Local Land Use Planning with PGIS in Protected Areas of Thailand

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Abstract

This article aims to identify the present task and future direction of Participatory GIS (PGIS) in Thailand's protected areas through an examination of the development of government conservation policy and the co-management approach as well as the progress made in PGIS principles and application in Thailand. The time line for the identification of protected areas in Thailand indicates that overlapping and unclear boundaries in protected areas are among the reasons for the inefficient environmental management of the local people's livelihoods. As the participation of local people in development projects can assist in sustainability, PGIS has played a significant role in local land use planning. The PGIS evolution in Thailand has progressed in three steps since the 1980s with advances in ICT, and in the last 15 years, the reduced cost of the PGIS has enabled the local people to more easily apply and operate the program. This trend has emphasized the importance of capacity building by local people in successfully adapting land use planning to the changing environment. Recent climatic and demographic changes as well as the introduction of the "Local title deeds" policy mark the future axis of PGIS applications as these are expected to shift the local land use planning focus.

Keywords: Land use planning, GIS, participatory approach, protected area, Thailand

I. Introduction

Dudley (2008) defined a "protected area" as an area of land and/or sea dedicated to the protection and maintenance of biological diversity and associated cultural resources, which is managed by legal or other effective means. These protected areas are the cornerstones of the global community's environmental conservation. There are many types of protected areas each of which has varying objectives and designations in different countries, such as national parks, nature reserves, and national reserves. In 2003, the International Union for the Conservation of Nature (IUCN) classified these protected areas into six categories: 1) Strict Nature Reserve/Wilderness Areas, 2) National Parks, 3) Natural Monuments, 4) Habitat/Species Management Areas, 5) Protected Landscape/Seascapes, and 6) Managed Resource Protected Areas (Scherl *et al.* 2004). As global concerns for biodiversity have increased, additional areas have been identified for protection (Thomas *et al.* 2002).

In Thailand, although the primary objective in protected areas is the conservation of biological diversity and critical habitats in the forest, forest areas had been significantly reduced before the establishment of protected areas. There are many

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driving forces that can threaten a nation's biodiversity and natural resources, such as national development policies, economic development, and population growth. Such threats can include the granting of forest logging concessions, cash crop agricultural expansion, population settlement expansion, the tourism industry, and illegal logging and hunting. The declaration of a protected area, therefore, is one of several measures designed to conserve areas rich in biodiversity and natural resources. Hence, these areas are the main focus for government natural conservation policies.

Conservation areas have been established in Thailand as Protected Area Estates, which comprise National Parks, Wildlife Sanctuaries, Non-hunting Areas, Botanical Gardens, Arboreta, and Forest Parks (Table 1). From Table 1, it can be seen that Thailand has placed more than 20% of its land area under some form of protection, which is among the highest rates in the world (ICEM 2003). The number of protected areas in Thailand is expected to further increase in the near future with 40 sites of 18,540.493 km^2, or 3.51% of national land currently under consideration.

However, from an effectiveness viewpoint, Thailand still has several problems, such as conserved forest area encroachment and the illegal hunting of wild animals, all of which have led to conflicts between park authorities and the local community. For example, Table 2 shows the number of cases that occurred in a national park area from 2005 to 2008. This information shows that government conservation policy implementation has been inefficient in protecting national conservation resources. This is especially noticeable in encroachment, with the management situation having been unchanged for many years. According to an NGO investigation, conservation forest encroachments in this area have occurred for several reasons such as the abandonment of farmland, shifting cultivation and illegal logging with the support of external investors (Hemwan 2013). To cope with this situation, park authorities, unfortunately, have had limited power to prohibit and arrest offenders. The investigation also revealed that information on land use boundaries within park territories was unclear to

Table 1 Number and area of Thailand's Protected Area Estates by type (2013)

Type of Protected Area	Number of Reserves	% in total national land area	Area (square km)
National Park	127	12.12	62,170.86
Wildlife Sanctuary	58	7.19	36,929.36
Non-hunting Area	67	1.04	5,379.02
Forest Park	119	0.28	1,455.81
Botanical Garden	15	0.01	58.96
Arboretum	54	0.01	36.08
Total	440	20.66	106,030.09

Source: National Parks Division, DNWP, 2013.

Table 2 Cases in Doi Phu Kha National Park (2005–08)

Years	Total Cases	Issues		
		Encroachment	Illegal Logging	Illegal Hunting
2005	41	15	8	18
2006	51	30	5	16
2007	30	17	1	12
2008	34	34	—	—

Note: Doi Phu Kha National Park was established in 1999.
Source: Doi Phu Kha National Park.

the local communities, an issue that also appears to be one of the basic reasons for conflicts between local communities and park authorities.

The protected areas under the national conservation laws have often been declared by the government without consideration of the local people, and have therefore often included local communities in the forest whose livelihoods were directly affected by such conservation policies. This has resulted in the persistent neglect of the local residents in national parks and forest reserves (Pimbert *et al.* 1995). As shown in the above case of the highlands in northern Thailand, there is a contradiction situation between the central government's conservation policies and the sustainability of the local people's livelihoods. While the main focus of conservation policy is usually set on the protection and restoration of forest cover, the local people, who are often indigenous to the area and practice traditional farming, are now being pushed to modify their source of living.

These protected areas are under a unilateral management by the government, which has the right to prohibit occupation and arrest offenders. Therefore, these protection rules are applied with the assistance of law enforcement to resolve conflicts between local communities and forestry agencies. However, it has become apparent that some other mediation or conflict resolution methods are needed to overcome this dichotomy between forest protection and the agricultural systems of the local people. This situation, then, demands an examination of the local land use planning framework in protected areas under the government's current conservation policies.

II. Development of Conservation Policies and Protected Areas in Thailand

Government policies of protected area seek to conserve natural resources and biodiversity with a spatial aspect. At present, Thailand's protected areas are classified into 8 types, as listed in Table 3: 1) Marine Sanctuaries, 2) National Parks, Botanical Gardens and Arboretums, 3) National Reserved Forest Areas, 4) Watershed Class Areas, 5) Wildlife Sanctuaries and Non-hunting Areas, 6) Forest Park Areas,

Table 3 Legislation of protected areas in Thailand

Name of Protected Area	Year	Authority	Managing Organizations
—	1941	The Forest Act, B.E. 2484	Royal Forest Department (RFD)
Marine Sanctuaries Area	1947	The Fisheries Act, B.E. 2490	Department of Fisheries
National Park, Botanical Garden, Arboretum	1961	The National Park Act, B.E. 2504	Department of National Park, Wildlife and Plant Conservation (DNWP)
National Reserved Forest Area	1964	The National Reserved Forest Act, B.E. 2507	Royal Forest Department (RFD)
Watershed Class Area	1982	The Cabinet Resolution, B.E. 2525	Office of Natural Resources and Environmental Policy and Planning
Wildlife Sanctuaries Area, Non-hunting Area	1992	The Wildlife Protection and Reservation Act, B.E. 2535	Department of National Park, Wildlife and Plant Conservation (DNWP)
Forest Park Area	1992	The Forest Park Act, B.E. 2535	Department of National Park, Wildlife and Plant Conservation (DNWP)
Natural Environment Protected Area	1992	The Environmental Enhancement and Promotion Act, B.E. 2535	Office of Natural Resources and Environmental Policy and Planning
Herbal Protected Area	1999	The Thai Traditional Medical Wisdom Protection and Promotion Act, B.E. 2542	Department of Thai Traditional and Complementary Medicine

Source: Biological Diversity Division, 2014.

