PLATFORMS AND TERRACES

Bridging participation and GIS
in joint-learning for watershed management
with the Ifugaos of the Philippines

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Bridging participation and GIS in joint-learning for watershed management with the Ifugaos of the Philippines

Rhodora M. Gonzalez

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Platforms and Terraces: Bridging participation and GIS in joint-learning for watershed management with the Ifugaos of the Philippines

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Cover: Batad rice terraces
Banaue, Ifugao, Philippines
(Photographed by Tet & Nap Manuel)

To the Ifugaos,
whose age-old rice terraces
demonstrate to the world that simple,
but joint, concerted action creates a beautiful
and complex harmony of life in a fragile environment.

Frequently-used local terms:

baddang	- workgroup for constructing and maintaining terrace walls and canals
barangay	- the smallest political-administrative unit in the Philippines
lupun	- council of elders
mumbaki	- priest / medicine man
mun-unod	- person in charge of monitoring terrace/irrigation canal conditions
payoh	- terraced field
sitio	- a neighborhood, several of which make up a *barangay*
tomoná	- agricultural leader
ubbu	- workgroup for planting and harvesting
uma	- swidden farm

Frequently-used abbreviations:

BSWM	- Bureau of Soil and Water Management
CAR	- Cordillera Administrative Region
CB-CO	- community-based community organizer
CB-NRM	- community-based natural resource management
CECAP	- Central Cordillera Agricultural Programme
CSDM	- collaborative spatial decision making
DBMS	- database management system
DEM	- digital elevation model
DENR	- Department of Environment and Natural Resources
DFD	- data-flow diagram
E-R	- entity-relationship (diagram)
GIS	- geographic information systems
GPS	- global positioning system
ILWIS®	- Integrated Land and Water Information System (GIS software)
INDISCO	- Inter-regional Programme to Support Self-reliance of Indigenous and Tribal Communities through Cooperatives and Other Self-Help Organizations (an International Labour Organization programme)
ITC	- Ifugao Terraces Commission
LMU	- land mapping unit
LUT	- land use type
LUR	- land use requirements
NGO	- non-government organization
NCGIA	- National Center for Geographic Information and Analysis (in USA)
NIA	- National Irrigation Administration
NRM	- natural resource management
NSO	- National Statistics Office
PDI	- Philippine Daily Inquirer
PLA	- participatory learning and action
PPDO	- Provincial Planning and Development Office
PHC	- Philippine Historical Commission
PRRM	- Philippine Rural Reconstruction Movement
SALT	- sloping agricultural land technology
SPOT	- Système Probatoire d'Observation de la Terre (French satellite)

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Preface

"Go to the people with your GIS, and see what happens." That was the first advice I got from Prof. Röling when he saw my proposal. I had wanted to do research on indigenous knowledge in natural resource management (NRM), and I proposed to formalize it into a geographic information system (GIS) for development planners. I realized the contradiction and naiveté. Since then, this research has evolved into a bold exploration about participatory use and development of a GIS in joint-learning about the environment. I went to Ifugao to do it with the 'people of the earth.'

The problems currently facing the Ifugaos' more than 2,000 year-old terraced agriculture in the Northern Philippine uplands provided an awesome exemplar in understanding the interlocking relation between people and space. I devoted much attention to tracing their traditional resource management practices and institutions, because they succeeded in bringing about and maintaining this extraordinary structure for such a long time. Then, both researcher and researched could learn from past success, and thence, deliberate together over present and future possibilities. However, the present multi-actor situation and the rate at which Ifugao's environment is degenerating require facilitation for convergence of the knowledge processes involved in debating perceived desirable futures. I explored GIS' capabilities and speed in integrating data from disparate sources, and in providing a consistent framework for analyzing and making visible complex spatial relationships.

Platforms and Terraces brings light to what transpired after I tinkered with the computer in the very remote rural setting of Ifugao. Most previous efforts at using GIS with communities have relegated local participation to 'providing information' and way-finding. I concentrated on interactively developing a spatial database with the Ifugaos. My exploration hit upon the workability and merit of involving poor resource managers when using GIS in understanding their environment. Through 'spatial dialogue,' Ifugao farmers participated in interpreting aerial-photographs and satellite images, in mapping their situations and aspirations into meaningful diagrams, and in tracing together their successful past. I discerned remnants of a spatial information system, embedded in their traditional agricultural practices, that helped in timely monitoring of local conditions and collectively deciding for action in resource management. It illuminated the design of a prototype GIS that facilitates learning about their problematic situation, and articulation of local perspectives in their present multi-actor watershed management.

This research was able to demonstrate that limitations in computer know-how are not a deterrent to engage in GIS-assisted joint learning for channeling efforts towards new platforms to debate about environmental futures. Local participation is precisely the key in systematically taking stock of the resource base, monitoring and understanding local conditions by sharing perspectives, and debating collective action for sustainable NRM. *Platforms and Terraces* is about cultivating such human activity systems that in turn nurture the land. It is about using participatory methods with modern geo-information technology to serve in rural development. Systems developers may find it useful in striving for a more humane GIS through participatory design. It also opens a new window for participatory development professionals, and offers a reason to look at so-called 'top-down' technology with less skepticism.

This book was created by stimulating collaborative effort among many institutions and individuals. I wish to express my sincere appreciation, first of all, to the International Institute for Aerospace Survey and Earth Sciences (ITC) in Enschede, The Netherlands for funding this research. ITC's joint M.Sc. and Ph.D. programs with Wageningen University honed my base at the cutting edge of technology. I have been most privileged to get invaluable support from remarkable individuals in both institutions. My profound respect and gratitude go to my tandem of promotores— Prof. Niels G. Röling and Prof. Klaas Jan Beek are wellsprings of keen understanding, infectious enthusiasm, and extreme patience. Co-promotor Dr. Michael K. McCall provided support. They all pored over every draft for the much needed incisive critiques. Those pages became an arena for our ideas, but I reserved my liberty and responsibility for what sees print. I thank them for such a rare opportunity. I thank them for bearing with me.

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I thank PRRM, especially its former president (now Agrarian Reform secretary) Horacio Morales, vice-presidents Isagani Serrano, Lisa Dacanay, Baby Roy, and Marlon Palomo, Tolits Gonzales, Bec Coronado, Giovanni Reyes, the Ifugao Branch Office staff headed by Peda Umalco, and former staff (now Provincial Board member) Esther Licnachan for all the support and the fun during my fieldwork.

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Special thanks to my husband, Aldo, for his perseverance, and our children—Julian, Katrina, and Domenico for their untold sacrifices when I was away from home, sometimes virtually. Their e-mails, chats, Internet-phone calls, and rhythmic knocks at my door overcame the distance and affirmed my resolve. I must not forget Katy, our cat, for the reassuring purr that accompanied my keyboard's rapping in the wee hours of the morning. To my mother, and the rest of the family and in-laws for their prayers, their long-distance encouragement, and for keeping me abreast of domestic news. I look back yearning for the loving memory of my father and his undying faith in people's creativity he proudly called, "*abilidad*."

I share this joyous moment with all of you for helping me learn about learning, learn about our connected life-worlds, and in the successful birthing of my first book about it.

Rhodora M. Gonzalez
The Netherlands
7 June 2000

Chapter 1

Wondering about a wonder: The problematic context

A world heritage: A living monument to people's collective, voluntary spirit.

1.1 The wonder that is Ifugao

"Some scholars have called the Ifugao terraces the '8th Wonder of the World.' In our sincere estimate, it is the first wonder of the world. Why? Because all the other so-called world wonders were done under a tyranny that utilized slave labor. Only the Ifugao rice terraces were constructed voluntarily by a free people without a central authority."

—Alejandro R. Roces, distinguished Filipino writer and educator

"No tribal Khufu[1], or Shih Huang Ti[2] fearful of mortality and foreign invaders, called on the Ifugaos to build this great edifice. We can only surmise that they looked at the hills and decided in common to eke their livelihood step after step, not conscious that at the end of it, they would have built an enduring edifice to their needs, a stately mansion to their collective soul."

—Adrian E. Cristobal, distinguished Filipino writer

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1 The Egyptian pharaoh who ordered the construction of the Great Pyramids to be his tomb.
2 The Chinese emperor who ordered the construction of the Great Wall of China to ward off invaders.

The Ifugao rice terraces are the most famous among similar terrace works found throughout the Asia-Pacific region, because they reach the highest altitude (1,600m), are the best built, are the most extensive (PHC 1940), and demonstrate heavy engineering and hydraulic work using traditional skills (de Boef 1990). The terrace walls consist of big stones taken from the riverbeds and placed accurately one on top of the other like a jigsaw puzzle, using clay to fill the gaps. They have to be well maintained to protect the fields, and for the comfort of all who walk on them. Irrigation is controlled by elaborate systems of dikes and sluices. All the work is done with wooden spades (sometimes shod with iron), crowbars, digging sticks, and bare hands. Should there be no water source on a mountainside, bamboo pipes and wooden troughs (and now, also plastic and metal tubes) are used for long-distance channeling of water from higher mountain springs. They pass along sheer cliffs to the top of the lower hills and mountains, where they fill the highest terraces. Once filled, the water spills over miniature waterfalls to the next lower terrace until the whole mountain or hillside is irrigated. In this way, soil nutrients are also recycled by field-to-field transport. Terraces are kept inundated throughout the year to prevent erosion, to control the weeds, and to keep various aquatic fauna for extra protein.

Ingenuous terracing in such extreme environmental conditions made Ifugao so world renowned that in 1995, it was inscribed in the UNESCO World Heritage List of cultural and natural properties considered to be of “outstanding universal value” (UNESCO 1995). Later in 1997, the American Society of Civil Engineers unveiled their marker at a vantage point overlooking the town of Banaue, in recognition of the Ifugao terraces as an “engineering marvel.” Quite daunting, but I also felt privileged to embark on my research journey in such an awe-inspiring and stimulating environment.

1.2 Behind the scene

The captivating landscape of Ifugao tends to veil a problematic situation that threatens the very foundation of this living monument. Close inspection reveals abandoned and crumbling terrace walls, thinning forests, and landslides. Erosion, as well as slash-and-burn farming, are rampant (PPDO 1996). To this one should add Ifugao’s poverty incidence[3] that hovers around 75% of its population and is considered the worst in the region (PPDO *op.cit.*). I found a hardy people struggling to survive and maintain a majestic but fragile mountain environment, which their ancestors have crafted to be their home. With a personal computer and newly acquired knowledge in geographic information systems (GIS), and my luggage, I set out on my research journey, amazed by this ancient world wonder, and all the more puzzled whether modern geo-information technology could be of any use in saving such a heritage.

My initial research findings indicate that the crumbling terrace walls of Ifugao are but manifestations of a much larger societal problem. Traditional farming and mastery of the art and skill in tilling and maintaining the terraces are being lost to more lucrative enterprises and wage-earning jobs in the lowlands. The young, educated population lacks the awareness of traditional culture and expresses little

[3] An income below US$1,288.35 per annum per family based on 1991 survey (PPDO 1996).

desire to go back to the province for economic reasons. Dressed-up natives asking money in exchange for posing before cameras, and scattered plastic bottles of mineral water are dismal signs of a fast spreading of irresponsible tourism. The situation is aggravated by a decline in the practice of traditional community workgroups *(ubbu* and *baddang)* which is crucial to terrace maintenance. There is increasing dependence on government and project dole-outs, as different agencies of varying persuasions and levels of authority train their efforts at saving the terraces, especially after the UNESCO declaration.

While many of these efforts are directed at propping up the physical structure, this research also views the situation from the social science side. It must be remembered that the rice terraces are a creation of the unique Ifugao culture and so, the disintegration of the social organization that maintained the structure for generations, as related above, is the basic threat to terrace sustainability. This problem can be traced to the incorporation of a once closed Ifugao society into a global economic order since 1900, with the arrival of American colonizers, who took over after Spain's 350 years of failed dominion. It can be gleaned from a classic documentation of the state of affairs in 1908, when volunteer teacher Roy F. Barton (1919/1969:2) described the ongoing agriculture as the "highest form of mountain agriculture with crops tended so skillfully and artistically." After living with the Ifugaos for eight years, he concluded his observation thus (*Ibid.*:xxi):

Fig. 1.1 Frantic efforts to prop up the physical structure of the terraces.

> "Given dentists and physicians, I doubt gravely if any society in existence could afford so much advantage in the way of happiness and true freedom as does that of the Ifugaos."

World War I had cut short his stay, but Barton (1930:296) returned in the 1920s to continue his work, and he wrote:

> "Well, we have made our will the 'gardener of the soul' of that people; we have made them raw material out of which to work a national stunt; with government, schools, and a brand of education to them of doubtful value, we are fast destroying a culture incalculably old. Whether they profit more than they lose by the process, no one can be sure."

Looking back (and not even 100 years ago), one would suspect that the sudden exposure to economic competition as monetary exchange took over barter, the draw of new jobs at American mining sites and vegetable farms in the neighboring province of Benguet, the introduction of a colonial religion and educational system that are far removed from the realities of the place, the relegation of "backward and uncivilized" local knowledge to the backseat of community development, and the collapse of collective decision making through *ubbu* and *baddang*, proved disastrous to what the Ifugaos had successfully maintained for reportedly more than 2,000 years.

1.3 Dating games

The actual age of the terraces is not exactly known. Barton (1919/1969:4) estimated that "the Ifugaos must have lived in their present habitat for at least two thousand years, and these figures are too small." (Dumia 1978) writes that the "defiant," "warlike," and "savage" *Igorrotes* were "discovered" by the Spanish *conquistadores* in 1572 during the conquest of Ilocos region, but the Spaniards were met with such fierce resistance that they had to withdraw. Early radiocarbon dates set the Ifugao terraces' beginnings from the 7^{th} to the 11^{th} century while recent Carbon14-dating indicated an age of about four to five centuries (A.D. 1555 ± 60 yrs.) for the post used in an original terrace-embankment which was exposed by a landslide in 1961 (Conklin 1980). This research abides by the "more than 2000 years" estimate etched at the municipal marker of the town of Banaue. Whatever the exact date is, there is universal agreement that this traditional agro-ecological system of the Ifugaos was able to support a relatively high population density for many centuries without depleting its natural resources (UNESCO 1995).

Table 1.1. Ifugao's population record culled from different accounts

YEAR	POPULATION	SOURCE
1916	129,380	O.Beyer (in Barton 1919/1969)
1918	66,400	after an epidemic Barton (1919/1969)
1932	73,155	Dumia (1978)
1946	50,000	Post-War estimate Dumia (1978)
1960	76,788	Provincial census
1970	92,487	Provincial census
1975	104,707	Provincial census
1995	149,598	Provincial census
1998	158,708	Projection (ann.growth rate of 1.99%)
2000	165,088	Projection (ann.growth rate of 1.99%)

Table 1 summarizes Ifugao's recorded population. It was historian O.H.Beyer (Barton 1930:60) who reported early counts of 129,380 in 1916, which ranked it as 7^{th} in population among the peoples of the Philippines, and this area was then considered "one of the world's thickly populated regions." This is also an indicator of the number of people necessary to maintain the terraces that had been built. After an epidemic[4] in 1918, a census report counted only 66,400 (Dumia 1978). World War II was fiercely fought in Ifugao, as it was here where the Japanese put up their last stand before surrendering, and that reduced the population to 50,000 in 1946. From then on, population grew steadily and in 1995, it was reported to be 149,598 with an average annual growth rate of 1.99% (PPDO 1996). The projected population for 1998 (fieldwork period) is 165,088. The average Ifugao household size comprising extended family (nuclear family and other relatives) is 5.12 (PPDO 1996).

[4] A BBC (British Broadcasting Corporation) documentary reported a well known worldwide epidemic around this time and during WWI, attributed to pneumonia virus.

1.4 Family matters

The basic unit of an Ifugao society is the family, consisting of a husband and wife plus their children. One's relatives up to the 4th degree comprise a clan. This is what Barton (1919/1969) called "kin group," which means the combined descendants of the eight pairs of great-great grandparents, extending laterally to include the third cousins. Marriage is considered an alliance of families, such that husband and wife are merely allies. This means that the ties that bind each to his/her own family are much stronger than the ties that bind them together (especially if they are childless). "Family unity must at all hazards be preserved as the family is the only thing of the nature of an organization the Ifugao has" (Barton 1919/1969:8).

