	-
18 Klong Mae Raka	30,731				-	-	-	-	-	-	-
19 Klong Suan Mark	65,470				-	-	-	-	-	-	-
20 Lower Ping	378,141				-	-	-	-	-	-	-
Lower Sub-Basins	***682,059***	-	-	-	-	-	-	-	-	-	-
Ping Basin	**2,458,854**	-	-	-	-	-	-	-	-	-	-

Figure 26. Organizational and Administrative Indicator Scoring

	4. Overall Local Org Capacity & Complexity			4.1. Capacity		4.2. Compexity
				4.1.1.	4.1.2.	4.2.1.
				Loc Govt Capacity Score	Network Experience Score	Admin Simplicity Score
Sub-Basin	**Score**	weighted total	***source:***	onep, DOLA	Need data	Panya, ONEP
Upper Sub-Basins				***1.1***	***-***	***2.6***
			weight:	*1.0*	*1.0*	*1.0*
1 Ping part 1	**2.4**	4		1.6	-	2.5
2 Mae Ngad	**2.1**	4		0.8	-	2.8
3 Mae Taeng	**2.0**	3		0.9	-	2.4
7 Mae Khan	**2.4**	4		1.7	-	2.2
9 Mae Klang	**3.0**	5		2.0	-	3.0
11 Mae Chaem upper	*****	*		*	-	2.9
12 Mae Chaem lower	**2.2**	4		1.0	-	2.6
14 Mae Teun	**2.0**	3		0.7	-	2.7
Middle Sub-Basins				***1.6***	***-***	***1.8***
			weight:	*1.0*	*1.0*	*1.0*
4 Ping part 2	**2.3**	3		3.0	-	0.0
5 Mae Rim	**2.8**	4		0.9	-	2.7
6 Mae Kuang	**2.2**	3		2.1	-	0.6
8 Mae Lee	**2.8**	4		1.1	-	2.5
10 Ping part 3	**2.4**	3		0.9	-	2.2
13 Mae Had	**3.0**	4		0.9	-	3.0
Lower Sub-Basins				***1.4***	***-***	***2.4***
			weight:	*1.0*	*1.0*	*1.0*
15 Ping part 4	**2.3**	3		1.3	-	1.8
16 Huay Mae Thor	**2.8**	4		0.8	-	3.0
17 Klong Wang Chao	**2.7**	4		0.9	-	2.9
18 Klong Mae Raka	**2.5**	3		0.8	-	2.7
19 Klong Suan Mark	**3.0**	4		1.4	-	2.8
20 Lower Ping	**2.2**	3		1.8	-	1.2
Ping Basin				**1.3**	**-**	**2.1**