7) Natural Environment Protected Areas, and 8) Herbal Protected Areas (Biological Diversity Division 2014). Since October 2002, Thailand's protected area system has been mainly managed and supervised by two organizations: the Royal Forest Department (RFD) and the Department of National Park, Wildlife and Plant Conservation (DNWP), both of which handle forestation, forest production and preservation. This means that there is at least a dual protected area system in Thailand, even though both departments belong to the Ministry of Natural Resources and Environment (MONRE).

Table 4 shows the timeline for government involvement in the protected area. In the early period of enactment, the government focused on the management of forest concessions for logging and wildlife products. For that purpose, the Royal Forest Department and the Forest Protection and Reservation Act, B.E. 2481 were legislated in 1893 and 1938, respectively. In this legislation, the forest areas were loosely defined with wording that indicated that it covered the land that was not already covered by other land laws. Therefore, the forest areas came to include not only the forests, but also every piece of land that was not yet legally occupied. It covered the country widely in areas and sometimes even overlapped with the agricultural lands of the local people, as many areas had been declared only by the early period's legal definition when the basic national map had been incomplete, and also indicated that the forest areas often had unclear spatial boundaries.

Later, the government regulations had a more focused conservation-oriented direction such as in the National Parks Act, B.E. 2504 (1961), the National Reserved Forest Act, B.E. 2507 (1964) and the Wildlife Protection and Reservation Act, B.E. 2535 (1992). These were the main laws for the prevention of encroachment into protected areas and for biodiversity and ecosystem conservation (Hemwan 2005). This conservation-oriented legislative policy commenced with the establishment of the Khao Yai National Park in 1962, which was the first international standard protected area in Thailand. The number of protected areas then increased rapidly in the 1980s, by which time the nation's forests had already become substantially degraded and fragmented, primarily due to

Table 4 History of government involvement in protected areas

Year	Legislation	Notes
1896	Establishment of the Royal Forest Department	Mainly focusing on the forest management for forest concession of logging and wildlife products.[1]
1938	The Forest Protection and Reservation Act, B.E. 2481	Defining the forest area as public property including desolate and fallow land.[1]
1941	The Forest Act, B.E. 2484	Further definition of the forest area as every piece of land that is not covered by other land laws.[1]
1961	The National Park Act, B.E. 2504	First concrete legal conservation of national resource and biodiversity by designating protected area as national park.[1]
1964	New legislation of the National Reserved Forest Act, B.E. 2507 (replacement for the Forest Protection and Reservation Act, B.E. 2481)	Further definition of the forest area including the land in the mountains, rivers, water bodies, lakes, islands and seashores, which nobody occupies legally.
1982	Watershed Class by the Cabinet Resolution, B.E. 2525	Classifying watershed area into 5 classes according to physical capacity of hydrology and natural resources for sustainable management.
1992	The Wildlife Protection and Reservation Act, B.E. 2535	Affected by international pact (CITES). Designating to Wildlife Sanctuaries and Non-hunting Area.

Source: [1]Kaosa-ard *et al.*, 2012.

logging, agricultural and/or settlement expansion (ICEM ibid.), and also some areas overlapped with other protected areas.

In particular, the National Reserved Forest Areas, which cover 230,280.64 km^2 (43.6% of national land area) over 1,221 sites, usually overlap other protected areas. These areas were identified in the National Reserved Forest Act, B.E. 2507 (1964), which was an improvement of the Forest Protection and Reservation Act, B.E. 2481 (1938). Figure 1 gives an example of the overlap of the National Reserved Forest Area and the National Park Area in Nan Province, where the aforementioned case in Table 2 is located. In addition, in this area, there are also overlaps in the National Reserved Forest and Watershed Class Area, which were declared under Cabinet Resolution, B.E. 2525 (1982).

Doi Phu Kha National Park in Nan Province is the fourth largest national park in Thailand with 98 local communities within or on the park boundaries, most of whom had settled in this area long before the establishment of the national park in 1999 and had practiced conventional agriculture for their livelihood. However, after the central government extended its control over this remote area, these traditional cultivation practices were regarded as illegal and were restricted by the national park laws. The national park boundaries were declared without any local community participation, and the park authority operations at the beginning also lacked any local participation. This situation occurred because the main focus of the government