The firstborn is a defining member of an Ifugao family because of the customary law of primogeniture— the eldest child (whether a male or a female) inherits the best and the biggest portion of family properties. If there be only one property, he/she takes it all. And because of his/her greater wealth, the eldest naturally comes out to be the family leader or center, or counselor. Together with the lion's share of family property, the eldest child also inherits the "sacred responsibility" (non-compliance is taboo) of being the rallying point to whom the rest of the family may come for any assistance.

Inheritance is more of a nature of trust administration on behalf of the clan than an absolute ownership. It is a holding in trust for the perpetuation of the family and the clan, as it is the Ifugao custom that land and articles of value that have been handed down from generation to generation cannot be the property of any individual. An Ifugao therefore, exists primarily for his family and the future generations of it. However, propinquity immediately comes next (Barton 1919/1969; Conklin 1980). Neighborhood alliances *(ubbu)*, which are governed by agro-ecological concerns, supersede distant family. This means helping in a neighbor's farm weighs more than helping in a relative's farm in another town.

1.5 Lessons from the past

Preliminary scrutiny reveals that there is much to learn from the folk wisdom that was able to sustain Ifugao for centuries. Terrace construction and maintenance is the unique way of creating a habitat out of an otherwise hostile mountain environment. The main source of labor for the cultivation and maintenance of the terraces, the irrigation system, and the *uma* (upland swidden farm) is provided by the family and the clan. This labor is not paid in cash, but farm produce and services are exchanged instead. It is part of family tradition to lend a hand in these activities to ensure the future of the next generations. There is this principle on which the Ifugao society is based: "The family exists principally for the youthful and the generations of it" (Barton 1919/1969:114) and when death approaches, one is happy if he/she could fulfill this duty as a responsible and dignified Ifugao—"pass on to his/her descendants the family's rice fields intact" (Dumia 1978:3). They are an invaluable treasure, not an exploitable piece of property. An informant narrated that he bought back a sister's rice field which was sold to a non-relative while he was working in Baguio City-- *"It is our family's pride and it should be kept within the family."* The buyer respected his right to reclaim. This is how Ifugaos value their land.

A practice called *ubbu* "plays a vital role in the regular upkeep of the rice fields, especially since employment of work animals is impractical" (Dulawan 1992:26). It provides additional support to the very labor-intensive terrace agriculture— from planting, weeding, and harvesting, to general terrace maintenance. It also represents the cohesion of a whole village in natural resource management. Workgroup members called mun-uubbu, who are usually neighboring households take turns in working on each other's terrace farms, do it. Labor exchange is computed in terms of the number of working days rendered, regardless of the kind of activity. Rotation schedules are drawn up and are faithfully obeyed, but allow flexibility in case something more urgent happens— like terrace erosion or collapse of a dike. In this case, help is extended to the more urgent task. The farmer who is helped reciprocates by offering food and drinks for each day's work.

Another workgroup called *baddang*, organizes the men in constructing and maintaining irrigation canals. Labor exchange is computed by the size of terraces one owns— the bigger the terraces, the more number of workdays to render. Fines in terms of chickens are exacted from those whose terraces would benefit from the irrigation but did not participate in its construction. Irrigation maintenance assigns a *mun-unod* or checker who monitors canal status everyday as he goes about removing weeds, leaves, soil and stones that may have accumulated. The owners of terraces that are affected by any damage will have to act together to make immediate repairs. The *mun-adog* is a watcher at night to guard against stealing of water, especially during the summer months. Those caught are warned at first offense and punished after the second— all the water is drained from the offender's terrace and livestock is collected as fine.

The *muyong* is a family owned and managed forest that is crucial for the prevention of soil erosion and for maintaining terrace moisture. This is why most *muyongs* are located above the rice terraces. The owner plants the desired trees valued for timber which are used for building their houses, for wood carving, and fuel. Within the *muyong*, selective cutting and thinning known as *pucho* is practiced. Felled trees are replanted for regeneration. The *muyong* has a unique law of inheritance in that it is never partitioned but inherited as a whole. The first child inherits the father's *muyong* if it is bigger than that of the mother. The second child inherits the smaller— an apparent recognition of negative consequences in parcelizing the forest.

Everybody follows a cropping calendar (discussed in Chapter 5). A *tomoná* (agricultural leader) determines exactly when planting time should start in his/her *himpuntona'an* (agricultural district) after he performs *lukya*, a religious rite for the purpose. Everybody is expected to follow, otherwise a fine is imposed— the rite will have to be performed again at the expense of the person who did not obey the planting time. That means providing the sacrificial animals, food and drinks for the ritual. The reason for such a strict compliance with the cropping calendar was explained thus: this is to evenly distribute the effect of pests over the whole village, and in the end achieve a higher total harvest. As Manong Greg, an informant, animated: *"If we don't plant at the same time, can you imagine the rats having a good time waiting for the rice to mature and to feast on, one plot after the other?"* Consequently, harvesting at the same time deprive these pests of food for a considerable length of time, and hopefully, they would die or go somewhere else.

Another intriguing rice ritual is the *paad*. This is performed at the village granary some three months after planting season when rice starts to mature, to call on the rice god to cause the grains to mature well. Three chickens are offered. This ritual is also for the purpose of binding the people not to eat fish, shells, snails and other aquatic fauna until after the *kahiw*, which is the ritual well after harvest time that specifically frees the people of the *paad* vow. Nobody had questioned this practice before but upon my prodding for any possible reason aside from purportedly offending some spirits and getting sick, a plausible explanation was elicited from Manang Rosa, an informant: “to allow sufficient time for the aquatic fauna to grow and reproduce.” It is similar to the “close season” in hunting. The end of the *paad* cleverly coincides with the end of the agricultural calendar, when feasts are widespread.

Ifugao’s cohesive community tradition had demonstrated to the world that sustainability, as Röling and Wagemakers (1998) describe it, “is an emergent property, an outcome of a collective decision making” of a voluntary and responsible interaction among the members of a community. For it is to everybody else’s benefit that an eroded dike of a neighbor is repaired; that the family *muyong* (forest) remains intact to preserve the whole watershed; that everybody plants and harvests at the same time to evenly distribute damage by pests; that one’s diet is adjusted to allow aquatic fauna to reproduce. In each case, selfish interest is subordinate to that of the community. In the process of simple but joint, concerted action, a beautiful system of terraces that withstands the ravages of time and continues to be functional has emerged— one that spelled sustainability for generations. Sad to say, but one reason behind the province’s present ecological disarray is that modern influences have driven many contemporary Ifugaos to lose faith in these time-tested indigenous practices. There is much to learn from them and draw the strength— the wisdom to act and change the deteriorating course towards a sustainable future.

1.6 The location

Ifugao is about 320 km. north of the Philippines’ premier city of Manila and is reached afer a 10-hour bus ride across much of Luzon Island— the largest island among 7,100 that comprise the country (Fig.1.2). From the lethargic, monotonous view of the central plains of Luzon, one is transported to a breathtaking, panoramic splendor. Ifugao is a landlocked province that occupies 251,778 hectares near the foot of the vast Cordillera mountain ranges. It used to be a part of Mountain Province, which lumped together most of central Cordillera but became independent in 1966 after Republic Act No.4695 subdivided Mountain Province into four. It represents 14% of the present Cordillera Administrative Region (CAR) which is composed of six provinces of northern Luzon, namely: Abra, Apayao, Benguet, Ifugao, Kalinga, and Mountain Province. Ifugao is located at approximately 16° 30” to 17° 5” North latitude and 120° 45” to 121° 35” East longitude with Lagawe as the capital town (see Fig.1.2). The ten other towns that make up Ifugao are: Aguinaldo, Alfonso Lista, Asipulo, Banaue, Hingyon, Hungduan, Kiangan, Lamut, Mayoyao, and Tinoc. This research is carried out in the town of Banaue.

Ifugao’s landscape is composed of rugged mountains, low-lying hills, and a small alluvial portion along the Magat River on the east. The Ibulao, Alimit, and

Lamut rivers are the main drainage ways of the province contributing to the waters of Magat Dam, the biggest in Luzon Island with a total volume of 1,250 million cubic meters (NIA 1996). It supplies 360 MegaWatts of power to the whole Luzon grid (PPDO 1996). Ifugao rises from 200m above sea level at the eastern Lamut town to the highest peaks of the western bordering mountains of Mt. Pulog at 2,928m. About 55% of the province's land area has slopes of more than 50%, which are very steep and mountainous while only around 20% of the land area is gently sloping and undulating, with less than 18% slope (PPDO 1996). The rest are rolling to steep hills.

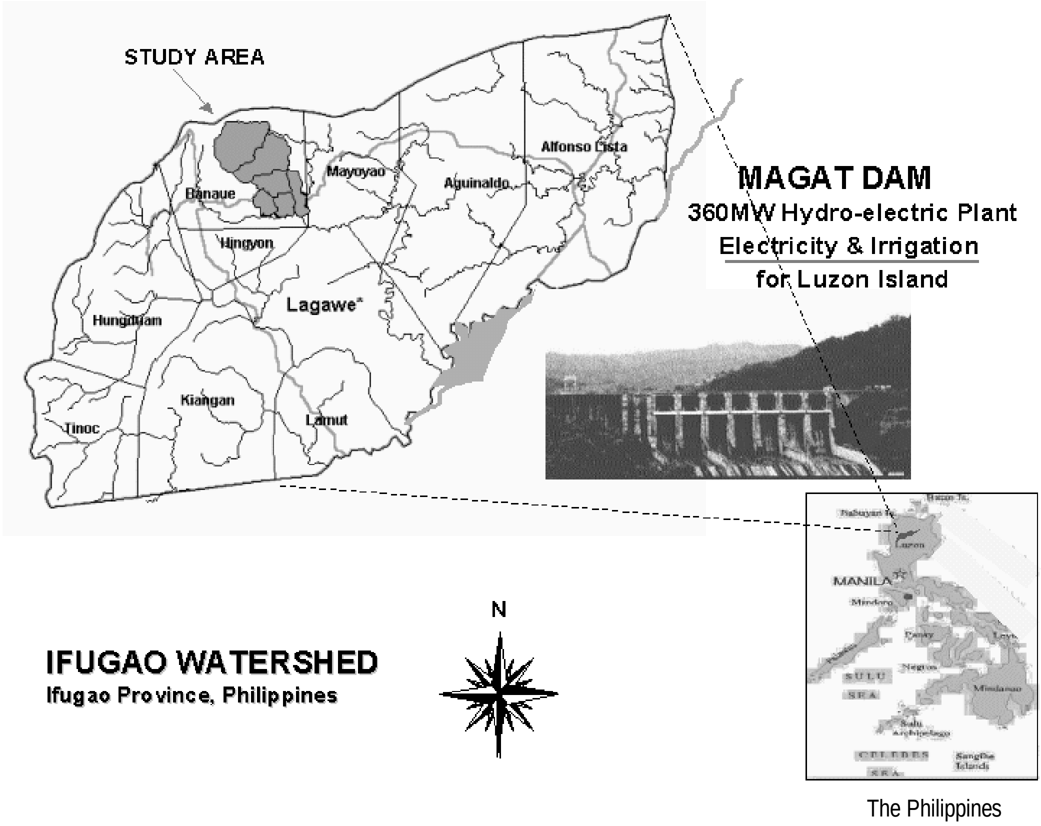

Fig.1.2 Location of the study area

With such a steep topography, 90% of Ifugao's land area is declared as forest land and the remaining 10% are called "alienable and disposable" by the official land classification (DENR 1996), which stipulates that all land with 18% slope or more is forest land. In terms of actual land cover, however, most the province is open grasslands (64% of the total area) and forests (26% of the total area) while only 8% of the total land area is used for agriculture (PPDO 1996). There are no mining operations in the province.

The climate of Ifugao manifests itself in having a dry season from December until April and a rainy season during the rest of the year. The high altitudes have generally lower temperatures (ranging from about 19°C to 24°C) with high humidity (70-80%) and exposure to the rain-bearing northeasterly winds. Average annual precipitation is 3,700mm which makes Ifugao a generally wet region and is responsible for its many groundwater resources but also makes it prone to landslides and gully erosion.

1.7 The people

Except for some distinctions, the people of Ifugao are similar to their tribal neighbors like the Bontocs and the Kankanaeys, Ibalois, Kalingas, and Apayaos. Spanish colonizers collectively called them the *Igorots (Ygolotes or Igorrotes)* to refer to all the defiant mountain people in this part of the country and described them as "wild," "backward," and "savage" headhunters for consistently rejecting all foreign intrusion into their way of life (Dumia 1978). Because of the colonial connotation, the majority of these mountain people do not want to be called *Igorot*. The people of Ifugao province refer to themselves as *Ifugaos*.

Ifugao is the modernized form of the word *ipugó* (accent on the last syllable) which means "human beings," or "people of the earth." This term distinguishes the mortals from the deities and other supernatural beings that inhabit the five worlds of the Ifugaos, namely: *Luta* (earthworld), *Kabunyan* (skyworld), *Dalom* (underworld), *Daya* (upstream world), and *Lagud* (downstream world). The term *ipúgo* (accent on the second syllable) also refers to "people of the hills," which is derived from the word *pugu* meaning, "hill."

Recent archeological findings that the earliest man had lived in the Philippines from at least 400,000 to 500,000 years ago (Dumia 1978) repudiated the migration-wave theory (INDISCO 1993, PHC 1940) posed by scholars about the origins of the Ifugaos. However, the old Ifugaos themselves believe that they are direct descendants of the deities of the skyworld. In their songs and rituals called *baki*, they narrate how the deity *Wigan* of the skyworld, sent down his son *Kabigat* and his daughter *Bugan* to the fertile valley of Kiangan town so that they would become the first parents of the then unpopulated Ifugao land. The Ifugaos and the Cordillera communities in general remained unconquered during three centuries long Spanish rule in the Philippines. The Americans triumphed in using a policy of punishment and persuasion (Alangui, et al. 1994) and opened the first schools, hospitals and churches in 1905 that that greatly changed Ifugao's way of life.

The Ifugaos had a significant role in Philippine history during the Japanese occupation period of 1941-45 as they actively joined the guerillas against Japan. "They lost a large number of people but had set a standard of loyalty that was unsurpassed" (Eggan, in Barton 1969:xvii). The rugged mountains at the western town of Hungduan was the site of Japanese General Tomoyuki Yamashita's last stand before his surrender to the combined Filipino and American "liberation"[5] forces in the town of Kiangan on September 3, 1945 that officially ended World War II in the Philippines.

1.8 Into the mainstream

The post-war period was characterized by the consolidation of "democratic[6]" political structures and processes from the national down to the *barrio* level. This meant the complete alteration of indigenous socio-political structures and institutions.

[5] It is the contention of local guerillas that the Americans came back (after their retreat in 1944) just when the war was almost won, took the credit, and eventually, re-established their rule in the country.

[6] The term is rhetoric in that only those educated by the American schools effectively participated.

Positions of authority and leadership shifted from those who had mastery of customary laws and rituals, to those who were educated by the American-introduced schools. The lettered have the advantage of understanding announcements, requirements, and are able to fill-out and file certificates of candidacy at the Commission on Elections office in town.

However, present day government institutions have to compete for the people's reverence. For example, a *barangay*[7] captain lamented, *"A Barangay Ordinance was passed for us to plant at the same time, but it was not followed."* But in another *barangay*, an alcohol ban was successfully enforced with the help of the women constituents. The functions of government are accomplished by the simultaneous operation of collective kinship obligations, together with common understanding of the *adat* (customary laws); in particular the inviolability of personal and property rights (Alangui *et al.* 1994). A *lupun* (council of elders), is still resorted to for settling serious conflicts between villages, for their being knowledgeable of local history.

Ifugao's religion is pantheistic-animistic[8] in nature and has a well-developed cosmology (Alangui *et.al.* 1994). Adult males with the proper training functioned as priests (*mumbaki*). Today, the majority of the population has been converted to numerous Christian sects. Marriage ceremonies combine church celebration with traditional *cañao* (feast) rites. Monogamy and presenting dowry are still practiced. The first child still inherits the best farmland (the biggest in size and/or the irrigated ones) and carries the responsibility to care for the other siblings, who get what is left and often help in cultivating the former's farm.