Figure 27. Area-Based Indicator Scoring for Local Government Capacity

		unit: square kilometers						unit: Percent													4.1.1
		Local Government Classification						Percentage Distribution						Area-Based Local Gov't Capacity Score							
		Munic	elected sub-district government					Munic	elected sub-district govt					Munic	1	2	3	4	5	Point	Relative
Sub-Basin	***Total Area***	***Tessaban***	***TAO Classification Level***					***Tssbn***	***TAO Classification Level***					Relative Weight of capacity by							Capacity
			1	***2***	***3***	***4***	***5***		***1***	***2***	***3***	***4***	***5***	multiplied by % of land area						Score	Score
	sq km													**3.00**	**2.50**	**2.00**	**1.50**	**0.75**	**0.25**		
1 Ping part 1	1,974	42	-	-	14	921	997	2	-	-	1	47	51	0.06	-	-	0.01	0.35	0.13	0.55	1.58
2 Mae Ngad	1,285	6	-	-	-	0	1,278	0.5	-	-	-	0	100	0.01	-	-	-	0.00	0.25	0.26	0.76
3 Mae Taeng	1,958	16	-	-	-	146	1,795	1	-	-	-	7	92	0.03	-	-	-	0.06	0.23	0.31	0.89
7 Mae Khan	1,833	139	-	-	-	438	1,257	8	-	-	-	24	69	0.23	-	-	-	0.18	0.17	0.58	1.66
9 Mae Klang	616	18	-	-	29	376	193	3	-	-	5	61	31	0.09	-	-	0.07	0.46	0.08	0.70	2.00
11 Mae Chaem upper	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12 Mae Chaem lower	3,896	102	-	-	-	261	3,532	3	-	-	-	7	91	0.08	-	-	-	0.05	0.23	0.36	1.02
14 Mae Teun	2,896	3	-	-	-	-	2,893	0.1	-	-	-	-	100	0.00	-	-	-	-	0.25	0.25	0.73
Upper Sub-Basins	***14,458***	***327***	***-***	***-***	***43***	***2,142***	***11,946***	***2***	***-***	***-***	***0.3***	***15***	***83***	*0.07*	*-*	*-*	*0.00*	*0.11*	*0.21*	***0.39***	***1.12***
4 Ping part 2	1,617	168	90	21	277	467	594	10	6	1	17	29	37	0.31	0.14	0.03	0.26	0.22	0.09	1.04	3.00
5 Mae Rim	508	-	-	-	-	58	450	-	-	-	-	11	89	-	-	-	-	0.09	0.22	0.31	0.88
6 Mae Kuang	2,734	296	32	2	198	401	1,805	11	1	0.1	7	15	66	0.32	0.03	0.00	0.11	0.11	0.17	0.74	2.13
8 Mae Lee	2,081	36	-	-	0	393	1,651	2	-	-	0	19	79	0.05	-	-	0.00	0.14	0.20	0.39	1.13
10 Ping part 3	3,452	27	-	-	1	299	3,125	1	-	-	0	9	91	0.02	-	-	0.00	0.06	0.23	0.31	0.91
13 Mae Had	520	8	-	-	-	14	498	1	-	-	-	3	96	0.04	-	-	-	0.02	0.24	0.30	0.87
Middle Sub-Basins	***10,911***	***534***	***121***	***23***	***477***	***1,632***	***8,124***	***5***	***1***	***0***	***4***	***15***	***74***	*0.15*	*0.03*	*0.00*	*0.07*	*0.11*	*0.19*	***0.54***	***1.56***
15 Ping part 4	2,983	108	-	-	174	189	2,512	4	-	-	6	6	84	0.11	-	-	0.09	0.05	0.21	0.45	1.31
16 Huay Mae Thor	644	-	-	-	-	34	610	-	-	-	-	5	95	-	-	-	-	0.04	0.24	0.28	0.80
17 Klong Wang Chao	649	-	-	-	-	80	569	-	-	-	-	12	88	-	-	-	-	0.09	0.22	0.31	0.90
18 Klong Mae Raka	902	-	-	-	6	9	887	-	-	-	1	1	98	-	-	-	0.01	0.01	0.25	0.26	0.76
19 Klong Suan Mark	1,132	4	-	-	-	477	651	0.3	-	-	-	42	58	0.01	-	-	-	0.32	0.14	0.47	1.35
20 Lower Ping	2,980	197	-	-	-	1,215	1,568	7	-	-	-	41	53	0.20	-	-	-	0.31	0.13	0.64	1.83
Lower Sub-Basins	***9,289***	***309***	***-***	***-***	***180***	***2,004***	***6,796***	***3***	***-***	***-***	***2***	***22***	***73***	*0.10*	*-*	*-*	*0.03*	*0.16*	*0.18*	***0.47***	***1.36***
Ping Basin	**34,659**	**1,170**	**121**	**23**	**700**	**5,778**	**26,866**	**3**	**0.3**	**0.1**	**2**	**17**	**78**	0.10	0.01	0.00	0.03	0.13	0.19	**0.46**	**1.33**

Figure 28. Area-Based Indicator Scoring for Local Government Capacity

unit: Score

Sub-Basin	Local Network Experience Score
1 Ping part 1	3
2 Mae Ngad	-
3 Mae Taeng	-
7 Mae Khan	-
9 Mae Klang	-
11 Mae Chaem upper	3
12 Mae Chaem lower	3
14 Mae Teun	-
Upper Ping Basin Ave	
4 Ping part 2	-
5 Mae Rim	-
6 Mae Kuang	3
8 Mae Lee	-
10 Ping part 3	-
13 Mae Had	-
Middle Ping Basin Ave	
15 Ping part 4	-
16 Huay Mae Thor	-
17 Klong Wang Chao	-
18 Klong Mae Raka	-
19 Klong Suan Mark	-
20 Lower Ping	-
Lower Ping Basin Ave	
Ping Basin Ave	

Needs ratings according to simple scale:

0 = no relevant local networks are known to exist

1 = a few local networks have begun, but they have little experience thus far

2 = fairly experienced local networks exist, and are beginning to interact with each other

3 = experienced local networks exist, and have begun efforts to build an alliance at sub-basin scale

Figure 29. Administrative Simplicity Indicator Scoring for Ping Sub-Basins

unit: number of admin units | unit: Score | 4.2.1

Sub-Basin	Administrative Units: DOLA – Province	DOLA – Districts	Loval Govt – Tambon	Loval Govt – Munic	MoNRE – Watrshd units	MoNRE – Parks & WLS	Administrative Simplicity Score (Relative Coord. Difficulty Weight multiplied by number of units): Province	District	Loc Govt	Watershed	Conserv	Weighted Complexity Total	Admin Simplicity Score**
							3.0	2.5	2.0	1.0	1.5		
1 Ping part 1	1	5	13	3	3	4	3.0	12.5	26.0	3.0	6.0	50.5	2.5
2 Mae Ngad	1	2	11	1	2	1	3.0	5.0	22.0	2.0	1.5	33.5	2.8
3 Mae Taeng	1	3	14	1	8	4	3.0	7.5	28.0	8.0	6.0	52.5	2.4
7 Mae Khan	1	5	19	3	8	2	3.0	12.5	38.0	8.0	3.0	64.5	2.2
9 Mae Klang	1	1	5	1	3	2	3.0	2.5	10.0	3.0	3.0	21.5	3.0
11 Mae Chaem upper	1	1	5	-	9	1	3.0	2.5	10.0	9.0	1.5	26.0	2.9
12 Mae Chaem lower	1	3	9	2	10	3	3.0	7.5	18.0	10.0	4.5	43.0	2.6
14 Mae Teun	2	2	9	1	8	2	6.0	5.0	18.0	8.0	3.0	40.0	2.7
Upper Ping Basin Ave	***1.1***	***3***	***11***	***2***	***6***	***2***	***3.4***	***6.9***	***21.3***	***6.4***	***3.6***	***41.4***	***2.6***
4 Ping part 2	2	13	76	13	3	1	6.0	32.5	152.0	3.0	1.5	195.0	-
5 Mae Rim	1	3	9	-	4	3	3.0	7.5	18.0	4.0	4.5	37.0	2.7
6 Mae Kuang	1	10	63	13	1	2	3.0	25.0	126.0	1.0	3.0	158.0	0.6
8 Mae Lee	1	5	16	4	-	1	3.0	12.5	32.0	-	1.5	49.0	2.5
10 Ping part 3	3	7	17	2	3	3	9.0	17.5	34.0	3.0	4.5	68.0	2.2
13 Mae Had	2	2	5	1	-	1	6.0	5.0	10.0	-	1.5	22.5	3.0
Middle Ping Basin Ave	***1.7***	***7***	***31***	***6***	***2***	***2***	***5.0***	***16.7***	***62.0***	***1.8***	***2.8***	***88.3***	***1.8***
15 Ping part 4	2	7	30	2	1	3	6.0	17.5	60.0	1.0	4.5	89.0	1.8
16 Huay Mae Thor	1	2	4	1	1	2	3.0	5.0	8.0	1.0	3.0	20.0	3.0
17 Klong Wang Chao	2	4	4	-	-	2	6.0	10.0	8.0	-	3.0	27.0	2.9
18 Klong Mae Raka	2	5	9	-	-	1	6.0	12.5	18.0	-	1.5	38.0	2.7
19 Klong Suan Mark	1	3	9	1	-	3	3.0	7.5	18.0	-	4.5	33.0	2.8
20 Lower Ping	2	7	49	8	-	2	6.0	17.5	98.0	-	3.0	124.5	1.2
Lower Ping Basin Ave	***1.7***	***5***	***18***	***2***	***0.3***	***2***	***5.0***	***11.7***	***35.0***	***0.3***	***3.3***	***55.3***	***2.4***
Ping Basin Ave	**1.5**	**5**	**19**		**3**	**2**	**4.4**	**11.3**	**37.6**	**3.2**	**3.2**	**59.6**	**2.1**