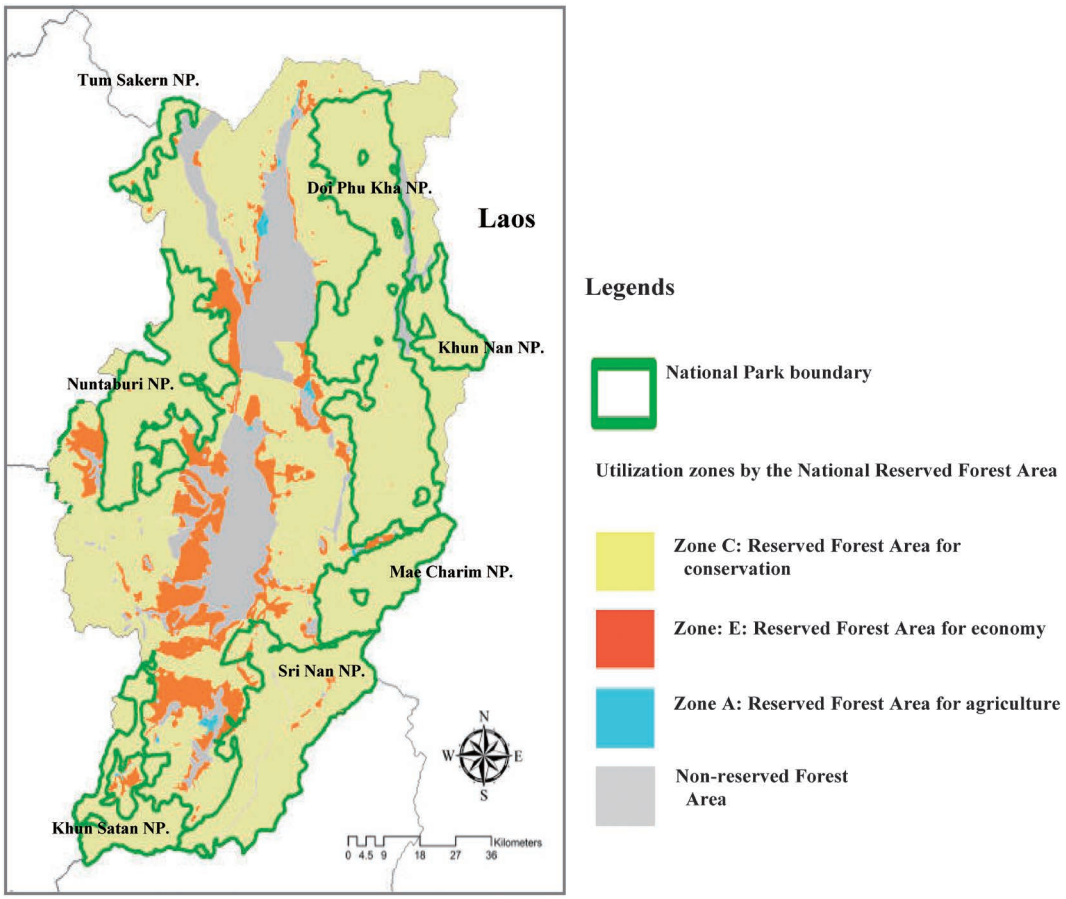


Figure 1 Overlap of National Park Areas and National Reserved Forest Areas in Nan Province

policy was on the protection and restoration of the forest cover and the authorities did not have enough information on land use patterns or the local communities' territories. Accordingly, the local people's livelihoods were in a contradictory situation between the two policies of natural forest conservation and economic development, which could be primarily ascribed to overlaps between the designated forest areas and the agricultural land.

There have been many similar cases in the protected areas of Thailand, especially in the remote northern region highlands. Since the 1990s, the government has attempted to solve such problems in some areas through cabinet resolutions; for example, in 1993 (B.E. 2536), 1997 (B.E. 2540), 1998 (B.E. 2541), 1999 (B.E. 2542), and 2001 (B.E. 2544) (Kaosa-ard *et al.* 2012). However, these measures have had limitations as the implementations of cabinet resolutions were less reliable and lacked continuity because of the uncertain periods of the administrative cabinet. Many problems have remained unsolved under a rapidly changing situation, which has made the conservation policy in protected areas more difficult to implement on site and more complicated because of such influences as the high population growth rates of hill tribe communities, the introduction of commercial agriculture, improvements in convenient infrastructure, and lower levels of health and household income. Therefore, critical social problems relating to land use conflicts have arisen not only among neighboring communities, but also with lowland farmers and forestry agencies. More recently, natural environmental changes and climate change, which are concerns on a global scale, have also had a substantial impact on local communities. For instance, increases in average annual rainfalls and heavier rainfall in a shorter period have resulted in a greater number of landslides, severely influencing the livelihood stability in local communities.

The above discussion suggests that Thailand has so many types of forest conservation areas that have failed to be adjusted as situations changed and have been implemented without any coordination between the authorities and the local communities. It also indicates that Thailand has not had adequate guidelines for the efficient management of protected areas. Therefore, it seems more practical to seek to solve these land use problems by improving the operational management guidelines on site rather than through a consolidation of the associated laws. More appropriate guidelines need to be proposed using a multi-disciplinary approach, so as to fully understand and analyze the complicated situation of the local communities and identify the appropriate constraints to ensure sustainable development. At the same time, solution processes should be designed with a co-management approach in which all stakeholders in the protected areas share the management responsibilities and outcomes.

III. Co-management Approach in Thailand

As mentioned in the above section, to solve the problems in the protected areas, proper management is required that includes all stakeholders such as the local government, local organizations, and the local communities. Several previous studies have suggested that the proper co-management of protected areas can alleviate deforestation and assist in constructing sustainable relationships between human beings and the forest ecosystems; that is, the optimal formula for successful forest conservation is joint control and/or management by the government and the local people (Isage *et al.* 2001). However, creating a common understanding of the concepts and sharing a common way of thinking and acting in the communities may be quite complicated. In this respect, the operational processes embodied in Participatory Learning and Action or Participatory Research Methods (PRM)

could be helpful to ensure that participation is at the center of the co-management of protected areas.

Tan-kim-yong *et al.* (1994) defined participatory land-use planning as a process that involved local people in the management and development of the forest and land resources. In this context, land use planning means the systematic assessment of land and water potential, and also reflects an alternative utilization of the land resources and socio-economic provisions so as to ensure the selection and adoption of the best land use option for the local people to be able to adapt to the environmental and socio-economic changes. Land use planning in a specific area should be developed by taking the balance between natural resource conservation and local livelihood into consideration. An effective and integrated livelihood perspective is indispensable to conservation and sustainable management as it allows for a deeper insight into the livelihood strategies of people in these vulnerable environments, and therefore can provide effective measures as to how the access to resources is organized. Accordingly, the sustainable livelihood analytical framework plays a crucial role (Mirijam *et al.* 2005). Sustainable livelihood can be analyzed from two aspects: environmental sustainability, which focuses on the external impact on natural resources and the basis of the communities' livelihoods; and social sustainability which focuses on the internal capacity to withstand outside pressure (Chambers and Conway 1991).

Tan-kim-yong (1992) also illustrated a sustainable development framework, within which ecosystem sustainability could be achieved by a planned and managed participatory approach to the balance between the production system or livelihood principles and natural resource conservation, as shown in Figure 2 (JoMPA 2009). In practice, understanding the local people's livelihood needs and future development should be considered in the first operational process stage. If the local people who live close to or in the natural resource areas are able to determine alternative and sustainable livelihood options, they can then change their natural resource utilization patterns from being consumption-oriented to being conservation-oriented. Therefore, local land use planning needs to include a framework for dialog to encourage local communities to develop stable and continuing livelihoods based on more efficient and conservation-oriented land use management. Communities that have adapted themselves to efficient land use management have been shown to be able to support their livelihoods sustainably. However, the question remains as to how to encourage communities to develop more efficient land use plans for a stable livelihood based on cultivation (Hemwan 2014a).

Environmental and natural resource management problems have extended beyond the capacity of any single discipline. To solve complex situations which involve many stakeholders, appropriate guidelines are required, which integrate knowledge through a multi-disciplinary approach. This approach is especially important in the remote highland areas that cover a variety of protected areas with distinctive features, so it is important to employ both local knowledge and advanced technical support to understand the specifics of the area and identify the pertinent issues, which would lead to the efficient management of the environment and/or sustainable development of resources.