Since the arrival of the Spaniards, rice and money for exchange of goods and services have replaced barter. Furthermore, the Ifugaos began coming down to the lowlands for contract labor at farms in Nueva Vizcaya and Cagayan Valley, and with the mining companies and vegetable farms of Benguet. Introduction of modern technology such as the use of high yielding rice varieties (HYV), chemical fertilizers and pesticides have become popular with some Ifugaos, especially in Lamut town. But for the Banaue area, organic fertilizers still predominate. There are three institutes offering tertiary education in the province but the more economically well off pursue higher education in Baguio City, Benguet, Nueva Vizcaya or Manila.

Today, there is growing indifference by Ifugao's young people toward traditional knowledge. Many of the educated children have a tendency to get rid of old customs and traditions considered as "backward" and "uncivilized"— colonial labels that remain imprinted in their minds (Alangui, *et.al.* 1994). Many young people have now chosen to move to places where schooling and jobs (that correspond to what they are taught in schools) are more easily obtained, leading to a shortage of skills and labor in the mountain villages. This trend is largely attributed to the prevailing educational system that is far removed from the actual rhythm and realities of its environment. Studies indicate that the content and the approach are not relevant to the needs and conditions of the communities, and propose "ones that should be based on their lives and activities" (Alangui et al. 1994: xvi) and should therefore strengthen local development.

[7] A *barangay* (composed of several *sitios*) is the smallest political-administrative unit in the country.
[8] Simultaneously identifying god with the universe ("skyworld") and living things ("earthworld").

1.9 Problematic present

Fig. 1.3 A landslide in October 1998 buried houses on its path.

Ifugao life has always been austere, but today the decreasing level of self-sufficiency threatens survival. The province is a member of the so-called "Club 20," the group of 20 poorest provinces (out of 73) in the country. Ifugao has the highest poverty incidence, the worst underemployment rate, and the lowest life expectancy in the Cordillera Administrative Region (PPDO 1996). Conditions of life in Ifugao require more than the simple needs of the past such as cash, goods and services— needs which subsistence farming cannot easily provide. This means more pressure on the already dwindling natural resources of the area. About 51% of its forest lands are either open, denuded, logged over, or have become brushlands. Only 34% remains under forest vegetation (DENR 1993). As a result, soil erosion threatens the very foundation of the Ifugao landscape. Ironically, while the province's rice terraces are regarded by conservationists and ecologists as "one of the soundest soil and water conservation structures ever built by humans" (Conklin 1980: 27), Ifugao has the largest area (141,753 has.) affected by moderate to severe erosion within the Cordillera Administrative Region (PRRM 1993).

From interviews, personal observations and official documentation, the following is a summary of problems compounding the erosion of Ifugao's biophysical system:

- siltation and breakdown of control structures of unmaintained irrigation canals:

  Of the 155 communal irrigation systems in the province, only 60 are fully operational, 3 are non-operational, while the rest are partly operational (PPDO 1996).

  "The owner is too old to do farmwork but the young ones are too lazy to do the maintenance work."

  "The landslide happened 3 years ago, but you see the owner has not yet repaired his *payoh.*"

- depletion of forest resources for local wood supply:

  As of 1987, forest cover amounts to a measly 26% of a province that is officially classified as 90% forest (PPDO 1996).

  "The legends say that this place was called Cambulo because of the presence of many trees called *buloh.* But that kind of tree is very hard to find here now."

  "There are no woodcarvers in our *barangay*, but the woodcarvers from the other *barangay*s sometimes encroach in our forest and take the trees away."

- intensification of *uma* (swidden or "slash-and-burn" farming) that depletes the grasslands:

  Rice sufficiency rate has decreased from 97% in1985 to 80% in 1990 with a corresponding decrease in area planted to rice (down from 10,300 has. in 1985 to 8,530 has. in 1990) and production from 27,405 metric tons in 1985 to 24,190 metric tons in 1990; meanwhile, rootcrop production increased from 2,250 metric tons in 1986 to 3,517 metric tons in 1990

with a corresponding 7% increase in area planted (PRRM 1993)[9].
"Harvest from the *payoh* are not sufficient, so people have to supplement that with harvest from the *uma.*"

The current state of Ifugao is a result not only of the degradation of the biophysical system that used to sustain it, but also of the socio-cultural system embedded in its rice terracing agriculture. These threaten the sustainability of the rice terraces rooted in the Ifugao culture. These dramatic social changes are attributed to the following main factors:

- influence of foreign religion and education which drive young people away from their tribal customs, their land and agriculture:
  As of 1980, 43% of the population belongs to the Roman Catholic Church while the rest are divided among the other Christian denominations (Alangui, *et.al.* 1994).
  "We were told that our rituals were for the demons and so, we had to worship a different God. From then on, our way of farming related to the rituals for our rice god is also fast disappearing."
  "The moment one goes to college, that means going away from the farm."

- assimilation of lowland ways and migration to lowland areas where economic opportunities and the excitement of modern and urban life beckons:
  Between 1975 and 1980, out-migration of native Ifugaos (3,078) outnumbered in-migration of settlers from other places (1,704) by a 2:1 ratio (PRRM 1993).
  "I still perform our cultural dances, but my children (who are schooling in Benguet) refuse to perform our dances. They prefer the modern dance they see on TV."
  "I intend to move to Baguio City with my family and seek a better life for my children."

- economic pressure due to limited arable lands and economic opportunities:
  While almost 75% of Ifugao's population is engaged in agriculture, forestry, and fishery, only 53% of households has such activities as the main source of income; the remaining 47% rely on wages, entrepreneurial activities and gifts from abroad (NSO Survey 1988).
  "While waiting for harvest time, my husband works as a construction worker or whatever job is available in the lowlands."
  " Whereas before, 5 to 8 years of fallow was being observed in cultivating the *uma,* now we could only wait 2 or 3 years. Prices[10] of prime commodities have increased dearly."

- incursion of modern political systems into tribal leadership system which weaken traditional communal activities such as mutual help in terrace maintenance, irrigation and land tenure rights:
  The 1974 Ancestral Lands Decree (Presidential Decree 410) declared ancestral lands as alienable and disposable for exploitation by big business in the name of economic growth.
  The 1975 Revised Forestry Code (Presidential Decree 705) classified all lands 18% and above in slope as inalienable and indisposable for agriculture and settlement, making the government the landowner of the predominantly steep sloped Ifugao province.
  The 1978 Property Registration Decree (Presidential Decree 895) deemed land titles as the sole proof of land ownership.
  "We could not understand the need for that piece of paper (land title). Our ancestors have been living here long before this government came about."
  "The *barangay* council passed an ordinance that the whole *barangay* must plant rice at the same time, but it was not followed," (lamented a *barangay* captain).

With all these factors at play, misuse and abuse of the province's natural resources are

[9] Ifugao rice is harvested solely for domestic consumption.
[10] Purchasing power of the peso in 1998 = 0.72 using 1994 as base year (NSO, cited by IBON Databank)

spreading past the diminishing individual and communal land-nurturing responsibilities of the people. All these problems compound the increased siltation rate of the Magat Dam. About 33% of this dam's total catchment area of 412,000Ha. is in Ifugao, whose major river systems supply the dam's water (BSWM 1987). It was designed to last for 100 years but is now projected to serve for only 43 years due to accelerated erosion (NIA 1996). Table 1.2 shows the alarming increase in sedimentation rate of 18.6MCM/yr (million cubic meters per year) since the great earthquake of 1990 that triggered massive landslides. The 1995 NIA observation measured 12.8MCM/yr, which is way above the design rate of only 5.5MCM/yr. There is growing awareness that the fate of the dam depends much on Ifugao's watershed (PPDO 1996).

The message is clear: There is an urgent need to arrest the environmental degradation that threatens Ifugao's land-based economic activities, affects productivity, increases pressure on its limited resources and endangers the country's major source of electricity and irrigation water— the Magat Dam. As lands in the Cordillera region are known for their fragility and general unsuitability for agriculture, the ability of its indigenous peoples to transform this hostile environment to a productive habitat remains the resource to bank upon. The key lies in enhancing the ancient skills and present capability of the people to nurture and not abuse nature.

Table 1.2 Summary report on the status of Magat reservoir

Year of Survey	No. of monsoons after impoundment	Cumulative volume of measured sediment (MCM)*	Ave. Sedimentation rate (MCM / yr)	Cum.Total capacity lost (%)	Estimated catchment sediment yield (Tons / Ha / yr)
1984	3	22.0	7.3 (1982-85)	1.6	25.5
1988/1989	7	49.0	6.6 (1985-89)	3.6	23.5
1995	14	179.0	18.6 (1989-95)	13.5	45.0

*Million cubic meters *(Source: NIA 1996)*

1.10 Arena for action

Aside from local efforts, there have been many attempts from the national and local government units and also from non-government organizations (NGOs) to reverse the situation and save Ifugao from further deterioration. The Department of Agriculture is the lead agency involved. In 1982, it launched the so called "Save the Terraces Program" to promote vegetable production in Ifugao. It was accepted in the town of Kiangan, but was strongly resisted by majority of the farmers in the rest of the province for complex reasons ranging from taboos, lack of money for chemical inputs, to the system of property inheritance (de Boef 1990). Sharecroppers are bound by the preference of the inheritor. Traditional farmers and inheritors keep terraces filled with water as much as possible all year round to prevent erosion, because water or moisture in the terrace is the "main factor for the sustainability of terrace cultivation" (ITC 1995:51). Second-generation immigrants to the province who are not restricted by traditions or those with enough capital are mostly doing the conversion of terraces to vegetable farms (de Boef 1990).

In 1988, the Department of Agriculture again embarked on a community-led agricultural development program though the CECAP - Central Cordillera Agricultural Programme. It undertakes community-validated large-scale infrastructure building and micro-enterprises. Some of its projects include cementing main irrigation canals, footpaths, and bridges to increase access and mobility from production area to the main road. Credit and agricultural marketing activities are also provided to overcome difficulties in expansion and diversification of subsistence-based farming. CECAP is now in its second phase (1995-1999) in an effort to continue to raise rural incomes and living standards. It is now considering community-organizing efforts to sustain their projects.

Also in 1988, an NGO, the Philippine Rural Reconstruction Movement (PRRM) entered Ifugao and started grassroots organizing of people's organizations (PO) and development work using a community-based extension system strategy. After conducting orientation courses, the communities are organized and mobilized in solving community-identified problems. One of its projects is the propagation of sloping agricultural land technology (SALT)[11] at the swidden farms to minimize erosion and at the same time propagate fruit-bearing trees. Community-based natural resource management councils (CB-NRM council) are set up to sustain the efforts. A people's bank (Highlands Bank) was organized to federate local cooperatives and provide consolidated revolving funds.

Fig. 1.4 Constructing a water-impounding "spring box."

The Department of Tourism on the other hand declared (Proclamation No.1522) much of Ifugao as a tourist zone which therefore has to be under its administration and control. In 1994, the national government stepped in and the office of the president issued Executive Order No.158, which created the Tourism Department-led Ifugao Terraces Commission (ITC). It takes charge of the large-scale restoration and preservation of the rice terraces. It brings together the cooperation of various local government agencies (LGA) like the Departments of: Agriculture, Environment and Natural Resources, Agrarian Reform, etc., the local government units (LGU) and local people's organizations (PO) in order to provide a "holistic solution" to the problem. While primarily created for the restoration and preservation of the Ifugao terraces, the ITC recognized the need to "establish a strong LGA-LGU-NGO-PO collaboration for maximum participation and complementation in the use of existing resources" (ITC 1995: ii). It pointed to an overlapping program of activities undertaken simultaneously by different agencies that have direct impact on terrace restoration and preservation (*Ibid.*).

The Ifugao terraces set the stage for all these agencies to supposedly come together and work for the same cause: creating a new workable strategy for present day Ifugao to sustain the environment that supports its life. However, divergent views,

[10] The SALT was originally developed by an NGO in the Southern Philippines and has gained acceptance both locally and abroad in controlling erosion and augmenting incomes. See Annex A for more details.

goals and objectives are expected to clash as each one tries to proceed according to their chosen development path. Complicating the matter is that these NRM actors are interdependent because they are dealing with the same area and therefore the action of one affects the desired outcome of the others. Negotiations are inevitable. For example, PRRM is trying to revitalize the spirit of cooperation and responsibility exemplified by their traditional workgroup called *baddang*, but government projects simply contract terrace repair jobs with local menfolk. As elaborated in Chapter 7, an externally initiated project-dependent people and a continuously eroding environment now characterize the local development landscape.

1.11 Facilitating for convergence

It becomes evident that the effort to save the Ifugao terraces is not just a struggle to control the eroding environment by technical intervention but more so to try to bring different actors with different perspectives about the problem to work together in its management. Natural resource management (NRM) therefore, becomes management of people who manage the resources— an integrated natural resource management becomes necessary. The main issue now is how to create structures and processes that can bring forth a jointly agreed upon image of their environment, involvement, and joint activity.

Pretty (1994) argues for supporting the capacity of actors to seek the interplay of multiple perspectives and continually learn about changing conditions so that they can act rapidly to transform existing situations. Such efforts create "joint systems of learning and inquiry" (Pretty 1994, Checkland 1991, Sriskandarajah, Bawden & Packam 1989) and are needed to encourage wider involvement and action. Daniels & Walker (1996) call it "collaborative learning" and emphasize the importance of activities that encourage combining knowledge from various sources and perspectives in order to jointly address the complexity of NRM. The challenge then, is to create ways and means to channel efforts from those who are in a position to work together and start to create and strengthen collective learning and action to improve a problematic situation— to facilitate for convergence.

Conklin (1980) saw a collective mechanism in the *himpuntona'an* or "agricultural districts" in Ifugao tradition. They have particular center points called *puntona'an* (ritual field). District constituents headed by their respective *tomoná* (agricultural leader) literally converge at their respective ritual fields to perform their rice rituals. Essentially, however, they decide to jointly commit themselves to concerted, responsible actions for the good of the whole agricultural district. Each district has boundary markers, called *panalongdongan* (flat stones at entry points) and *changla* (red plant) presumably to clearly define and broadcast the space to care for, and the territory to defend from intruders (*Ibid.*). The *tomoná* encompasses an important area-specific process in natural resource management, a process with the potential to be strengthened by the spatial analysis capabilities of GIS (see Chapter 3).

My enthusiasm for using GIS-technology is partly because I was originally tasked to learn whether computerized geo-information technology could be used in enhancing work at the office of the PRRM. But more logical is the spatial dimension of Ifugao's problematic situation. Historical evidence shows that traditional terrace management revolved around these geographically explicit "agricultural districts" that Conklin (*op.cit.*) pointed out, but did not elaborate on sufficiently in terms of corresponding spatial management configurations. With today's displacement of the *tomoná*, tracing back the significance of these "agricultural districts," and supported by a GIS, could contribute to understanding and learning from tradition that may benefit the present direction.

I also observed that today's NRM actors are using maps to articulate their plans. Official landuse maps, the Ifugao Terraces Commission's zoning map, PRRM's environmental scanning and mapping, and the *barangay* sketch maps, all become the basis for their respective action plans. I anticipated clashes of "points of view" and "value judgment" in using every space. I tried a way to strengthen a process that enables— a GIS-assisted joint learning among actors of an "agricultural district," in understanding their environment and in jointly planning for concerted effort towards improving their situation.

1.12 The research journey

This book is about an attempt to use participatory methods in designing a GIS for facilitating a multiple actor intervention in natural resource management at the local level and articulating the same at the provincial level. It is based on 13 months of fieldwork in four adjacent *barangay*s of Banaue in Ifugao. I chose the study area because the original research objective was to "incorporate indigenous knowledge of natural resource management in a geographic information system to assist in community-based sustainable development" programs being undertaken by PRRM. Ifugao is a unique habitat that has survived for generations and offers tremendous opportunities for a study in sustainability. PRRM's field office in the area is an added advantage because of the established rapport with the community.

Speeding up and systematically understanding the complexity of the province's rapidly deteriorating environment explain the attempt at harnessing computer power. There is urgency, because not only a whole indigenous culture is being lost, but also the magnificent structure that it has carved to be its habitat. What was once a harsh, mountain environment of agriculturally unproductive land is now usable to produce the country's staple food. It is now degenerating to silt up the Magat Dam, a major power and irrigation reservoir of the whole Luzon grid.