** calculated as [(<max total>-<total>) / (<max total>-<min total>)] *3

Figure 31. Overall Summary of Weighted Indicator Scoring for Ping Sub-Basins

	Summary Overall Weighted Scores		1. Grouping Lowland Zone Bias Score		2. Overall Natural Resource Issues		3. Overall Social & Economic Issues		4. Overall Local Org Capacity & Complexity	
Sub-Basin	**Score**	weighted total		*source:*	**Score**	weighted total	**Score**	weighted total	**Score**	weighted total
Upper Sub-Basins			***1.88***							
				weight:		**2.00**		**3.00**		**1.00**
1 Ping part 1	**3.00**	91	2.24		**3.0**	16	**2.7**	19	**2.4**	4
2 Mae Ngad	**2.18**	66	2.27		**2.3**	12	**1.9**	13	**2.1**	4
3 Mae Taeng	**2.89**	88	1.59		**2.7**	14	**2.7**	19	**2.0**	3
7 Mae Khan	**2.35**	72	1.95		**2.5**	13	**2.0**	14	**2.4**	4
9 Mae Klang	**2.78**	85	1.87		**2.5**	13	**2.6**	18	**3.0**	5
11 Mae Chaem upper	*****	*	1.43		*****	*	*****	*	*****	*
12 Mae Chaem lower	**2.69**	82	1.88		**1.8**	10	**2.8**	20	**2.2**	4
14 Mae Teun	**2.93**	89	1.93		**2.2**	12	**3.0**	21	**2.0**	3
Middle Sub-Basins			***2.54***							
				weight:		**2.00**		**3.00**		**1.00**
4 Ping part 2	**2.82**	78	2.80		**2.4**	23	**2.1**	8	**3.0**	6
5 Mae Rim	**2.23**	62	2.32		**1.4**	14	**2.5**	10	**2.2**	4
6 Mae Kuang	**3.00**	83	2.63		**3.0**	29	**1.6**	7	**2.4**	5
8 Mae Lee	**2.27**	63	2.59		**1.8**	17	**1.9**	8	**2.4**	5
10 Ping part 3	**2.32**	64	2.33		**1.2**	12	**3.0**	12	**2.0**	4
13 Mae Had	**2.05**	57	2.73		**1.1**	10	**2.6**	11	**2.4**	5
Lower Sub-Basins			***2.80***							
				weight:		**2.00**		**3.00**		**1.00**
15 Ping part 4	**2.71**	64	2.81		**2.3**	17	**2.2**	9	**2.4**	4
16 Huay Mae Thor	**2.27**	54	2.54		**1.7**	13	**2.0**	8	**2.5**	5
17 Klong Wang Chao	**2.77**	66	2.53		**1.7**	12	**3.0**	12	**2.6**	5
18 Klong Mae Raka	**2.69**	64	2.99		**1.9**	15	**2.5**	10	**2.3**	4
19 Klong Suan Mark	**2.51**	59	2.55		**1.8**	13	**2.2**	9	**3.0**	5
20 Lower Ping	**3.00**	71	2.94		**3.0**	23	**1.8**	7	**2.7**	5
Ping Basin			**2.33**							

Figure 32. Natural Resource Issues Weighted Indicator Scoring for Ping Sub-Basins