In many cases, sustainable development encompasses basic spatial planning dimensions, decision-making and management. If spatial aspects are neglected in the analysis, it is almost impossible to gain a full understanding of the situation or identify all possible problems. The relationship between man and environment cannot be understood without reference to the characteristics of location because the environment is represented by spatial relationships between physical objects and human activities, both of which have certain

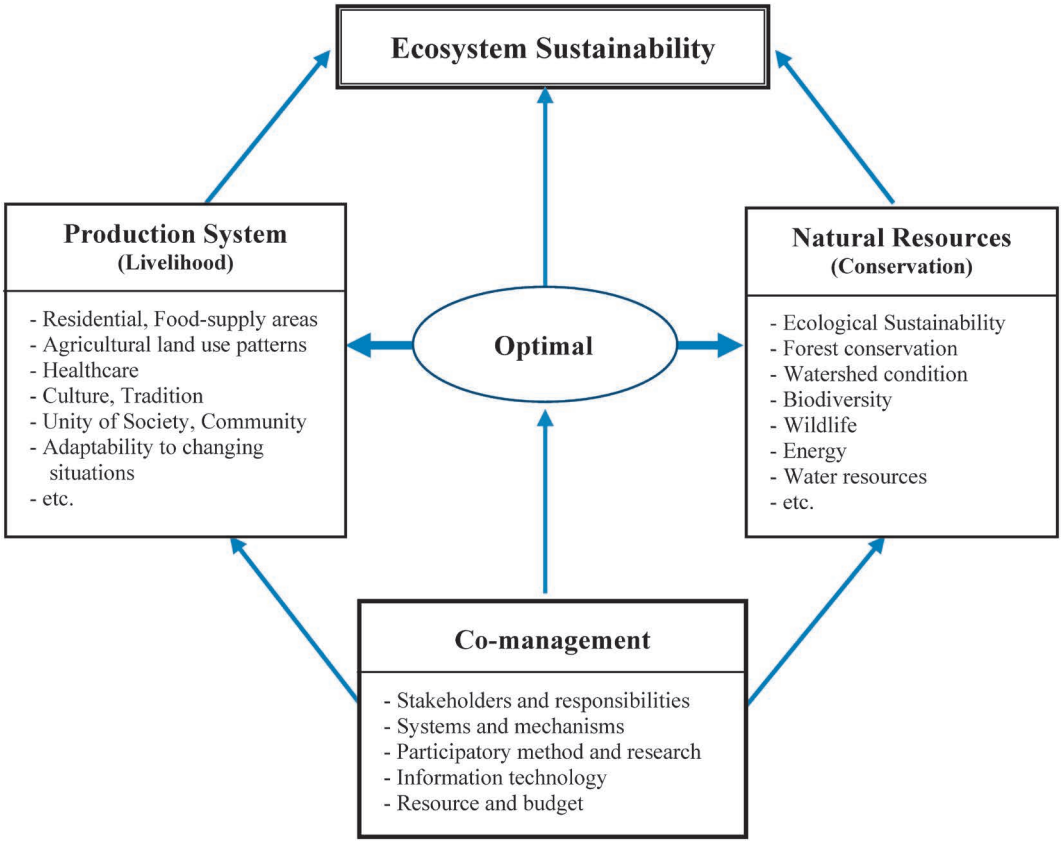


Figure 2 Sustainable development framework
Note: The arrows indicate the attention directions.

impacts on the environment in a spatial dimension (Campagna 2006). Therefore, a spatial solution scope should be included in the operations to identify the problems in a specific area.

IV. Geographic Context for the Significance of Participatory GIS

Geography is a spatial science that deals with the analysis and management of a spatial solution. Geographical analysis generally has three main components: dimensions of place, space and scale; a synthesis framework for the dynamic relationships between environmental-social and human-social interactions; and spatial displays to express the images and perceptions in written, mathematical or digital forms through mapping, remote sensing and GIS (Pongprayoon 2006; Tungprasert *et al*. 2002).

In the classic Greek and the Roman periods, geography emphasized place and its relationship to other known places at that time, and was a description which answered the where, why and how questions about a certain place. “Place” has been a significant concept (Pongprayoon 2003) and still important today for the explanation of phenomena and location as part of the present geographic concept of space and its assistance in allowing people to observe their surroundings and make comparisons of their familiar place with others at a distance. This dimension is closely related to individual experience or attention, which varies from person to person. Place is recognized by the individual as a location with social relations reflecting

economic and societal structures, and this recognition generates a sense of place that represents the relationship of the people to that place. A human life binds into a place as their residence or original habitat with a sense of affection for the locality (Hemwan 2014a).

This geographic viewpoint commands a consideration of both the physical and cultural aspects of a place, which are affected by different features of the earth's surface. Therefore, geographers emphasize the significance of understanding the relationships between man and the environment as well as the results or effects of their interactions within different places. Advances in science in the modern period further developed the principles and methodology for geographic concepts to create new landscape concepts (Figure 3). Landscapes were another geographic concept widely used to describe the differences and similarities of areas. The landscape concept led to an extension of a new branch of study, regional geography, which became popular with geographers in the early 20th century.

"Space" is a special word which has represented a new geographic concept since the late 1950s. The space concept developed from the concepts of place and landscape to emphasize the topological and geometric features of place. Accordingly, contemporary geographic analysis with dynamic scales now encompasses the three main concepts of place, landscape and space. While geographers are interested in any spatial aspect of phenomena, patterns or activities including environmental situations and human activities such as topographic conditions, climate, land use pattern, and population distribution, the concept of space enables a more precise basic analysis of the spatial dimensions in quantitative terms; for example, location, distance, size, scale, distribution, and their mutual relationships.

Another geographical viewpoint provides the framework for a synthesis of the dynamic relationships between human activities and the environment. In the applied field of geography, this often concerns