In PRRM's ten years of development work in Ifugao, the search for a fresh strategy cannot be underestimated. The Ifugaos alone have the know-how in caring for their unique environment, but the extent of the problem is a national concern (and now, inviting international attention with the UNESCO declaration). New avenues and new tools are available and have to be explored to help the Ifugaos learn about ways to deal with their problematic situation. GIS technology is a promising tool, and my attempt to use it with the Ifugaos is analyzed in the following chapters.

Chapter 1 describes the problematic context by tracing Ifugao's history that showed (1) these hardworking people's adherence to collective action was undermined by modern influences, thereby (2) threatening the sustainability of the whole watershed and of a vital source of power and irrigation water of the island. (3)

Their traditional and successful NRM organization was embodied in the institution of the *tomona* and the workgroups *ubbu* and *baddang* in a definite area called the *himpuntona'an* (agricultural district) and ably supported by the organization of the family and the clan. Furthermore, (4) their traditional leaders, notably, the *mumbaki* (priest/medicine-man), *munkalun* (go-between), and *tomoná* (agricultural leader), with their respective expertise and their conglomeration into a *lupun* (council of elders) comprise the nerve center of indigenous knowledge. (5) Traces of their traditional information system are gleaned from these institutions.

Present-day multiple-actor complexity is the basis for putting forward a "joint learning system" strategy to pick up lessons from this glorious past and debate on how to jointly work for a perceived desirable future. The well-documented capability of GIS to provide a consistent framework for spatial analysis offers a promise and is explored, but in a participatory manner, to involve different NRM actors to integrate their qualitative spatial knowledge as well in generating new insights. This book also hopes to describe the experience of doing this exploration among a neo-literate society in a remote, rural setting. The journey proceeds this way:

Chapter 2 - explains the particular research problem and objectives, highlighting the basic questions and methodological issues in operationalizing a participatory GIS among the Ifugaos in order to aid their community development efforts, particularly in natural resource management.

Chapter 3 - concerns the shift in my perspectives with regard to the research focus, and the theoretical issues which explain the conduct of the research and the analysis.

Chapter 4 - examines the state of the art in using participatory methods in the development of a GIS. It discusses some traces of the traditional information system and describes its evolution to the present. It gives some recommendations to develop a GIS in a participatory way.

Chapter 5 - is a description of the old and new Ifugao setting with respect to the management of their natural resources, specifically, the watershed. It shows how the old Ifugao social structure had succeeded in maintaining their terrace structures and how the present is trying hard to continue.

Chapter 6 – highlights the step-by-step development of a computerized GIS among the Ifugaos, which was done by using participatory methods. It analyzes the experiences in engaging in a joint learning process for local participants and researcher alike, in understanding interconnections in their watershed.

Chapter 7 - is devoted to the discussion of particular applications of GIS in community development processes. One is about terrace monitoring and the other, reforestation. It also shows how the intensity of local activities is reflected from the status of the watershed forests.

Chapter 8 - revisits the research objectives in Chapter 2 and summarizes the salient findings and their significance in the study of geo-information, indigenous knowledge, and rural development. It discusses the conclusions and makes suggestions for future research.

Chapter 2

Learning paths: Objectives and methods

Joint learning towards understanding a problematic situation.

2.1 Introduction

After the comprehensive discussion of the problem context— that which the Ifugao society is currently facing, and its implications for the whole region and the country, this chapter focuses on the research problem I chose to embark on. As a research cannot lay claim to solve a societal problem, it can only try to contribute to facilitating the problem solving process in order to improve the situation. I first describe my original task and interest in the chosen subject, given my personal background in rural development work, computerized databases and newly acquired expertise in using GIS. The chapter shows how this particular research topic was developed, and the mix of personal, academic, and occupational considerations in searching for the role that geo-information technology could play in facilitating a multiple actor NRM negotiation. A "joint learning" approach is put forward in order for the different actors to jointly understand their problematic situation.

The chapter goes on to describe the available instruments, my early exposure to some of them at work and at the academe, and how I used them in the present study. It refers to research paradigms of the quantitative and qualitative kind, the case study approach, and action research that helped shape the outcome of the whole research process.

2.2 The research problem

In Chapter 1, I recognized the presence of many actors engaged in their own ways with Ifugao's "problematic world" setting (see Fig.2.1). A "social actor" which, for brevity, I refer to as 'actor,' is a social entity which have "power or agency" or the capacity for voluntary action (Long and van der Ploeg 1989:241). The word 'actor' is used as metaphor to emphasize the need for coordinated action in NRM, in the same way as performing in a theatre. Thus, it can be an independent individual, but it can also be a collective of individuals as represented by formal organizations (e.g., NGO, churches) or an informal group (*e.g.,* indigenous people, tourists).

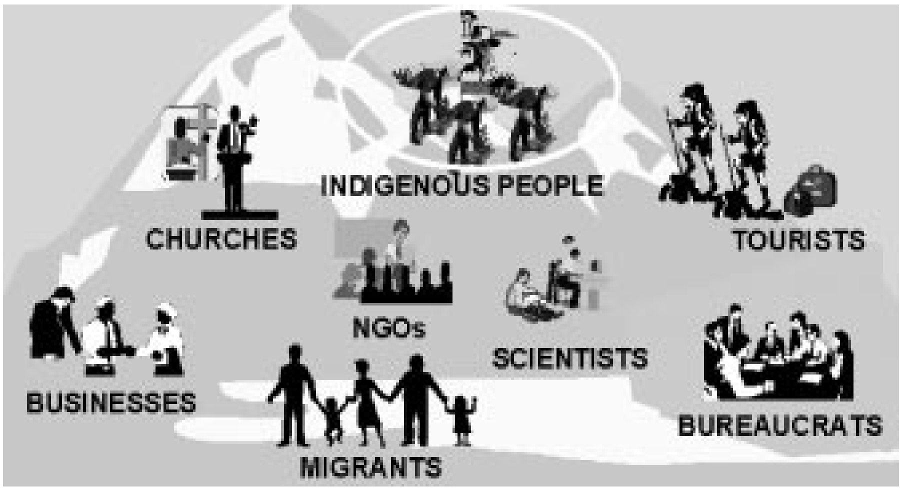

Fig. 2.1 Different actors with different perspectives in Ifugao's NRM

In the beginning, there were only the indigenous peoples of Ifugao who managed their natural resources well for centuries, until they were colonized and opened up to external political and economic influence since the turn of the century. Ifugao's NRM is now affected by the interactions among different agencies with different and/or conflicting interests and perspectives such that, an integrated approach to NRM becomes necessary. An "approach" is a way of "going about tackling the problem" (Checkland 1993:5), and an "integrated approach" is striving to facilitate for convergence. This is for different actors to work together and address the complexity of NRM. This is because, more often that not, those most affected but with no means to articulate their perspective have no other choice but to accept the dominant view. For example, "priority areas" for development have to be accepted by the Ifugaos as presented to them by the Ifugao Terraces Commission (ITC) without consciously deliberating what the local priorities are. The result is an alienated, dole-out dependent paid work force that sometimes do "lousy jobs in order to expect another round of externally generated projects" (pers.com. Manang Rose 1998). This is at the expense of a continuously eroding environment, as the reconstructed walls give way after some time. Initial findings showed that the basic issue they face is coming to terms with the multiple perspectives involved in viewing the problem, debating on it and coming up with a common view for joint action— the need to share an appreciation of and a vision for the space they share.

I entered the picture with my newly acquired skill on the capabilities of GIS for integrating disparate data about a particular space, and based on that, for analyzing relationships among “objects” found in this space. But given the multiple perspectives at play, different “objects” and different interpretations of these “objects” are expected. The capabilities of GIS for integrating, and visualizing and communicating these differences will be put to the test. In this particular case, the “objects” are Ifugao’s natural resources, which have to be negotiated among the different actors involved (*e.g.*, as to what, and where, and how, they are managed). The effort to integrate is sure to go beyond individual action models for managing the rice terraces and include the whole community which consists of interdependent aggregates of the society (such as the clans) and other entities (such as government and non-government organizations) which share the same object of activity.

The challenge is to facilitate the convergence of the different knowledge processes (pers.com. Röling 1997) of these actors in understanding and improving a problematic situation and creating “platforms for decision making” (Röling 1994). Pretty (1994) calls it “joint learning,” Daniels and Walker (1996) call it “collaborative learning” while Beek (1997) calls it “building bridges,” in arguing that the complexity of the world will only be understood through group inquiry and interaction. This implies three possible mixes of co-learners (Pretty 1998): those from different disciplines, from different sectors, and from outsiders (professionals) and insiders (local people).

In this undertaking, the last type is most discernible, and so, participation of the researcher and the researched in tackling their complex situation is first envisioned. That is, joint learning with and among NRM actors in the “agricultural districts.” Secondly, the observed proliferation of externally initiated projects in the preservation of the Ifugao environment requires some forms of negotiation (*e.g.*, setting priorities), and since higher levels of decision-makers (national and international) have become concerned with the development of Ifugao, aggregation of information for their understanding also becomes necessary. Therefore, joint learning with and among higher-level NRM decision-makers that are concerned with policy formulation, such as the municipal and provincial government, is also in order. Limited time and resource constraints allowed this researcher to actually engage with only a limited number of social actors. My learning engagement with the local Ifugao farmers was more intensive, because in the present set up, theirs are the marginalized perspectives which need to be considered in order to increase their capability in the ensuing negotiation processes.

Joint learning does not have to be carried out in a gathering of all social actors together such as being inside a classroom. It is about developing procedures to enable different knowledge processes to interact. These social actors are engaged in “social relations” and can become effective only through them (Latour 1986). These social relations enable each of them “to influence others or to pass on a command (*e.g.*, to get them to accept a particular message) which rests fundamentally on the actions of the chain of agents, each of whom translates it in accordance with his/her own projects” (Latour *op.cit.*:264). These are operationalized through “communication channels” between agencies such as memoranda, public meetings, petitions, bilateral or multi-lateral agreements. Long and van der Ploeg (1994) noted that in the process of making decisions and actions, social actors implicity or explicitly use such “discursive means” in formulating objectives and presenting arguments for the decisions taken. An example of this communication channel is described in Chapter 6.

My main consideration in focusing on the research problem is the role that GIS technology can play in it, if ever it can. The original task entrusted to me by my organization began simply by asking me how GIS could be used to systematize the growing amount of land-related work in the office, by "incorporating indigenous knowledge of NRM in a GIS." But in the course of learning the technology's strength in analyzing spatial relationships and its heavy dependence on modeling the "real world," I anticipated the implications for the organization's methods of work (discussed in Chapter 3). The question of how this "real world" will be modeled, and by whom, becomes imperative because conflicts in describing and doing something to this "real world" are inevitable, and negotiations are necessary. If agreement is reached, the model of the "real world" is necessarily a "negotiated model" or a compromise. In PRRM's parlance, it is a "leveling-off" among the actors such as the "terms of agreement" or "memoranda of understanding" that are usually undertaken with other organizations in joint projects. My aim (as for my organizational working principle) is to equip local communities to be able to jointly understand and articulate their views in such negotiation processes. GIS technology is not the solution in itself, but is a very promising tool for learning together about the environment to be jointly managed. It provides the important visualization of people's views which are difficult to verbalize.

- The research problem then, is: can GIS provide tools to facilitate thinking, negotiation, and active social construction of natural resources in shared learning and concerted decision making about NRM?

2.3 The research objectives

Based on the general research problem stated above, I came up with a research objective— one that this research hopes to achieve after considering time constraints, my organization's methods of work, the conditions in the field, and my own understanding of GIS theories, participatory, and actor-oriented approaches.

The main objective of this research is:
To explore the use of participatory methods and Ifugao farmers' participation in developing a GIS for facilitating multiple actor learning about their problematic situation in natural resource management at the local level and articulating the same at the provincial level.

The value of participation is emphasized (discussed in Chapter 4) because GIS technology and its data sources (like maps, aerial photographs and satellite images) are all products of central disposition (*i.e.*, produced by the military and technology experts) and therefore, their use usually precludes participation of local resource managers who are actually the ultimate decision-makers. Moreover, facilitation for local level NRM intervention as well as for the provincial level gives recognition to the "multi-level dimension" of actors, stakeholders or decision-makers who have common (or conflicting) interests in a particular space (Hurni 1997:213). They need to negotiate and define the next step to take. The provincial government of Ifugao, as well as the national government (by creating a presidential commission), are actively involved in shaping the local development in terms of projects to preserve the landscape and enhance tourism. They need to be adequately informed to guide their actions and/or policies which, if based on aggregated information, may also reflect local NRM managers' perspectives in the *barangay*s.

In view of the above, I considered the following specific objectives and research questions to guide the research process, and to help achieve the main objective:

Specific objective 1
To trace the history of Ifugao's NRM in order to learn about the traditional spatial information system its people used in maintaining their terrace ecosystem, and how it evolved into its present situation. *(Chapters 4 and 5)*

Q1.1 *Is it feasible to recognize and explain Ifugao's traditional spatial information system from tracing the history of its NRM?*
Q1.2 *Who were responsible for maintaining the traditional information system? How was it used? How was it maintained?*
Q1.3 *What is the present information system? What caused the changes from the traditional to the present information system?*

Specific Objective 2
To identify the past and present actors in Ifugao's NRM, to determine their corresponding interests, and/or changes in their inter-actions as a step towards understanding individual and mutual interests in NRM negotiations. *(Chapter 5)*

Q2.1 *Who are the past and present actors in Ifugao's NRM processes?*
Q2.2 *What are their interests? How have these changed over time?*
Q2.3 *What are the interactions among these actors? What are the common and/or conflicting interests among these actors?*

Specific Objective 3
To participate in and observe NRM activities of the different actors in order to better understand the processes and interactions involved and identity those with potential applications for GIS. *(Chapter 6)*

Q3.1 *What are the main NRM activities of the different actors? How do these NRM activities relate to each other?*
Q3.2 *Is geographic location important in carrying out these activities?*
Q3.3 *What information is exchanged about these activities? Who collects this information? How is it collected?*
Q3.4 *What are the potentials for local participation in developing a computerized GIS?*

Specific Objective 4
To use participatory methods with GIS techniques in developing an NRM information system that integrates qualitative and quantitative spatial information in order to make visible the different knowledge processes and facilitate their interaction in NRM at both local and provincial levels. *(Chapters 4 and 6)*

Q4.1 *What are the experiences, in the Philippines and elsewhere, of using participatory methods in the design and development of GIS?*
Q4.2 *Can qualitative spatial information like narratives and sketches be incorporated in a computerized information system? If so, how? If not, why?*
Q4.3 *Can aerial photos and satellite images of regional scale be used in participatory planning for local level NRM ? If so, how? If not, why?*

Specific Objective 5
To assess the present outcomes and the potential of the participatory GIS developed in Ifugao for effective NRM at local level, and for articulation with provincial managers. *(Chapters 7 and 8)*

> ***Q5.1*** *Can GIS effectively help different actors, including local farmers to learn together about the state of the environment? If so, how? If not, why?*
> ***Q5.2*** *Can GIS be used to help people who live in an isolated rural society, still largely relying on an oral tradition, and with limited access to electricity, learn more about their environment? If so, how? If not, why?*
> ***Q5.3*** *What is the potential for the GIS developed with the participation of Ifugao farmers to assist them in terrace ecosystem maintenance?*
> ***Q5.4*** *What is its potential in articulating local plans to provincial managers?*

The research questions are not limited to the items enumerated above. They can be considered as the major research questions, as many other questions arose in the course of the research itself, and are discussed in the narrative of the next chapters. Also, being the researcher, and at the same time a PRRM staff, brings forth questions about my role as an actor in Ifugao's NRM— am I a dispassionate observer or a consciously active participant, too? These considerations are but part of my attempt to investigate how multiple perspectives in the management of natural resources can be facilitated to converge and work towards a common objective.