	2. Overall Natural Resource Issues			**2.1. Degradation**			**2.2. Hazards**		**2.3. Water Use**			**2.4 Water Quality**	
				2.1.1.	**2.1.2.**	**2.1.3.**	**2.2.1.**	**2.2.2.**	**2.3.1.**	**2.3.2.**	**2.3.3.**	**2.4.1.**	**2.4.2.**
				Forest Conversion Score	Forest Deterior Score	Soil Erosion Score	Flooding Risk Score	Landslide Risk Score	Agric Irrigation Score	Groundwater Use Score	Low Dry Season Flow Score	Water Quality Problem Score	Wastewater Problem Score
Sub-Basin	**Score**	weighted total	*source:*	CMU data	CMU data	Panya data	Panya	Need data	Panya data	Panya data	Panya data	Panya	CMU
Upper Sub-Basins				***0.4***	***0.5***	***1.8***		-	***1.8***	***0.1***	***1.4***		
			weight:	*2.0*	*2.0*	*2.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*
1 Ping part 1	**3.0**	16		0.6	2.4	1.6	1.4	-	0.7	0.0	1.4	1	2
2 Mae Ngad	**2.3**	12		0.6	0.3	1.6	1.2	-	2.3	0.1	2.2	1	0
3 Mae Taeng	**2.7**	14		0.7	0.2	1.4	2.8	-	2.7	0.0	0.8	1	2
7 Mae Khan	**2.5**	13		0.5	0.4	1.8	1.4	-	3.0	0.5	0.7	1	1
9 Mae Klang	**2.5**	13		0.5	0.5	2.3	1.6	-	1.5	0.0	1.0	1	1
11 Mae Chaem upper	*	*		*	*	*	*	-	*	*	*	*	*
12 Mae Chaem lower	**1.8**	10		0.3	0.1	1.6	1.6	-	0.9	0.0	0.9	1	1
14 Mae Teun	**2.2**	12		0.2	0.4	2.3	1.3	-	1.1	0.0	2.4	1	0
Middle Sub-Basins				***1.0***	***0.9***	***1.0***		-	***1.9***	***1.3***	***1.8***		
			weight:	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*2.0*	*2.0*	*2.0*	*2.0*	*1.0*
4 Ping part 2	**2.4**	23		2.0	3.0	0.7	1.5	-	1.5	2.2	1.9	2	1
5 Mae Rim	**1.4**	14		0.6	0.6	3.0	1.1	-	1.7	0.1	0.8	1	1
6 Mae Kuang	**3.0**	29		1.3	1.1	0.9	0.8	-	2.5	3.0	3.0	3	2
8 Mae Lee	**1.8**	17		0.8	1.1	0.9	2.2	-	1.7	1.0	2.5	1	0
10 Ping part 3	**1.2**	12		0.5	0.4	0.6	0.6	-	1.1	0.2	1.2	2	1
13 Mae Had	**1.1**	10		0.8	0.6	2.8	0.9	-	1.6	0.1	0.0	1	0
Lower Sub-Basins				***1.6***	***1.2***	***1.2***	***1.7***	-	***1.6***	***0.4***	***1.9***		
			weight:	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*2.0*	*2.0*	*2.0*	*2.0*	*1.0*
15 Ping part 4	**2.3**	17		1.1	2.0	1.0	1.0	-	1.2	0.0	1.7	2	2
16 Huay Mae Thor	**1.7**	13		0.2	0.9	1.7	1.0	-	0.3	0.1	2.1	1	2
17 Klong Wang Chao	**1.7**	12		0.7	0.8	1.7	3.0	-	0.2	0.0	0.9	1	2
18 Klong Mae Raka	**1.9**	15		1.3	1.7	0.7	1.1	-	0.7	0.0	2.2	1	2
19 Klong Suan Mark	**1.8**	13		1.1	0.3	1.7	1.4	-	0.7	0.1	1.8	1	2
20 Lower Ping	**3.0**	23		3.0	0.3	1.1	2.2	-	2.0	0.6	2.3	2	2
Ping Basin				**0.9**	**0.7**	**1.4**	**1.5**	**-**	**1.7**	**0.6**	**1.6**	**-**	