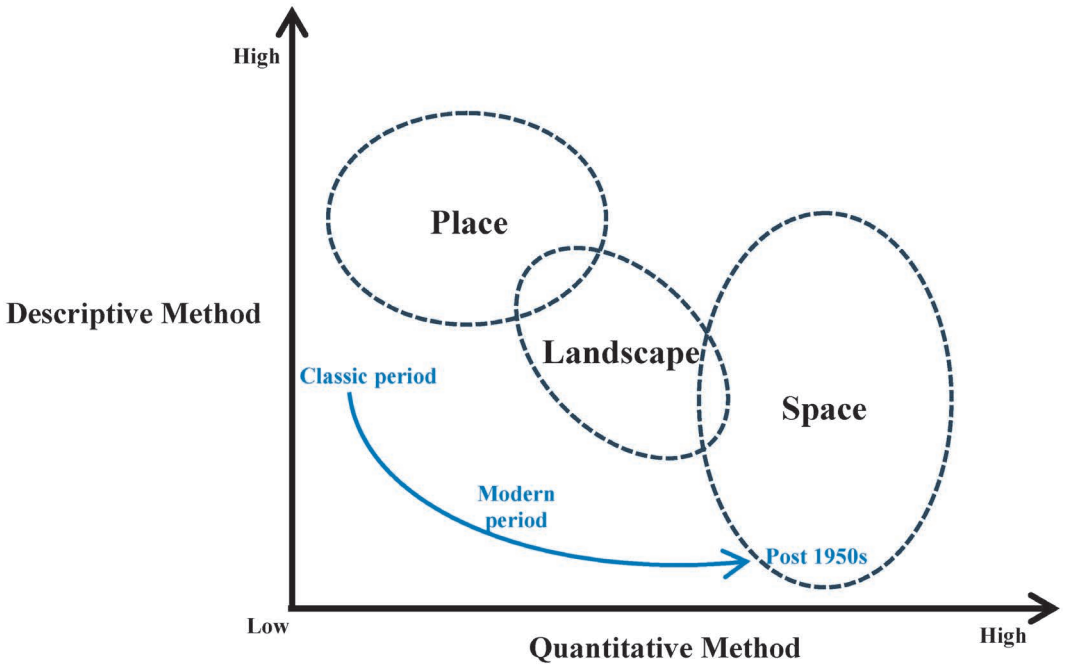


Figure 3 Methodological area for geographic concepts

solutions to socio-economic problems that have been caused by the complicated relationship between various factors and/or processes in an area. A deep comprehension of these relationships is required to identify problems in the spatial dimension so as to determine the correct solutions. However, this method usually relates to a personal realization or understanding often bound to a place and affected by a spatial perception. Therefore, a participatory approach is necessary to understand and explain the spatial perceptions of the local people, which can be represented using mental maps. A mental map is a type of spatial display that allows for a visualization of particular perceptions and understanding about a place through a mental arrangement of the desired spatial habitation image and the location knowledge. In other words, a mental map is a psychological mechanism through which people can apply their knowledge to behavior in a certain environment. From an outsider's view, a mental map reflects people's knowledge and behavior within an environment.

In this respect, spatial displays play an essential role in geographic analysis and synthesis. Because of the advances in information technology, geographic processes using the computer-based processing of digital patterns have rapidly developed and have contributed to more efficient data-management and image processing in more flexible formats and with fewer restrictions. Spatial tools have also improved because of progress in such technologies as digital mapping, remote sensing and GIS quantitative techniques. GIS has thus developed to become a geographic knowledge application with three core concepts: reliable analysis, spatial display and advanced spatial tools.

Participatory GIS (hereafter PGIS) is an integrated GIS process that encompasses a participatory approach and is a key tool for geo-information acquisition and analysis which can be used as an interactive communication or decision-making tool in collaborative public planning and management meetings. In this way, PGIS has contributed to a new participatory approach which encompasses different application aspects from conventional GIS implementation. For co-management approaches in the protected areas of Thailand, PGIS can be useful in identifying problems and developing strategies and solutions in partnership with the local communities and outside stakeholders.

V. PGIS Progress in Thailand

Sustainable development is based on planning, decision-making and management and is a comprehensive process that can focus on multi-dimensional problems aimed at achieving a balance between economic development, environmental protection, and social equity and welfare (Campagna *ibid.*). The utilization of geographic information to support sustainable development across spatial dimensions is a complex information system that requires certain tools to analyze the available data. The latest geospatial technology, therefore, offers more reliable tools for analysis, problem and solution identification, decision-making and other management operations. Through this process, the final goal of sustainable development can be achieved. As the growing number of development projects using PGIS in developing countries suggests, local people are fully capable of using Geospatial Information Management Tools (hereafter GIMTs) to record and display spatial information to manage their land and resources. Thailand is among such examples, although it still has issues with resource management project operations. Local people are able to "work on their maps," and use the GIMTs effectively to express their opinions in discussions on sustainable resource use (Hemwan 2015). The progress of PGIS applications to local land use planning in the protected areas of Thailand is presented here with some examples to discuss the role and performance of PGIS in the achievement of sus-

tainable development.

GIS was applied for the first time to support land use planning for better sustainable development in Thailand more than 30 years ago. It was introduced independently from PRM in the late 1980s and went through significant changes in the 1990s with the development of modern spatial information technologies such as GIS, low-cost GPS, remote sensing imagery and analysis software, the open access to data via the internet and the steadily decreasing cost of computer hardware (Hemwan 2014b). In the initial PGIS period in the 1980s, several development projects employed PGIS to manage precious natural resources and/or to conserve biodiversity. However, the PGIS implementation faced many obstacles due to its low quality and the high price of computer hardware, software, and peripheral devices. In addition, because of national security concerns, it was difficult to access the geo-spatial data from state agencies. Therefore, the PGIS operation was quite limited in Thailand at that time.

At the same time, the Sam Mun Highland Development Project (SM-HDP) in 1987–1994 had devised a process called "Participatory Land Use Planning (PLP)." This project was conducted in the highlands of Chiang Rai Province in northern Thailand in collaboration with Chiang Mai University and the Royal Forest Department. The main objective was to solve conflicts between the local villagers and forest officials so as to allow for the smooth development and management of natural resources in the highlands. The PLP process was characterized by three aspects: geographic techniques or the understanding of the physical situation through mapping and 3D modeling: operational processes, which comprised training, planning, and other participatory methods: and a social scientist's view, which encompassed with cultural-social knowledge and methodologies such as the behavior of groups and organizations, ethnic differences and conflict management (Tan-kim-yong *et al.* 1994). SM-HDP was the first project in Thailand that proposed guidelines for the application of PGIS and which developed the fundamental PGIS concepts for use in operational processes. Spatial tools such as topographic maps, 3D models and freehand land use maps were used to share or exchange spatial information in the local area to allow for collaborative management (Figure 4), which facilitated the negotiation stage for mediation between the villagers and the officials. This process emphasized the need to focus on a common understanding of the local situation by all stakeholders in the area. One of the most noticeable achievements of this project was the application of guidelines on a participatory process for the operations and introduction of assistance tools, which was consequently referenced by many other development projects.

In 1986–1994, CARE Thailand and ICRAF Chiang Mai were involved in a development project called "The Natural Resource Management Project" in Chiang Mai Province. The PLP concept was adapted and applied to the operational processes in this project, the main objective of which was an improvement in the local people's awareness of the impacts of the agricultural system on the soil and other natural resources in watershed management. An agroforestry concept was also integrated into the project as an alternative land use for resource management. PGIS supported this project as a tool for computer-based spatial data collection and communication. ICRAF Chiang Mai was responsible for the GIS processing that supported the project operations. The project received assistance from Chiang Mai University for the field survey of the local communities' land use system, which was coordinated as a part of the Queen Sirikit Forest Development Project under the Royal Forest Department in the local area (Thomas *et al.* 2003). This PGIS process was, at that time, called "Participatory Land Use Mapping" (Figure 5). This proj-