2.4 Research strategy

As discussed above, the strategy I am putting forward to address the complexity of NRM is a learning-based approach— a "joint learning." Joint learning is the interaction of knowledge from different perspectives in understanding and improving a problematic situation (Pretty 1994). In the same vein, Daniels & Walker (1996:72) argue for "collaborative learning" in order to address the failure of NRM organizations in accommodating the "interdependence among good science, good civic dialogue, good local knowledge, and good learning." Woodhill and Röling (1998:47) call it "social learning" and underscore the "need to focus on integrating the creative capacities of people, whether they be land users, lay people, natural scientists, social scientists, policy makers or politicians" through cultural transformation and institutional development. Emphasis is given to "understanding" because in a complex situation involving multiple perspectives, defining the problem is itself problematic. Checkland (1993) refers to it through the German word *Weltanschauung,* which describes the existence of meanings that different people attribute to what they perceive according to the "human activity system[1]" they are engaged in, and which shapes the way they handle issues they face in this world. Zaltmann (1982, cited in Baraba 1990) calls it the "law of the lens" in using metaphor to illustrate the differences in people's perspectives likened to the use of different eye glasses. Warren (1975) calls it "world view" in recognizing that although we live in the same world, we live differently, and so we live different worlds.

It shows therefore, that at whatever scale we talk about, whether national or regional or *barangay* level, we are talking about a community of individuals with

[1] Can be the profession or discipline one is engaged in, or the economic class one belongs to.

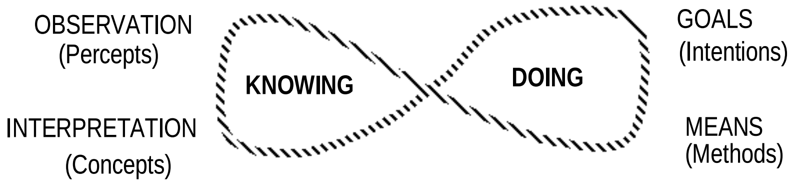

Fig.2.2 Knowledge-action path
(adapted from Bos 1974)

his/her own decision based on his/her own *Weltanschauung* or his/her own "lens" or his/her own "world view." And because of this, negotiations for meanings are inevitable in managing a common environment. Bawden, *et.al.* (1983:13) describe it as "sharing different ways of seeing the world as a first step in doing new things in it." Information describing the natural resources of this environment are presented and debated upon among different actors and form the basis for management decisions in formulating development strategies.

This research follows the learning model (Fig.2.2) with the knowledge-action path as suggested by Bos (1974). It is similar to Maturana and Varela's (1987:27) argument that "all knowing is doing and all doing is knowing." In other words, what we know depends on our experience of the world (or what we do) and what we do depends on what we know. There is iteration in the connection between action and experience which is aptly symbolized by the lemniscate (infinity symbol in mathematics). It also shows that although human beings act on concrete things, their actions are guided by images of nature (observation and interpretation) as perceived by them (Nazarea-Sandoval 1991). Observation and interpretation, or the path of knowledge, enlighten the path of choice that is bound by the goals or objectives and constrained by the means. These activities continue and the paths of knowledge and action are "alternately moving into the foreground or receding into the background" (Bos 1993:4) as one performs periodic assessment of results. This means one may choose to improve on one path or the other depending on the necessity at any time. For example, if the ability to know is improved, then later, the ability to do things may improve as well. Bawden and Macadam (1991:1) succinctly put it this way: "As what we do in this world is determined by the way we see it, then if we want to

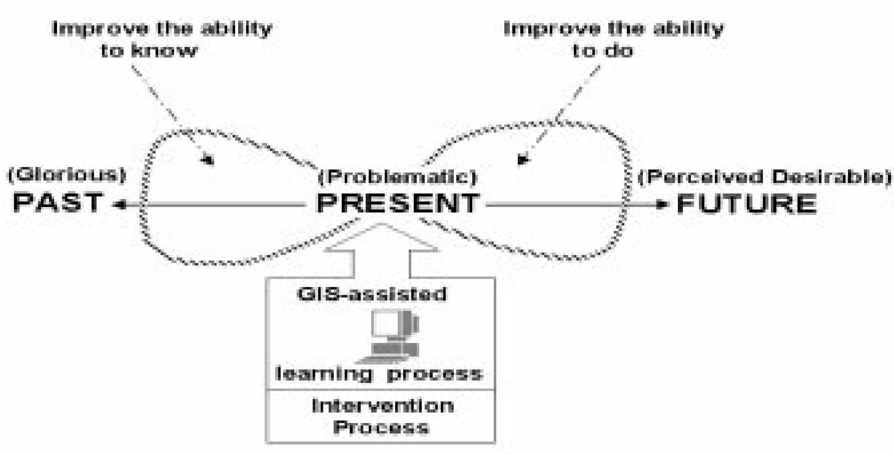

Fig.2.3 Ifugao's GIS-assisted learning context

change the way we do things, we need to change the way we go about our seeing." And since each path continuously feeds on the other, then as the ability to do things are improved, the knowledge path is further enriched— that's the iteration between knowing and doing.

In Ifugao's learning context using the lemniscate knowledge-action path, the strategy for a GIS-assisted joint learning process (Fig.2.3) begins with tracing its "glorious past" in order to gain insight into its problematic present (Chapter 5) and to work for a jointly perceived desirable future (Chapter 7). In particular (as a specific research objective), the possibilities are explored for developing a computerized GIS with local participation that is informed by experiences in the traditional NRM.

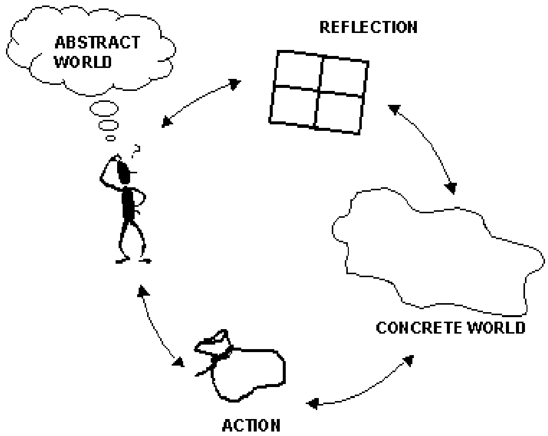

Fig.2.4 A learning process (Bawden and Macadam 1991)

Bawden and Macadam (1991:1) illustrate the dynamic process of learning (Fig.2.4) which they call a "flux between sensing and making sense." It is an ever-recurring process of seeing "reality" through our own "little window" *(Weltanschauung)* on the concrete world, such that "what we will find out, is in part, pre-determined by the perspective we adopt" and "what we do in the world is determined by the theories we construct from our experiences in it"— again, the inseparability of "knowing and doing." The "little bag of tricks" represents constructs like explanations, hypotheses or theories that we develop from what we see in this world, and which get tested as we go about experiencing it. This process of learning

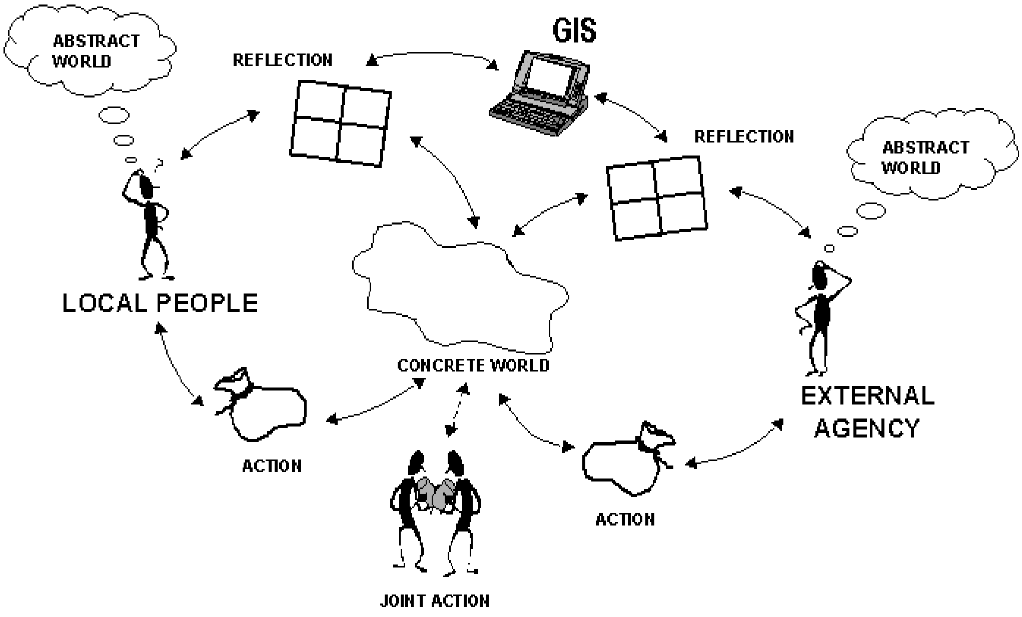

Fig.2.5 GIS-assisted knowledge process interaction in learning about the world

about the world extends to what Kuhn (1962) calls "paradigms" that provide model problem-solution examples that have to change ("paradigm shift") when new experiences no longer conform to them ("anomalous").

I borrow the Bawden and Macadam model, which I find more illustrative (than the Bos model) when applied to the "joint learning" process among the many actors of the Ifugao setting, and to the role that GIS could play in it (see Fig.2.5). Local people and external agencies, with their own "little windows" on the concrete world they share, and with their own "little bags of tricks," are facilitated by GIS to make visible to themselves and to each other a glimpse into their "abstract world." It is like the expression, "See what I mean?" in the interaction of their knowledge processes, as they debate each other's worldviews. When a valuable insight into a problematic situation is exchanged (through language, action) between actors, Nonaka and Takeuchi (1995:11) call this process "conversion of tacit knowledge to explicit knowledge." That is, one's personal "hunch" which is very difficult to express (*i.e.*, "tacit knowledge") may be made "more explicit" during the course of visualizing and verbalizing and demonstrating— a knowledge sharing process. It is done this way, because as Khun (1962/1970:196) explains, "We have no direct access to what it is we know, no rules or generalizations with which to express this knowledge." Due to this limitation, the kind of "knowledge embedded in the stimulus-to-sensation route (especially those possessed by so-called 'experts') remains tacit" (*Ibid.*). Concepts about knowledge and knowing are further discussed in the next chapter. Operationalizing this "joint learning" configuration in the field is discussed in detail in Chapter 6.

2.5 A mix of methods

Manuals for conducting research and technical writing (Parsons & Knight 1995, Silverman 1996, CBE Manual 1988) define methodology as consisting of principles and practices of orderly thought or procedure, usually consisting of steps, applied to a particular discipline. The 1991 Random House Dictionary of the English Language defines methodology as a "system of methods, as those of science, and the underlying principles and rules of the system or procedure." These definitions combine the notion of a general guideline for action like "principles" or "philosophy," and the rigidity of a distinct set of "steps or procedures." Considering the complexity of the natural world and the human activities in it, a methodology for investigating a phenomenon has to be flexible and cannot be as precise as a step-by-step procedure. However, it will be a firmer guide to action than a philosophy. Taking this line, the conduct of this research does not follow the preciseness of a "method" or technique like a cookbook, but borrows from different methods, following what this researcher believes could be known by employing a particular method. For example, I interviewed the elderly or the former *tomoná* in order to understand the management structure and procedures in the early Ifugao's NRM; I asked a group of farmers to jointly sketch their village in order to obtain their common view of the environment.

Strauss and Corbin (1994) encourage such practice in support of Grounded Theory: a general methodology for developing theory that is grounded in systematically gathered and analyzed data (inductive data analysis). It allows researchers to utilize methods and theories held in previous researches provided they are relevant to the present inquiry. The use of multiple research approaches is an attractive strategy to overcome the drawbacks of individual approaches (Smithson 1991). The outcome of the research is therefore not a method but "a set of *principles of method*, which in any particular situation may have to be reduced to one uniquely suitable to that particular situation" (Checkland 1993:160). This general framework is declared an alternative to the "hypothesis-testing-and-bashing type" of research which is the dominant research procedure, called "positivist research." That is, a position (or hypothesis) is declared right from the start and is tested during the research process. This is suitable only to well defined problems which can be reduced to "making a choice between alternative means of achieving a *known end*… characteristic of all hard systems thinking" (Checkland *op.cit.*:15; italics mine). A fitting example is a sausage factory, where different ingredients are mixed and a known end-product is obtained; the problem revolves around choosing the best means of doing it.

The present research about Ifugao's problematic situation is an "ill-structured problem," because as Checkland (*op.cit.*) describes, it revolves around human understanding or sense making about the environment. This is more appropriately addressed by "soft-systems thinking" (*Ibid.*). In this case, even defining the problem is itself problematic, and the outcome is *unknown*. Therefore, in cases like this, the "situation in which the perceived problem lies (rather than the problem itself) is expressed" (*Ibid.*). I found out that the crumbling terraces of Ifugao are only the manifestation of a societal problem, and the problem of having different NRM actors doing their own thing. This is a complex situation involving human activities in space, and there is no quick nor single solution. I have to engage with the actors themselves to find out, in their view, how to improve their situation.

Given such a complex problem situation, this research is an exploration using a mix of methods that I deemed appropriate in every stage of local engagement—such as case study, interview, observation, interaction, historical analysis, in order to connect the relationships of events and personalities in the complex situation. Literature search reveals that this is following in the line of what is called "qualitative research" (Strauss and Corbin 1990; Frankfort-Nachmias and Nachmias 1996; Denzin and Lincoln 1994). Other relevant types of qualitative research are: grounded theory, ethnography, phenomenological approach, life histories, conversational analysis, and action research (see Strauss and Corbin 1990 for more details).

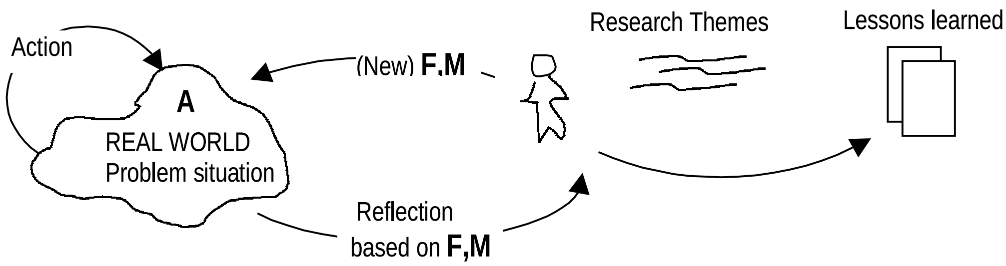

Fig.2.6 The action research cycle
(adapted from Checkland 1993)

This study takes after the action research type, which is characterized by: collaboration between the researcher and actors in the area, a process of critical inquiry, a focus on social practice, and a deliberate process of reflective learning (Checkland 1993). This engagement of practice and analysis contributes to theory building. Action research gained ground in the 1950s and is credited to Kurt Lewin's[2] view of the limitations of studying complex real social events in a laboratory-like fashion of artificially segregating one behavioral element from an event. The researcher becomes directly involved in the ongoing work and feeds results back to the other actors "to achieve practical or political improvement in the participants' lives (Clement and van den Besselaar 1993:33).

Action research is carried out thus (Fig.2.6): with a declared framework (**F**) of ideas and concepts, and method (**M**) for applying **F**, the researcher gets involved in the unfolding situation in the research area (**A**) with the view to helping bring out changes deemed "improvements" as negotiated with the actors involved. At the same time, the researcher is trying to make sense of the accumulating experience by means of the declared **F** and **M,** and in the process, learn more about the **A**, **F**, and **M**. Finally, the researcher exits from the situation and reviews the experiences in order to extract the various kinds of lessons which eventually join and enrich the sea of research themes because of a new understanding of **A**, **F**, and **M**.

This action research process in Ifugao is summarized thus:

1. *Enter Ifugao area* **A** *problematic context*:
   - breakdown of social structure, environmental degradation, the search for a better strategy to improve the situation.
2. *Establish roles*:
   - researcher and researched in knowledge interaction
3. *Declare methodology* **M** *and research framework* **F***:*
   - qualitative research, mix of methods (**M**) for a "joint learning" approach (**F**)
4. *Take part in the research process*:
   - community integration (*i.e.,* living in and interacting with actors in **A**)
5. *Rethink 2,3,4*
   - modify **F** and/or **M** if necessary in order to learn more about **A**
6. *Exit:*
   - back to academic/theoretical explorations to draw the relationships between the experiences in **A**, and the **F** and **M** used
7. *Reflect and record learning in relation to* **F**,**M**,**A**:
   - writing of this report

As the cycle goes on, the **F**, **M**, and **A** are changed as improvements are made and as the researcher and researched adjust to contingencies that arise in the process.