Figure 33. Socio-Economic Issues Weighted Indicator Scoring for Ping Sub-Basins

	3. Overall Social & Economic Issues			3.1. Poverty		3.2. Competition		3.3. Minorities & Urban		3.4. Health
				3.1.1.	3.1.2.	3.2.1	3.2.2	3.3.1	3.3.2	3.3.1.
				Low Income Score	Econ & Social Weakness Score	Land Use Restriction Score	Agricultural Conflict Score	Upland Ethnicity Score	Population Density Score	Health Problem Score
Sub-Basin	Score	weighted total	source:	Panya data	CMU data	Panya/onep	Panya/onep	ONEP, Panya	Panya	Needs data
Upper Sub-Basins				*1.9*	*-*	*2.8*	*2.3*	*0.8*	*0.3*	*-*
			weight:	*2.0*	*1.0*	*2.0*	*2.0*	*2.0*	*1.0*	*1.0*
1 Ping part 1	**2.7**	19		3.0	1	2.6	2.2	0.8	0.3	-
2 Mae Ngad	**1.9**	13		1.4	1	2.8	1.4	0.3	0.4	-
3 Mae Taeng	**2.7**	19		2.3	1	3.0	2.8	0.7	0.3	-
7 Mae Khan	**2.0**	14		1.4	2	2.3	1.5	0.5	0.4	-
9 Mae Klang	**2.6**	18		1.6	2	2.8	2.6	0.8	0.5	-
11 Mae Chaem upper	**0.0**			*	2	*	*	*	*	-
12 Mae Chaem lower	**2.8**	20		1.4	2	2.9	3.0	1.5	0.2	-
14 Mae Teun	**3.0**	21		2.2	2	2.9	3.0	1.3	0.1	-
Middle Sub-Basins				*0.5*	*-*	*1.8*	*0.7*	*0.2*	*0.8*	*-*
			weight:	*2.0*	*1.0*	*1.0*	*1.0*	*1.0*	*2.0*	*1.0*
4 Ping part 2	**2.1**	8		0.0	1	1.0	0.4	0.0	3.0	-
5 Mae Rim	**2.5**	10		1.4	1	2.3	1.4	0.0	1.2	-
6 Mae Kuang	**1.6**	7		1.0	1	1.6	0.4	0.0	0.8	-
8 Mae Lee	**1.9**	8		0.9	2	1.6	0.8	0.5	0.5	-
10 Ping part 3	**3.0**	12		1.7	2	2.3	1.1	3.0	0.0	-
13 Mae Had	**2.6**	11		1.8	2	2.0	1.6	0.1	0.6	-
Lower Sub-Basins				*1.5*	*-*	*1.6*	*1.0*	*0.1*	*0.5*	*-*
			weight:	*2.0*	*1.0*	*1.0*	*1.0*	*1.0*	*2.0*	*1.0*
15 Ping part 4	**2.2**	9		2.1	1	1.7	0.9	0.1	0.4	-
16 Huay Mae Thor	**2.0**	8		0.8	2	2.2	1.5	0.2	0.2	-
17 Klong Wang Chao	**3.0**	12		2.4	1	2.6	2.2	0.9	0.2	-
18 Klong Mae Raka	**2.5**	10		2.7	2	1.2	1.0	0.0	0.2	-
19 Klong Suan Mark	**2.2**	9		1.5	1	2.5	1.6	0.1	0.4	-
20 Lower Ping	**1.8**	7		1.1	1	1.0	0.8	0.1	0.9	-
Ping Basin				**1.1**	**-**	**2.2**	**1.2**	**0.3**	**0.5**	**-**

Figure 34. Local Organization Weighted Indicator Scoring for Ping Sub-Basins

Sub-Basin	4. Overall Local Org Capacity & Complexity Score	weighted total	source:	4.1. Capacity 4.1.1. Loc Govt Capacity Score	4.1.2. Network Experience Score	4.2. Compexity 4.2.1. Admin Simplicity Score
			source:	onep, DOLA	Need data	Panya, ONEP
Upper Sub-Basins				***1.1***	-	***2.6***
			weight:	*1.0*	*3.0*	*1.0*
1 Ping part 1	**2.4**	4		1.6	-	2.5
2 Mae Ngad	**2.1**	4		0.8	-	2.8
3 Mae Taeng	**2.0**	3		0.9	-	2.4
7 Mae Khan	**2.4**	4		1.7	-	2.2
9 Mae Klang	**3.0**	5		2.0	-	3.0
11 Mae Chaem upper	*	*		*	-	2.9
12 Mae Chaem lower	**2.2**	4		1.0	-	2.6
14 Mae Teun	**2.0**	3		0.7	-	2.7
Middle Sub-Basins				***1.6***	-	***1.8***
			weight:	*2.0*	*3.0*	*1.0*
4 Ping part 2	**3.0**	6		3.0	-	0.0
5 Mae Rim	**2.2**	4		0.9	-	2.7
6 Mae Kuang	**2.4**	5		2.1	-	0.6
8 Mae Lee	**2.4**	5		1.1	-	2.5
10 Ping part 3	**2.0**	4		0.9	-	2.2
13 Mae Had	**2.4**	5		0.9	-	3.0
Lower Sub-Basins				***1.4***	-	***2.4***
			weight:	*2.0*	*3.0*	*1.0*
15 Ping part 4	**2.4**	4		1.3	-	1.8
16 Huay Mae Thor	**2.5**	5		0.8	-	3.0
17 Klong Wang Chao	**2.6**	5		0.9	-	2.9
18 Klong Mae Raka	**2.3**	4		0.8	-	2.7
19 Klong Suan Mark	**3.0**	5		1.4	-	2.8
20 Lower Ping	**2.7**	5		1.8	-	1.2
Ping Basin				**1.3**	**-**	**2.1**