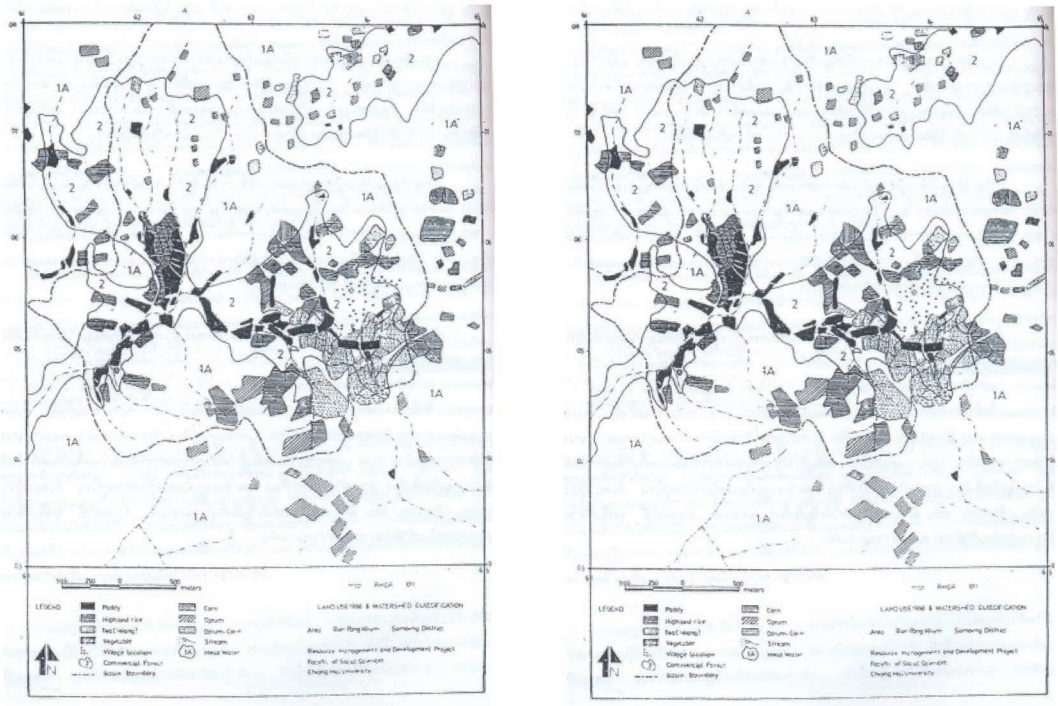


Figure 4 Freehand land use map of Pang Khom community
Source: Tan-kim-yong *et al.*, 1994. pp. 46–47.

ect was characterized by co-management collaboration between the various organizations and the local people, all of whom contributed to the collaboration through active participation. It was emphasized that appropriate resource management guidelines should be established in consideration of all stakeholders including the local government, non-government organizations, the local community and others (Tan-kim-yong 1992). This project contributed to the PGIS process in planning and co-management, and provided a good example for other development projects seeking to construct participative organizational schemes.

After the development of computer systems in the 1990s, the PGIS evolution in Thailand entered the second phase. It went through rapid changes with the development of advanced GIS, low-cost GPS, remote sensing and the associated analytical software. In particular, the decreasing price of computer hardware and software systems accelerated the efficiency improvements for the application of GIS, which allowed the PGIS to become increasingly more capable. However, PGIS had some operational limitations because the concept and the GIS techniques were still too difficult for the local people. As knowledge of geography and GIS processing skills were required to implement PGIS, it was usually operated by the development project staff in this period.

The Thai-German Development Program in 1990–1999 developed a process called "Community Base Land Use Planning and Local Watershed Management (CLM)," which was established in Mae Hong Son Province as a collaborative project between the Thai and German governments through the German Agency for Technical Cooperation. This project aimed to de-

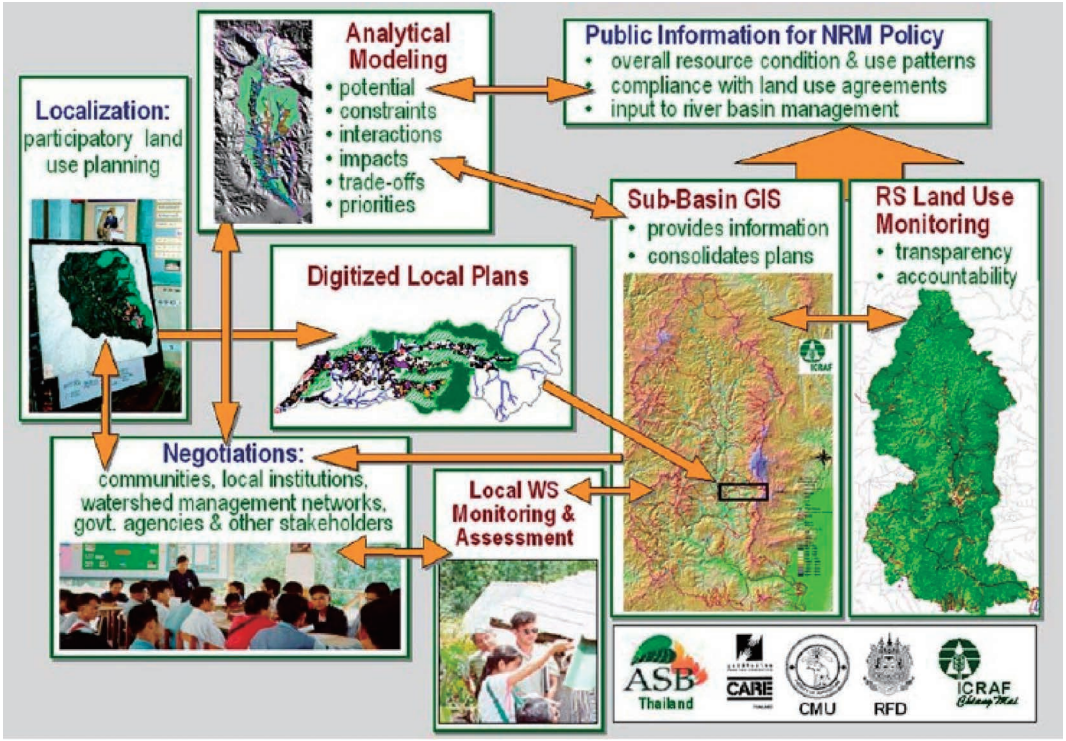


Figure 5 Support system for community agroforestry with PGIS
Source: Thomas *et al.*, 2003. p. 396.

velop co-management approach guidelines for the conservation of the highlands. CLM was a large-scale development project that employed PGIS for the hill tribe people's "land deal" process. The "land deal" in this project was an agreement between the local people and the authorities, and allowed land usufruct in exchange for the surrender of shifting cultivation method. The focus of this "land deal" was on the management of the shifting cultivation of the hill tribe people in a water source area within an autonomous administration scope. PGIS applications in this "land deal" process encompassed GIMTs such as 3D modeling, topographic maps, aerial photos, satellite imaging, and low-cost GPS and GIS, which were used to identify locations for the shifting cultivation areas, the permanent agricultural areas and the conservation forest areas. One of the most remarkable operations in this project was an enlargement of the work map to a scale of 1 : 8,000, or to the community level, as shown in Figure 6. This made it easier for the local people to participate in the PGIS process. Using the GIS as a computer-based cartographic system, it was easy to prepare maps of different scales, and this flexibility was clearly one of the main advantages of computer-based operations, which allowed for solutions to be found to the dislocation problems caused by the previous freehand mapping (Puginier 2002).