2.6 Quantitative and qualitative research

My decision to follow in the line of action research cycle calls for an understanding of what qualitative research is and how it is done. This is best understood by contrasting it with quantitative research. Definitions are a good start.

[2]According to Checkland (1993), notably, *Field theory in social science (1951).*

"Quantity" is: 1. A specified or indefinite number or amount. An exact amount or number. 2. The measureable, countable or comparable property or aspect of a thing (Random House Dictionary of the English Language 1991). This means that in measuring quantity, a number is assigned to represent magnitude according to a comparable, pre-defined unit like a centimeter. The magnitude of the measured quantity is compared to a standard quantity, whose magnitude is established or agreed upon (Hernandez 1994). There are also cases when different standards are used for measuring a quantity. For example, in measuring temperature in terms of ^{o}C and ^{o}F, a person used to the Centigrade-scale will have to think harder (conversion from one scale to the other) to make sense of the temperature expressed in the Farenheit-scale (and vice-versa). "Quantitative" knowledge is obtained whenever a standardized scale is used for anchoring the represented magnitude (*Ibid.*). The scale is the context that allows everybody to make sense of the magnitude. Quantitative research is founded on René Descarte's[3] argument for "certainty and self-evidence" such that "in the search for truth, investigators should stand back from those elements of the world that may otherwise corrupt their analytic powers" (in Hamilton 1996:62). The importance of mathematics and "objectivity" in the search for truth, in describing the "real world" is highlighted. Quantitative research therefore, uses mathematics or statistics in analyzing data to show the researcher as a detached observer, using the third person passive mode in reporting, to demonstrate his/her "objectivity" in arriving at conclusions or the "truth." As Snyder (1978, in Hirscheim 1985:20) notes: "…the Cartesian framework carried natural science as far as it could in the attempt to understand nature as something wholly distinct from the human observer." That is, the separation of mind and body.

"Quality" is: 1. A typical or essential feature or characteristic. 2. Character or nature, as belonging to, or, distinguishing a thing (Random House Dictionary of the English Language 1991). Quality, therefore, depends on someone who determines what is "essential" or not, in a given context. The word "qualitative" implies an emphasis on processes and meanings dependent on someone's value judgment and are "not rigorously examined or measured in terms of quantity, amount, intensity or frequency" (Denzin and Lincoln 1994:4; Silvermann 1997:1). Qualitative research, according to Strauss and Corbin (1990:17), is "any kind of research that produces findings not arrived at by means of statistical procedures or other means of quantification." This is because the variables of the study situation are not visible nor quantifiable— like human behavior. Although some of the data may be quantified as with census data, the analysis itself is a qualitative one.

Denzin and Lincoln (1994:2) further describe that qualitative research is "a multimethod, interpretive, naturalistic approach to its subject matter" as things are studied in their natural settings. The combination of multiple methods, empirical materials, perspectives and observers in a single study, sometimes called "triangulation," is an alternative to validation as this strategy "adds rigor, breadth, and depth to any investigation" (*Ibid.).* It was Kuhn (1970, in Hirschheim 1985:33) who argued strongly for "methodological pluralism" when he said: "The pull towards a single methodological perspective, with its clearly defined tools, needs to be resisted

[3] According to Hamilton (1996), notably, *Discourse on method* (1637).

because this single perspective designed for research in the 'normal science[4]', overlooks the anomalous quality of human experience. The difficulty for human science arises not from the need to change from one paradigm to another, but the need to resist settling down to any single paradigm."

Immanuel Kant[5] was the most prominent person who argued against Cartesian objectivism and ushered in the seeds of qualitative research. He recognized not just the imperfections of instruments for observation, but more importantly, that descriptions of the "real world" cannot be independent of the "inside-the-head" processes of the observer (and the observed, in the case of human subjects of inquiry) during data collection and later in the interpretation of results (in Hamintol, *op.cit.*). Kant and his successors and variants (*e.g.,* Georg Hegel, Karl Marx, Martin Heidegger, Thomas Kuhn, Jürgen Habermas) pointed out that perception is more than seeing; and that human knowledge is ultimately based on understanding, which is a mental process that cannot be separated from a person (Hirschheim 1985, Kuhn 1962/1970). The assumed disinterest of the observer (being "objective") is rejected by this school of thought, such that research is viewed as interactive (between the researcher and the research). This extends ultimately to the dabate about the nature of the "real world" itself, and is taken up in Chapter 3.

The main implication of these qualitative/quantitative differences for this research is that GIS, with its heavy reliance on modeling the "real world," has to consider both quantitative and qualitative representations of spatial knowledge. Frank (1996) also noted that qualitative (even incomplete) observations of space and reasoning are widely used by humans to understand, analyze, and draw conclusions about their environment. Hence, both the quantitative requirements of the technology and people's qualitative accounts, such as stories and sketches (quantification of qualitative knowledge, *e.g.,* in classifying space), which portray different views of a particular space have to be considered in the development of a GIS. Thus, the use of both quantitative and qualitative research methods are being proposed in this study. Analyzing qualitative data can be done by employing nominal and ordinal scales. With nominal scale, variables are nominated to a set or class described by name with no specific order (*e.g.,* rice, sweet potato, vegetables to inventorize crops); frequencies and aggregate totals may be obtained. Ordinal scale lists discrete classes with an inherent order or ranking (*e.g.,* high, medium, low). In both cases, no mathematical operations are involved. Other ways to quantify observations use interval scale and ratio (for more details, see Richards and Richards 1994, Lincoln and Guba 1985).

2.7 Computers and people

My decision to borrow from both qualitative and quantitative research methods can also be traced to the very nature of geo-information technology. It belongs to the family of information systems, which is "a social rather than a

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[4] Khun (1962/1970:10) defines 'normal science' as "research firmly based upon one or more past scientific achievements that some particular scientific community acknowledges for a time as supplying *the* foundation for its further practice" (italics mine, to emphasize adherence to a paradigm or model of the real world and the accompanying methods of inquiry about this world).

[5] According to Hirschheim (1985), notably, *critique of pure reason (1781).*

technical system" as it deals with communication of meanings between or among humans (Mumford, *et.al.* 1985:13). Nissen (1985:42) points out the misconception that "only the computerized parts tend to be called information system" and argues that "information systems development and use involve people in action; they are also based on human reasoning developed within the fields of logic and mathematics; they further comprise human use of language for arguing in everyday life.. in order to infuence human action." More emphasis should therefore be given to the neglected social dimension of information sytems. However, its being computerized makes it rigid in terms of modeling and therefore embedded in a rigid (*i.e.*, precise) representation of "a piece of reality" that it hopes to give information about. Furthermore, because "every representation is an interpretation" (Winograd and Flores 1986:35), accommodation of different interpretations is necessary in espousing participation.

Looking back some more in time, another consideration is the nature of work with the PRRM. Being engaged in rural development work, people and meanings that people ascribe to their environment were at the center of my concern. Personal fancy with computers and their use in rural development found its expression in working with the People's ACCESS (Alternative Center for Computer Education and Services). It belongs to PRRM's circle of organizations, but one which specifically devises ways to harness computer power in facilitating our work. It is engaged in computer literacy programs, creating databases about the physical and social environment of rural communities that this circle of NGOs works with, and facilitating computerized communication among these NGOs. Such was my casual entry into dealing with computers and people in the NGO environment of "capacity building" and "people engagement" in their own development process.

But after embarking on exploring the possibilities with the newly emerging GIS technology at ITC[6]-Enschede, I found myself seriously occupied with, and realized that I was all along engaged in, "systems analysis and design" with what I later came to know as the "hard systems" tradition. This is essentially the same as "systems engineering" and is traced to the 1950s when the RAND Corporation of America developed "systems analysis" as a "means of rationally appraising the alternatives facing a decision maker" (Checkland 1993:15). They employ the so-called "hard systems methodology." The "hardness" does not refer to the difficulty or quantifiable (concrete) nature of the problem, but to the method of inquiry that selects "between alternative ways of achieving a defined and unquestioned goal" (Lewis 1994:18). That is, the systems engineers know what must be done, and their problem is directed at the best way do it. The success of hard systems methodology led to attempts to use it in problems of social systems. They failed, because this time, purposeful human beings are a major component of the problems. Lack of consensus, fuzzy goals, ill-structured problems, "wicked," and "messy" characterize the problems involving social systems (*Ibid.*).

Checkland (*loc.cit.*) introduced the "soft systems" methodology that differs from the hard kind in that the "known–to-be-desireable ends cannot be taken as given," but are part of the problem themselves. Soft systems methodology is based upon a learning model rather than optimisation (or choosing the best means). He

[6] International Institute for Aerospace Survey and Earth Sciences in Enschede, The Netherlands.
(I affixed Enschede in order to differentiate it from the other ITC, the Ifugao Terraces Commission)

argued that human beings cannot be treated in the same way as natural systems because people have consciousness and free will, and are capable of giving meanings to what they perceive from the environment. Hence, the "desireable end" has to be negotiated and perhaps, re-negotiated as it may change with time, depending on what is perceived by the people concerned.

This research was a revelation of sorts for me, as I got exposed to the "other paradigm" in the conduct of serious investigation and periodic consultations with the Department of Communication and Innovation Studies in Wageningen,[7] notably with Prof. Niels G. Röling. He views "soft systems" thinking as the more appropriate approach to human activity systems as it takes to account the different ways people or social actors look at a problematic situation— that which describes Ifugao's multiple actor situation. After undergoing an unlearning and re-learning process, I later traced these distinctions to the basic epistemological debate about reality: the "positivist" (posits an objective reality) and the "constructivist" (socially constructed reality) viewpoints (see Chapter 3). The former had been more influential for its being the norm in my entire academic life until then.

From then on, I found myself straddling two competing paradigms and trying to balance my way across as I undertook this research. My biases can be seen occassionally as I shift methods to take advantage of strengths or go around weaknesses of one or the other. This I did cautiously with the able guidance from Prof. Klaas Jan Beek of ITC-Enschede. He advocates "building bridges" across disciplines in order to increase our understanding of this complex world, and reach agreements in managing it more sustainably. Dr. Michael K. McCall, also of ITC-Enschede, provided the energy in pursuit of mainstreaming indigenous knowledge. I am in a peculiarly difficult position, but a very challenging one, that I consider myself very lucky to get advice from such a combination of people in the know, to be able to grasp concepts that I had taken for granted before. Participation, empowerment, sustainable development, information systems, GIS modeling and the nature of the real world are some familiar concepts that have taken on new understanding for me, and which are strewn all over this book. The next chapter traces and expounds this new understanding. I limit my inquiry into possible room for local participation and the roles that other social actors can play in developing GIS-assisted NRM processes that build upon joint-understanding of the common space to be managed.

[7] Wageningen University in Wageningen, The Netherlands.

Chapter 3

Shifting viewpoints: GIS in a different light

Struggle to live in a fragile environment.

3.1 Introduction

This chapter is about the institutional setting and theoretical moorings that helped make my way in bridging participatory methods and information systems design concepts. I start by describing PRRM's methods of work and its need to systematize the storage and use of the growing amount of data about the status of resources and the people in its areas of operation. GIS is a new technology that seemed to fill this need. However, in learning *about* GIS to carry out an organizational task, I came to know how learning *with* GIS could reinforce a whole organizational practice of building on what the people know. My exploration took me to the periphery of learning's less trodden grounds of what is called constructivism. The principles of constructivism can be applied to learning with GIS, as constructivist theories of cognition describe conditions of learning ideally facilitated by GIS— *i.e.*, exploring, monitoring, spatial reasoning, and generating new perspectives. This insight provides the theoretical basis for a GIS-assisted joint learning approach in exploring and understanding Ifugao's complex problem situation.

3.2 PRRM's development intervention

The Philippine Rural Reconstruction Movement (PRRM) is a non-government organization (NGO) engaged in helping rural people build working models for self-governing, self-sustaining communities by jointly designing and implementing development programs in the countryside. It was founded in 1952, in the tradition of Dr. Y.C. James Yen of China's rural reconstruction principle of building on what the people have and what they know (see Box 3.1). As such, PRRM's area development work is anchored on participatory methods (see Chapter 4) to enhance local knowledge processes.

Box 3.1

Credo of Rural Reconstruction

Go to the peasant people
And live among them
Learn from the peasant people
Plan with the peasant people
Start with what they know
Build on what they have
Teach by showing, learn by doing
Not a showcase, but a pattern
Not piecemeal, but integrated approach
Not to conform, but to transform
Not relief, but release.

\- *Y.C. James Yen*

PRRM began as a small group of prominent Filipinos led by Dean Conrado Benitez of the University of the Philippines, and (as of 1998) has grown to 300 full-time and multi-disciplinary workers who are spread in 20 provinces across the country (PRRM 1998). Its field officers organize local inhabitants that belong to the marginalized sectors of the society— the agricultural workers, subsistence fisherfolk, tenant farmers and small-owner cultivators, indigenous peoples, rural women and the youths. They are organized into voluntary associations and cooperatives, called "civil society institutions" that form the bases of sustained initiatives through the following empowerment activities:

- conscientization and education
  - arousing community awareness and improvement
- mobilization and leadership formation
  - engaging in joint-projects and sharing of responsibilities
- skills and technology development
  - facilitating local capacity-building and innovation

These activities enable local inhabitants to advocate policies and programs that can lay the ground for genuine development for their benefit. This is in response to the failure of the mainstream development model to address poverty[1] and environmental degradation in the country. This intervention scheme is but an empowerment facilitation that is carried out in three stages: entry, consolidation and withdrawal. This is to prevent dependence of local organizations on the intervening NGO, and to ensure the long-term viability of development in the hands of the people who have to realize that only they can empower themselves. Their empowerment cannot be handed to them. By experiencing actual negotiations, they learn that they can achieve it by getting organized (*e.g.*, associations, cooperatives, federations) to strategize in engaging with other actors such as those representing the state and corporate sectors. Lobbying, advocacy, and elections (getting their ranks elected in government posts) are their main forms of assertion.

[1] 32.1% poverty incidence in 1997 (IBON Databank).

PRRM started its entry phase of organizing and joint-project identification in Ifugao in October 1988, and is presently consolidating local initiatives to scale-up and ensure that their capacities, practices, and resources are in place before withdrawal. This includes strengthening the CB-NRM councils (community-based natural resource management councils) which play major roles in local development planning. A part of this process is harnessing modern technology such as GIS to help "systematize" the yearly collected data about the status of resources to be managed in the area. These data are the bases of the CB-NRM councils' yearly local development planning and periodic assessments (see Chapter 6). I was specifically tasked to learn how to use GIS technology to reinforce this activity, and this research is intended for a pilot study. It aims to guide replication to other PRRM branches across the country.

However, after learning about GIS, I got to know that it is not only used to "systematize" spatial data. Its strength is in analyzing spatial relationships that could generate new insights about the space being managed, and which could help negotiate its use. This is expounded in the next section.

3.3 A new technology at hand

Definitions of GIS vary with every book about it. But most describe it as a computerized database about spatially referenced (or geographic) phenomena on earth that provides the following four sets of capabilities to handle the data: input, management (storage and retrieval), analysis, display (Burrough 1986, Aronoff 1989, Goodchild and Gopal 1989, Frank 1993). GIS has its roots in the traditional maps and cartographic processes, but its major difference from the analog counterpart is that it consists of an "organized set of numbers" (Berry 1995:ix). This provides possibilities for new procedures involving spatial statistics, map algebra, spatial analysis, and modeling which are done through computerized map overlay procedures to derive new information from the original set of data. They help generate views which are not seen before by combining, displaying, and debating about the results of analysis (*Ibid.*). These spatial analysis functions distinguish GIS from other types of information systems and make it suitable for various applications wherein geographic location is important to the analysis. There are several good introductions to GIS in Maguire, *et.al.*, (1991), Burrough (1986), Aronoff (1989), Thompson and Laurini (1992) which provide comprehensive overviews of GIS and its applications. One important application area is providing decision support for NRM. It is now widely used in land use planning, forest monitoring, bio-diversity conservation, and protection of habitat (Maguire, *et.al.* 1991).