The development of Information Communication Technology (ICT) in general has led to significant PGIS progress of PGIS in the third period. Since the 2000s, spatial information from several sources has been distributed by open access through the internet. In addition, alternative GIS software has become available because of the development of freeware such as Quantum GIS, Map Window GIS, GRASS GIS, and Google Earth, all of

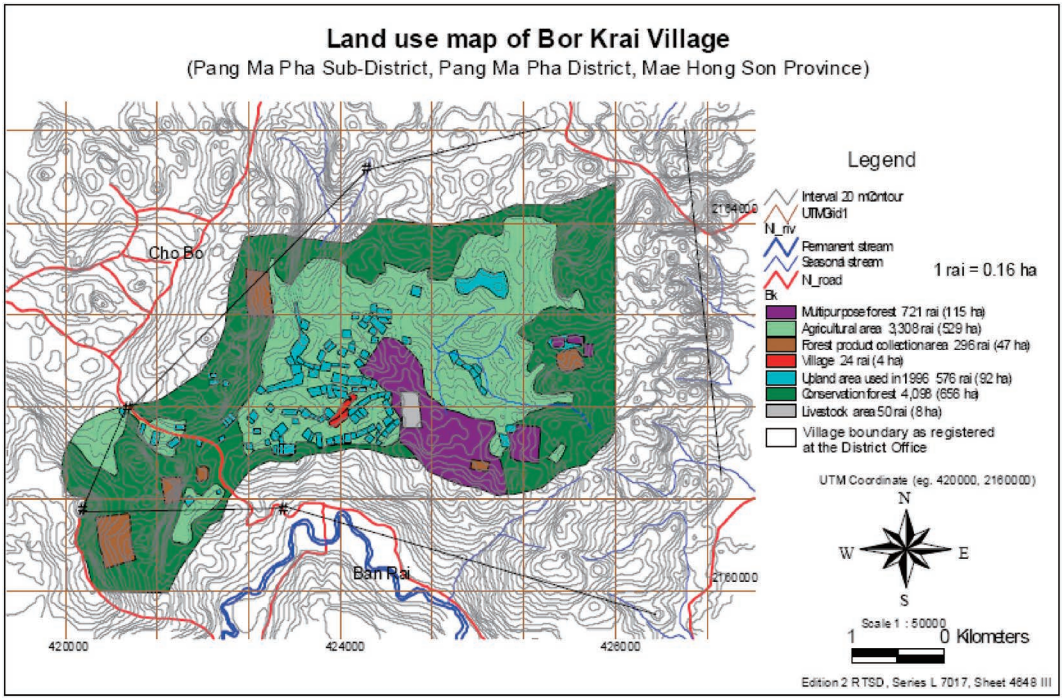
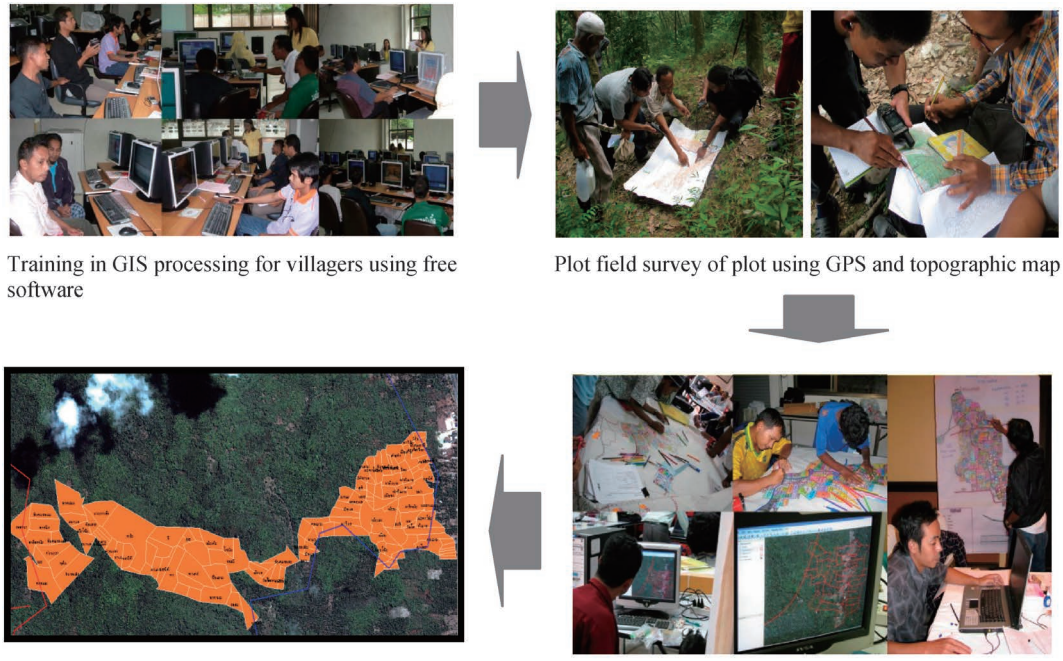


Figure 6 Land use map for Bor Krai village using GIS
Source: Puginier, 2002. p. 56.

which have similar capabilities to commercial GIS software. These developments have allowed for a continual reduction in the cost of computer systems, thereby positively affecting the PGIS process and making it more convenient for local people or organizations to adopt and apply GIS. The fall in computer hardware, software and data costs has been favorable for the implementation of PGIS by local people or organizations (Hemwan 2014b).

The project "GIS at Community Levels for Land Solutions" in Pudo Su-ngai Padi National Park, Narathiwat Province in 2007–2009 is described here as an example of a project in this third period. This project was implemented by the Thai government through the Committee for the Centre for Poverty Alleviation and Rural Development. The main objective was to determine a solution to the land conflicts between the local people in this protected area spread across three border provinces in southern Thailand, where national security problems can cause unstable social conditions. Because the park was established in 1999 and covered a great deal of the local people's agricultural land, it was essential to collect and confirm the local people's land information so as to be able to issue proper land titles. Therefore, this project employed the PGIS process to build a spatial land database in collaboration with the national park authority and the local people (Figure 7). The PGIS process was supported by the Community Organizations Development Institute. The collection, management and display of the geo-spatial data were enabled using GIMTs which were made up of a topographic map, low-cost GPS, and computer-based GIS with freeware. Training in GIS processing was held for all concerned people, which made the PGIS implementation easier as the villagers were able to handle the GIS using their own collected data. This project emphasized capacity building through the GIS processing and



Training in GIS processing for villagers using free software

Plot field survey of plot using GPS and topographic map

Plot information represented by GIS freeware in Som Poi village, Ba Cho District, Narathiwat Province

GIS processing for the creation of land information by villagers

Figure 7 Spatial solution process for demarcation in Pudo Su-ngai Padi National Park
Source: Community Organizations Development Institute, 2008.

the construction of a geo-spatial database by the villagers themselves.