In GIS, data are represented as layers (like several map sheets) with a particular theme on each that describes the environment under study (Fig.3.1). For example, roads and railways may be combined in a single layer of transportation data layer; forestland, terraced farm, grasslands may be combined in a single layer of landcover/landuse data layer. For each of these map layers, attribute data (descriptions about each feature of a data layer) can also be represented in tabular form, which are organized to maintain the links with the graphic form (see Chapter 6). Information within each of these layers can be arranged using two common formats or structures: raster and vector data structures (less common are the triangulated irregular network or TIN and Quad-Tree structures; for more details, see Aronoff 1989).

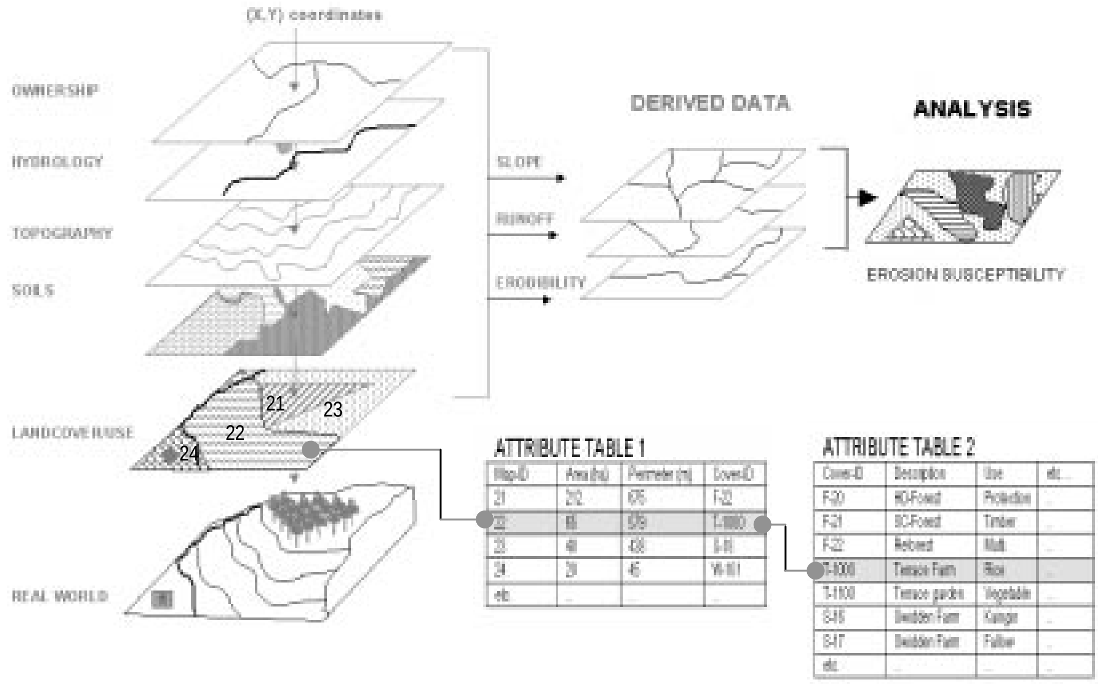


Fig.3.1 An illustration of GIS data organization and analysis

The raster format organizes data by subdividing space being studied into imaginary regular cells (commonly square shaped, called “pixels”), and the location of a geographic point feature is defined by the row and column position of the cell it occupies, line features as connected cells, while areas are identified as all of the cells comprising a feature (denoted by an identifier). With the vector format, a point feature is defined by a coordinate pair (X,Y), a line as a set of connected X,Y coordinates, and a polygon as a set of X,Y coordinates that close on itself. This makes crisp objects and so, vector format closely approximates hand-drawn maps; data processing in raster is faster. Which structure to use depends upon the purpose and/or limitations of a particular project or research, *e.g.*, available software and data. Ideally, modeling comes before deciding on which software to use, but sometimes (as in this research), hardware and software are pre-given. My discussion is limited to descriptions of these data structures (for more details about spatial data modeling in GIS, see Aronoff 1989, Peuquet 1990, Burrough and McDonnel 1998, Molenaar 1998).

The raster and vector formats of organizing data offer possibilities and constraints in representing the “real world.” In GIS, there are two ways of “viewing the real world”— the field view and the object view. In the field view (see Table 3.1), the world is assumed to be a “continuous field” and every point in this field is described by thematic attributes (*e.g.,* soil type, land cover) at that point; processes are described by changes in the attributes at a point and its neighboring points (Cheng 1999). In the object view, the world is assumed to be made up of “discrete objects” (with crisp boundaries) and every object (*e.g.,* canal) is described by thematic attributes (description of characteristics *e.g.,* length, width, construction type, etc.) and geometric attributes (description of boundaries); processes are described by the changes in the state of the object defined by the changes in its thematic and geometric attributes. Chapter 6 explains how I decided which view of the real world in GIS I used in this research.

Table 3.1 Two ways of viewing the world in GIS

	Field view	Object view
Assumption about the world:	A continuous field which can be modeled by mathematical surface functions	Made up of discrete, but interacting objects which can be modeled by points, lines and polygons
Which is described by:	1. A point (location x,y) 2. Thematic attributes at the point	1. Thematic attributes of each object 2. Geometric attributes of the object boundaries 3. Unique object identifier that links the object's thematic and geometric attributes
And processes described by:	Changes in the attributes at the point and its neighboring points	Changes in the state of the objects

Recent developments in spatial data handling (Burrough 1992, Molenaar 1998, Cheng 1999) recognize the uncertainties involved in defining object boundaries because, especially those of natural resources are not really crisp (*i.e.,* soil, forest, landforms). The problem extends to defining the objects themselves— existential, extensional, geometric uncertainties, due to difficulties in describing the complex real world (for more details, see Molenaar 1998). The use of "fuzzy sets" Zadeh (1965) is breaking new grounds in handling spatial objects' complexity through partial membership functions (*i.e.,* the object's membership in a class). It facilitates modeling objects with indeterminate boundaries (not crisp) as "fuzzy objects."

This discussion clearly shows that GIS relies heavily on representations or models of the real world as data about geographic phenomena that are of interest to the modeler are collected and organized according to an understanding of such phenomena. This is finally done in a computerized database, and so, models are technology-constrained, too. Moreover, we live in a complex world (*i.e.,* intricately connected, complicated relations and phenomena), and so, this complexity makes us select only the details which are relevant for our purposes. In this selection process, we create a "conceptual model" or an understanding of what the world is and how it behaves. Thus, even if a concrete world exists, the "real world" we talk about refers to our perceived view (our model) of what the world is and how it operates. This insight on the workings of GIS and my field experience in modeling Ifugao's complex problem situation made me rethink my understanding of the world model I am trying to investigate here. Am I a dispassionate observer and modeler of an objective reality? I shall clarify this matter in the next sections. So far, I have shown that when we need to make decisions, we refer to the world model we created which is much simpler than the real world itself because we pre-select details or data about it which are relevant to our purpose.

Mapping in GIS helps analyze and derive relationships among the gathered data about phenomena. It offers a tool to extend our understanding of our world that helps us make informed decisions by making visible their relationships in space— it not only shows "where is what," but helps the viewer infer the "so what?" after correlating the mapped phenomena. This is demonstrated in Chapter 6, when I inspected the 3D view of the terrain and visualized the organization of the "water districts". As I point out in Chapter 2, learning together with GIS can help make such relationships visible to one another. And if agreement is reached, the model of the "real world" is necessarily a negotiated model that draws on various models of the "real world". How the negotiated model emerges and changes under different interpretations becomes crucial for decision making, because this process makes way for dialogues that communicate meanings to deepen joint understanding of the common space to be managed. This is illustrated in Chapter 5, when the provincial government realized the significance of the "water district" boundaries instead of the political-administrative boundaries they are using. In the joint-learning strategy I put forward (see also Chapter 2), this model negotiation process directly involves the views of local decision-makers about meaningful boundaries instead of simply implementing choices based on an externally designed model of their world (see also two models of understanding Ifugao's watershed in Chapter 5).

This awareness about the real strength of using GIS in analyzing the space we live in made me diverge from my original organizational task. I saw its potential to help understand, and make visible this understanding of the "world", from the perspective of our rural farmers which is often un-represented and/or taken for granted in the mainstream development process. I saw its potential to equip them in NRM negotiations by being able to articulate their views through maps and map analysis in joint learning with other actors (see Chapter 2). However, as I explain in Chapter 5, in order to mediate the use of this technology, I needed to immerse myself in various aspects of local life, concepts, and institutions. Making acquaintance with local ways was essential for comprehending NRM processes and information use that are built around their world model; an information system is going to be built to serve it and communicate with other NRM actors.

The next section discusses the research output in consideration of the conceptual underpinnings and methodological constraints. These explain the way I used GIS with the Ifugaos.

3.4 The nature of the research output

Before setting up my computer, I first investigated how Ifugao's NRM is done in order to see where GIS application can play a role. To this end, I spent the first 3 months of my fieldwork time in familiarizing myself with daily life in Barangay Bangaan[2] and four other *barangays* in the study area. After the initial introductions, I immersed myself in Ifugao life and worked with them for 10 more months. This allowed me to experience one whole agricultural year while observing and discussing, and joining local meetings called 'community development planning' (see Chapter 6 for more details).

I also tried hard to blend with the local inhabitants in order to have a "feel" and "know" their lives. But I can never avoid the fact that I come from Manila, which is a very different cultural and socio-economic environment. In going around the study area, somebody had to be assigned to assist me in going up and down their terraced paths. This caused some delays, settling down in more accessible areas, awkward moments, and making fun of our differences. Likewise, by force of tradition, local inhabitants cannot refrain from giving me special treatment, for

[2] PRRM has a field office in Barangay Bangaan which helped me establish local rapport.

example, in assigning the best seat, in choosing the plate to eat, in inviting me to every social occasion. Some of them also tried to keep troublesome or embarrassing incidents from me, but I later knew from others— *e.g.,* water disputes during the El Niño, failure of one person to settle a loan that created confusion during harvest time, a boundary dispute between two *barangays*, petty robbery, disobedience of the young males to fetch the bundles of harvested rice atop the mountain terraces. The time I spent with them may also be too short, but I came to realize that I can never be just one of them, and that I am a guest, an external entity, an outsider, or an alien with my own “little planet” (the term they used to jokingly describe my office-bunk). There will always be some aspects of their lives that I, or any researcher for that matter, will never know. And those that I have known were seen from my own “window”, “lens”, or *Weltanschauung* (see also Chapter 2).

In this sense, I agree with Tamborini (1997:57) in synthesizing the findings of Piaget (1970), Maturana and Varela (1987) that “knowledge is not a direct representation of the world, but is rather a representation of the experience of the world”. Winograd and Flores (1986:74) likewise argue that “knowledge is always a result of interpretation which depends on the entire previous experience of the interpreter and on situatedness in a tradition; it is neither ‘subjective’ (particular to the individual) nor ‘objective’ (independent of the individual)” because it depends on commonly held beliefs. This is a relevant insight for me, as I have been raised and educated in striving for value-free and objective knowledge— that a researcher is a detached observer and therefore what he/she finds out is an “objective account” of reality. However, my field experience as researcher, a PRRM staff, a woman, and an urban professional, all in one, shaped the window with which I see Ifugao’s problematic situation. In the same way, I interacted with the farmers, the community organizers, the *barangay* captains, the municipal councilors, the provincial board members, the vendors, the tourist inn operators, the jeepney and tricycle drivers, the PRRM branch manager, the rest of PRRM’s staff, who each have their own window with a particular view and meanings, interests, and power relations within (and without) the research situation. We were active, value-laden, and purposeful participants. We were inter-actively producing the “relevant data” for this research when we talked about their work, their problems, their responsibilities, and their daily lives. What is a problem for one person (*e.g.,* abandoned neighboring terraces that invite pests) may not be a problem for another person (especially if he/she benefits from the situation); and I may also see a different problem (*e.g.,* a changed life style).

I therefore say that this research can never lead to a “value-free” and objective conclusion about what Ifugao is and how its resources should be managed. The local inhabitants and I were engaged in producing the model and the data of the study area through selective exchange of facets of our joint experiences, the analysis of which cannot wholly describe the “reality”. At best, we came up with agreed upon, useful concepts and procedures to improve some aspects of their problem situation during the period of this study. For example, the GIS-assisted terrace monitoring system that we designed (discussed in Chapters 6 and 7) can detect the changes they see in the degradation of the physical structure that need immediate attention (*e.g.,* erosion, irrigation, worm infestation), but it cannot capture the changes I saw in the Ifugao culture (*e.g.,* religion, education, organization) which greatly contribute in eroding the structure. The research output therefore, becomes a jointly determined product of the perspectives, purposes, and articulations of the researcher and the researched.

3.5 GIS and constructivism

The above discussion cannot avoid but point to the basic debate about the nature of knowledge and ultimately, the nature of reality— the objective, value-free stance of the conventional positivist view on the one hand, and the emerging socially-constructed world of the constructivist view on the other. This report does not intend to go deep into this paradigm clash, and I do not have the competence to do so. However, I will not dismiss it altogether as a domain that should be left only to philosophers, because of its implications for the joint learning approach I put forward to understand Ifugao's problem situation. It tells something about how we learn and what we learn, which is essential in working for an improved situation. Among others, Mumford, *et. al.* 1985, Maturana and Varela 1987, Guba and Lincoln 1989, Hirschheim, *et.al.* 1991, Röling 1996, Jiggins and Röling 1996, give comprehensive accounts of the issues surrounding the basic differences between these paradigms or "belief systems" that represent the most fundamental assumptions we are willing to make, and guide our activities in this world. I shall cite the salient points I gathered from literature about the new paradigm with respect to learning, and later, suggest what it means to GIS-assisted learning.

A constructivist rejects the conventional belief of positivists or positivism that by means of scientific procedures, we can have objective, value-free, unbiased knowledge about this world— the one objective "real world"; and that the role of scientists is to discover the truth about it while teachers spread the word. There is no doubt that the positivist tradition brought the industrial revolution to its height and improved human life; however, it also brought with it huge problems (Nissen 1985). The problem with this way of learning about the world is that a single model is promoted and assumed to work across space, time, and culture. The foremost example of failure in this belief, especially in NRM, is the Green Revolution program (Pretty 1995). Since then, a range of participatory methodologies such as Participatory Rural Appraisal (Ford, *et.al.* 1996), Farming Systems Research (Chambers, *et.al.* 1986), and Participatory Technology Development (Jiggins and Zeeuw 1992), have emerged in order to address the variability and complexity of real world problem situations.

Instead of linear knowledge transfer, constructivism argues that our understanding of the world (what it is and how it behaves) is socially constructed— that is, what one learns comes from interacting with others (*e.g.*, in the communities that one belongs to, whether academic, socio-cultural, occupational, etc.). And this process of generating knowledge is fraught with societal values, norms, goals, conflicts, etc. and laboratory constraints in materials and methods that influence what one can know. Learning is an active process in which meanings come from experiences, and knowledge is not transmitted directly from one knower to another but is built up or "constructed" jointly as people make sense of and agree on it. This is consistent with the learning model I put forward in Chapter 2, which notes the existence of "windows" representing theories, concepts, and procedures that pre-determine what one can know. Jiggins and Röling (1996:236) put it succinctly in saying that "although a tangible, real world exists, our knowledge about this world is not an objective (value-free) projection or reflection of that real world on the mind". In this sense, "multiple realities" exist as different people's models or interpretations of what the real world is, depending on the learning process each is undergoing.

Table 3.2 is my modification of Bednarz's (1998) analysis of similarities between constructivist learning and GIS (I added the last row, and changed the word "students" to "learners"). Bednardz made this comparison in order to give light to the general skepticism of American teachers in the move to introduce GIS in their secondary schools' (K-12) curriculum. The US National Geography Standards endorsed the use of GIS in teaching geography saying, "Geographic information systems make the process of presenting and analyzing geographic information easier, so they accelerate geographic inquiry" (Geography Education Standards Project 1994:45 cited in Bednarz *op.cit.*). ESRI (Environmental Systems Research Institute), a top GIS software manufacturer is in the forefront of this campaign, and this fanned suspicion about its vested interest. ESRI made a list of "concepts and skills which teachers can use GIS to teach in elementary, middle, and secondary schools, but it does not discuss the efficiency of the technology to accomplish these tasks" (*Ibid.*). In order to prevent a "technology-driven learning (*i.e.,* radio, TV, computer, multi-media) which "did not deliver the promised transformation of education" (*Ibid.*), concerned US educators analyzed what this new technology can offer. They found a justification for GIS in geography instruction within educational theory— that of a constructivist approach to learning.