This last case suggests that the nature and capacity of the local participants affected the efficiency of PGIS process in the third period. Since the late 1990s, many protected areas have been established in Thailand, which have directly affected the livelihood of many local people. However, even though the people in these areas all share the same sustainable development aim, actual situations vary from place to place, so the PGIS processes vary also. For example, in northern Thailand, most local stakeholders are from hill tribes and the PGIS process efficiency in their development projects is quite different from the deep-south provinces that have national security as a first priority. Although the advances in ICT may have similar effects for GIS, the application of PGIS to sustainable development projects still requires more elaborate and detailed guidelines based on each individual setting.

VI. Concluding Remarks

In this article, PGIS and its application in the protected areas of Thailand was discussed mainly from social and academic significance viewpoints. As with other applied sciences, PGIS was developed to be able to focus on changes in social needs on an academic basis. Consequently, a close examination of these needs can identify the present PGIS tasks and the future directions in Thailand. So far, rapid economic growth and environmental degradation have changed the social background of rural Thailand. At the same time, government policies have been affected by global nature conservation concerns. Under such circumstances, Thailand has sought a sustainable development path by applying PGIS to its operations.

On site, however, poor coordination between authorities and residents and even among government agencies has brought about confusion in the policies focused on protected areas. Therefore, issues have arisen because of the unclear local community boundaries of in the protected areas. Moreover, different types of protected areas often overlap, which has made the situation even more complicated. Such hasty, one-sided declarations of the establishment of protected areas have inevitably resulted in conflicts between authorities and local communities because of the evident contradiction between nature conservation and economic development, or, in other words, between the environment and livelihoods. Further, these conflicts can be found among neighboring communities and even between lowland and highland communities in a basin. From the government's viewpoint, these contradictions can also be regarded as a conflict of interest between nature conservation and the minorities' social integration. To cope with this multi-fold contradictory situation, the consolidation of laws or legislation seems to be the theoretically fundamental solution, although it is very complicated and time-consuming. More practical solutions can be reached through sustainable development with guidelines that are adapted to specific local conditions through co-management approaches, such as participatory local land use planning and the application of local rules. These can be conducted using a PGIS process with on site land use planning objectives.

Advances in geography and geographic methodologies have made PGIS a more convenient means for spatial solutions. The PGIS evolution, for which the concept is defined as an integration of GIS with a participatory approach, is attributable to advancements in geographic concepts. The traditional concept of "place" and its modern variant, "landscape," provide a synthetic viewpoint for the relationship between humans and their environment, further highlighting the relevance of geography as a development science. The concept of "space" after the reformation of geography in the 1950s emphasized the locational aspects of "place" for topological analysis and gave birth to GIS, which now serves as the technical basis for PGIS. At the same time, the traditional concept of "place" has also retained a cognitive connotation that can be represented by a so-called mental map in a spatial dimension. The advances in perceptive geographic studies of local people's knowledge and behavior have contributed greatly to the participatory approach in local land use planning. Since PGIS for sustainable development has evolved into a process of visualization or spatial display of local knowledge, its underlying direction is led by the progress in GIS.

The above review demonstrates the importance of the PGIS technological application impacts. The initial period in the late 1980s to the early 1990s was regarded as the adoption stage, in which PGIS was used as a component in operational guidelines. With the application of PGIS, PLP processes and participant coordination were introduced. However, at that time, GIS was only a state-of-the-art technology operated by experts, and the local people were merely the source of local spatial knowledge. The following period in the 1990s was characterized as PGIS diffusion, primarily because of the significant cost reductions in GIS thanks to ICT advancements. Although GIS in this period was still operated by experts, the local people became more familiar with the use of GIS outputs as a communication tool for spatial information. In the last period since the 2000s, PGIS processes have sometimes been adapted to local conditions through the local people's participation in collaboration with other stakeholders. This adaptation stage features the collection of spatial data and GIS operations by the local people themselves. This trend is being driven by further GIMT cost reductions in GIMTs and GIS freeware as well as by the open data policy of govern-

ment agencies.

Recently, another important movement has arisen from the needs of local sector. In 2010, the policy of "Local title deeds (*chanot chumchon*)" was announced as a Regulation of the Prime Minister's Office. The movement of "Local title deeds" originally started in Lamphun Province around 2000, and involved the issuing of title deeds for land acquired by people outside the village which had been left uncultivated for a few decades to reutilize them. Prior to this movement, in 1986, the land titling project started with the purpose of providing land security to the farmers, though some experts evaluated this project as a failure (Ganjanapan 1994). This project accelerated the commercialization and privatization of agricultural lands in the communities where the traditional communal management of lands had almost disappeared, with many farmers selling their land to land speculators. In these cases, certificates of "Local title deed" were prepared and issued by the local community groups. Although, these certificates are generally considered informal, some communities are permitted by local governments to cultivate the land using these certificates. These types of movements are slowly spreading all over Thailand, and include some communities in the National Reserved Forest Areas.

Local farmers working with the "Local title deeds" project first organize a management committee of about ten core members and some other normal members. Then, the committee formulates a regulation regarding the purchase and sale of land, the inheritance processes, land usage, and the duties of members. In addition, the committee prepares a title deed for each individual piece of land that shows the boundaries and areas of agricultural land on a satellite image. While this "Local title deeds" project is considered a form of participatory land management by the local communities, PGIS can be useful for this project as well because GIS knowledge is essential to prepare land use maps which show the agricultural land boundaries by land plot.

There is another significant aspect in the application of these "Local title deeds" to protected areas in the future. In Thailand, it is estimated that as the rural population decreases, the demand for agricultural lands is expected to also decline. If proper initiatives are not taken, much of the present farmlands may be abandoned. For sustainable land management in Thailand, these lands should be transferred into communal lands managed by the local communities in a participatory way. These communal lands could then be divided into either community forest lands or agricultural lands operating under "Local title deeds."

In conclusion, one of the most challenging tasks for PGIS at present lies in the promotion of the participation of local people in GIS operations to establish or improve their own local land use plans. For that purpose, the empowerment of local communities through GIS operation training should be emphasized as part of these operations. In addition, a shift in local land use planning focus will be required in the near future, to ensure that self-adaptation to environmental changes are considered. Natural environmental changes, such as climatic changes on the local scale, and demographic changes such as the depopulation in rural areas are expected to make more serious impacts on local communities. Communities that have successfully adapted to commercialization are urged to monitor and readjust their land use plans by themselves.

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(T) means "in Thai"
(TE) means "in Thai with English abstract."

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