Table 3.2 Comparing constructivist learning and GIS-assisted learning

Characteristics of constructivist learning	**Characteristics of GIS-assisted learning**
Learners construct knowledge.	Learners construct knowledge through building databases, maps.
Learners discover relationships through experience.	Learners explore spatial relationships through mapping.
Learners learn in complex, authentic situations.	Learners learn from "real-world "data and situations.
Learners manage their own learning.	Learners guide themselves, identify relationships through exploring data.
The process of learning is as important as the product.	GIS is a tool for exploring.
Learners learn from each other.	GIS makes available "real world" data to others. GIS helps discuss and build a common view.

(Slightly modified from Bednarz 1998)

The implications of constructivism for joint learning about Ifugao's multi-actor NRM problem situation is the recognition of the world models of these actors, and the possibilities for negotiating these models (*i.e.,* debating about each other's views) into an agreed upon, jointly constructed model of their jointly-perceived desirable future. Constructivism also lends a hand in modeling the real world with GIS. As discussed earlier in section 3.3, GIS does not project an objective world, but a constructed world model. GIS-assisted learning offers a possibility to extend our understanding of the environment, and hopefully inform our decisions in its management. Using GIS becomes a more explicit knowledge construction process— exploring, monitoring, spatial reasoning, and generating new perspectives about the environment.

Figure 3.2 is a schematic diagram of data flow in geo-information processing: data collection (surveying), input (database), analysis (processing) and output (graphic, alpha-numeric). Arrows connecting processing with world-model-surveying stage denote pre-processing of original data in order to be usable (*e.g.,* digitizing, classifying). The influence of the "world model" used in surveying, processing, and

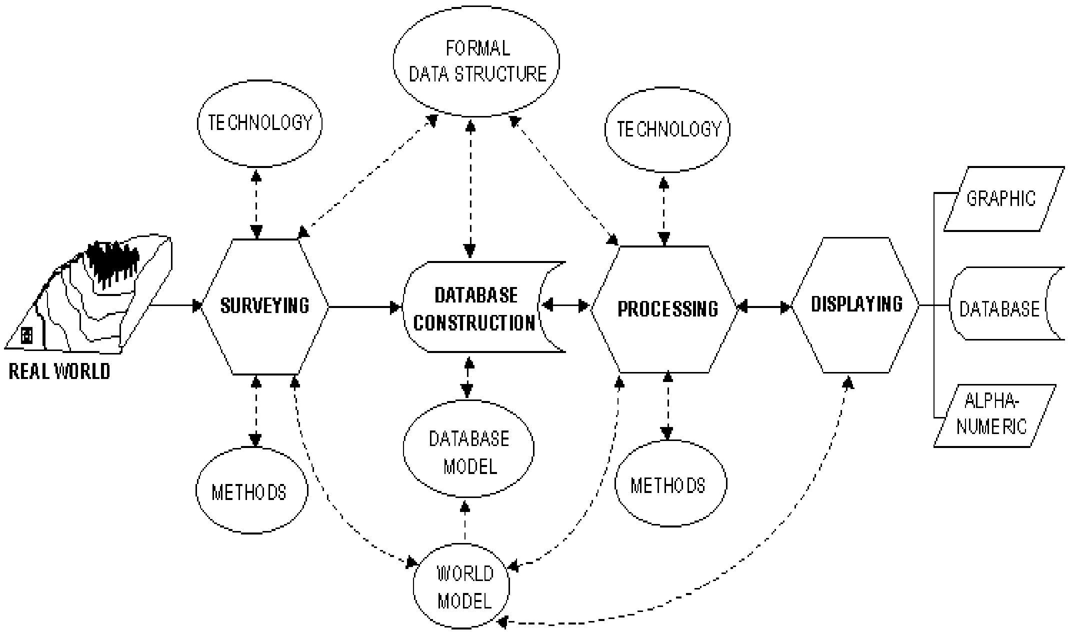


Fig. 3.2 Data flow in GIS *(Slightly modified from Molenaar 1989)*

database modeling, and the limitations imposed by the technology and methods clearly show the constructivist nature of GIS, and in general, of our attempts to know the "real world." The circularity suggested by the survey-world-model-processing-formal-data-structure loop portrays progressions in these attempts. I added the world-model-displaying loop to indicate that displaying can also modify the world model, as new information emerges through visualization as well. I used double arrows to illustrate the dynamism of the whole process. This denotes improvements in the technology and methods, and continuous change in formalizations, in the construction of our world model, hence, the continuous construction of reality. Chrisman (1999:2) calls it "going full-circle: social context influences GIS and GIS influences society."

This socially constructed nature of reality is indicated by a recent Ph.D. proposition, after successfully modeling the fuzziness of spatial objects (Cheng 1999)— "Modeling real world situations always leads to dissatisfaction, because each time a model has been improved, we become aware of a higher level of complexity in reality which our models cannot yet handle." While this statement recognizes the existence of a tangible complex reality, it also reveals that the "real world" or "reality" that we are talking about or modeling, and therefore basing our understanding and action on, will always be a constructed reality— constructed from an improved model. The work was truly impressive, but the dissatisfaction lies in the heart of positivism that "researchers simply discover eternal truths; (that) technology can rely on iterative approximation to move closer and closer to the ideal essential truth" (Chrisman *op.cit.*:3).

With constructivism, the role of researchers, science, and technology is "to provide people with new perspectives— the tools for continuous exploration and interactive learning about the world" (Röling 1997:251). Researchers can involve the researched in "constructing their own reality and agreeing on their own reasons for collective action" (*Ibid.*) for a jointly perceived desired future. Why their own reality?

Because they are the ones who will act on it, and their actions are guided by their image of it. Researchers and technology developers have an important role in extending their understanding of their reality to inform their decisions and actions, which affect our own as we live in one complex web of constructed realities.

3.6 Space for participation

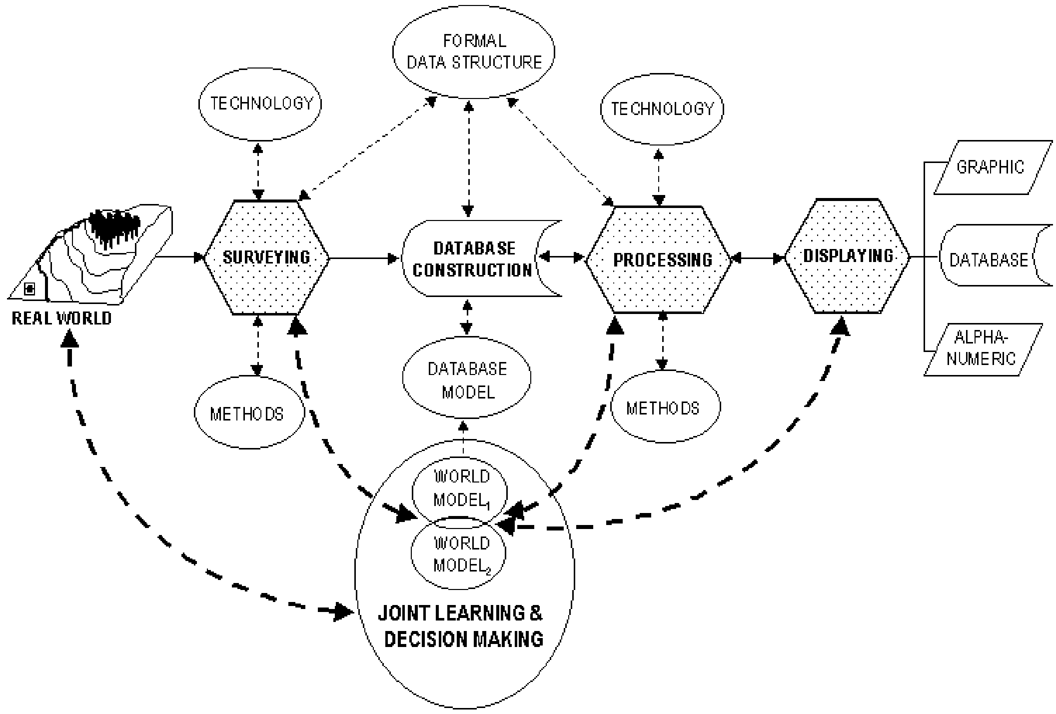
As Figure 3.2 shows, if the output of a GIS analysis is fed to a decision making process with a totally different users' world model, the result is an externally planned intervention. Here lies the danger, voiced by participatory development professionals (see Chapter 4), in reinforcing "top-down" development policies. GIS necessarily employs technology experts who get the upper hand in its use. Frank (1993:12) also notes that the reliance on GIS specialists for interacting with the system makes them "the bottlenecks: not only is it difficult to hire people with the necessary skills, but the arrangement itself impedes the innovative use of GIS." This problem not only refers to the development of so-called "user-interface" (*e.g.,* menu, icons, hypertexts) in GIS, but also, its "usability." It refers to "all the concepts that the user needs to understand the system, and to communicate effectively with it" (Frank *loc.cit.*). I would also add the problem pertaining to the world model at work as discussed above because, even after giving all the "user-friendliness" to a GIS, the "world view" which was utilized to build the system dictates the output which will be used to inform decision making in the "real world."

These problems can be traced to the positivist learning paradigm I discussed earlier, and clearly shows that participation of users, system designers, and technology developers is necessary for a GIS to effectively serve its purpose. Participatory approaches in systems development have gained ground since taking root in Scandinavia, in order to design information systems that effectively address the users' practice (Kuhn and Muller 1993). This pertains to the "users' worlds" which have to be included in the design to create better systems— they know "what works and what doesn't work… and many ideas on how to improve things" (Miller 1993:38). A special issue (June 1993) of the *Communications of the ACM* (Association for Computing Machinery) was devoted to participatory design, in recognition of its importance in improving the technology. As also shown in Chapter 4, participatory approaches in using GIS are spreading. This is a great challenge for GIS technology developers in considering other people's world models to improve the technology's adequacy in "human-computer interaction" (Medyckyj-Scott and Hearnshaw 1993).

Participation of Ifugao farmers in jointly developing a GIS involves delving into their world model in order for GIS to serve decision making in their domain (see Chapter 5). Figure 3.3 below shows that their participation can be effectively done during the following stages:

- surveying (selecting, gathering relevant data),
- pre-processing (preparing the data, setting database search criteria),
- displaying (discussing output maps).

In these stages, the world model is at play, but local participation is not so much constrained by computer know-how in database construction, because "the primary medium of participatory design is conversation" Novick and Wynn (1993:93). In GIS, Berry (1995:5) calls it "spatial dialogue." Sharing and comparing world models ($Model_1$ and $Model_2$) between researcher and researched, and among themselves (*e.g.*, in discussing, agreeing on the relevant data, on the meanings of output maps, etc.) communicate spatial reasoning that constructs the modeled maps. The maps become an "expression of user understanding of spatial interactions" (*Ibid.*).



Fig,3.3 Space for local participation in developing and utilizing a GIS.
(Slightly modified from Molenaar 1989)

3.7 GIS melting pot

"GIS is an eclectic field, not an isolated discipline" Berry (1995:xiii). It brings together "foresters, geographers, mathematicians, marketer, manager, and a multitude of others… and is enriched by the varied personalities and perspectives of all who pursue it" (*Ibid.*). Each of their world models are accommodated (as data layers) and can be tied together because they are geo-referenced— they have (or can be transformed to have) a common coordinate system (see Fig.3.1). These data layers can be used to interrogate the world model they represent, thus gain more understanding of convergence and divergence of different perspectives. This is essential in joint learning and informing the decision-making process (see Fig.3.3).

GIS is convenient to use in linking diverse interests and allowing different interest groups to communicate their respective perspectives of the same phenomenon (Harvey and Chrisman 1998). They are technological artifacts that produce other artifacts (*e.g.*, maps) to facilitate debate. Some authors call them "boundary objects" which are used to distinguish differences and common points of reference at the same time (Star and Griesemer 1989, Fujimura 1992, cited in Harvey and Chrisman, *op.cit.*). This being so, the same authors emphasize that GIS is "not merely a toolbox; it connects social groups (with divergent or even contradictory values), in the construction of new localized social arrangements" (*Ibid.*:1683). An example of such an arrangement in Ifugao's multi-actor NRM is discussed in Chapter 6 (Fig.6.8).

Figure 3.3 also shows the interwoven nature of science, technology and society. It shows the many disciplines involved. Each discipline plays a role in the construction of technology to learn about the real world and to do things in it; in improving the world model— in the development of methods and formalization of constructs to improve practice, and are in turn improved by practice. As no single individual can manage to do all of these, different disciplines need to converge and share their knowledge to improve decision making— to "build bridges" across disciplines to address the complexity of the real world (Beek 1997:207). This need became evident as this researcher tried to fill the role of different disciplinary experts in the field, *e.g.*, soil scientist, forester, hydrologist, among others (see Chapter 7) in trying to come up with a representative procedure for a particular GIS-assisted NRM undertaking. My own role was largely employing my understanding of geographic information systems (GIS) for organizing and integrating data from each of these experts, and for analyzing relationships among these data. It highlights the necessity, when using GIS, to bring together concerned NRM-actors and disciplinary experts for their knowledge about specific procedures in their own fields (or knowledge process).

In multi-actor NRM, Röling (1997:251) suggests to make GIS a tool for interactive learning, which means "active participation of those being researched in the construction of 'findings' about themselves." This is to facilitate what Giddens (cited in Röling, *op.cit.*) calls "double hermeneutic" in science— that is, learning from one another, which is characteristic of constructivist approach to learning. This is because almost always, "scientists are not interested in the mechanisms of the double hermeneutic" as they rely on publishing results in journals and letting other people "apply" it in technology, business, policy, etc (*Ibid.*). This transfer-of-technology model proved to be ineffective in striving for sustainable NRM (Chambers, *et.al.*, 1991), that's why, as I have elaborated earlier in section 3.5 (see also Chapter 4), participatory approaches have emerged.

GIS, being a melting pot of disciplines, and with its strength in spatial analysis and visualization, offers a big opportunity for "double hermeneutic" in NRM. As can be seen in Fig.3.3— the iteration and progression of knowledge gained between surveying and displaying reinforces the process of knowing and doing things in the real world, and interpreting the feedback from this world. Science plays a big role in this kind of learning by providing new ways of seeing, of interpreting observations, of informing policies (Röling, *op.cit.*). Moreover, as discussed in the previous sections (3.4, 3.5), reality is not directly reflected in the mind, but is constructed jointly as people engage in inter-personal sense making in their environment; therefore, joint learning among NRM actors is a necessary process in extending each other's understanding of the environment and in finding ways how we can adapt our practices based on this understanding. A participatory approach in GIS development offers a lot to this understanding. As the next chapters show, in doing this research with the Ifugaos, I learned from them, and they learned from what I learned from them.

Chapter 4

Participatory GIS: State of the art

"We are connected."

4.1 Introduction

Literature review reveals that there is no such thing, as yet, called "participatory GIS" in the sense of involving the poor farmers of the so-called Third World countries in its design, implementation and maintenance. Most examples show that local participation is limited to data gathering from so-called "informants." The ability to handle computers cannot happen overnight to poor Ifugao farmers, but I found out that the underlying problems in their participation are not the local attitudes towards, nor aversion to computers or technology. External factors inflicted development on the Ifugaos, disrupted their delicate ecosystem, and left them behind. The purpose of striving for a truly participatory GIS is not just for their ability to click the mouse, but more of their ability to share local concepts of space and facilitate a spatial dialogue among NRM actors to better understand their problematic environment.

This chapter not only examines recent efforts at using participatory methods in the development of a GIS in order to learn from worldwide experiences, but it also investigates the transitions undergone by the apparently successful traditional information system of the old Ifugao society. This is done to learn from its success and find traces that may serve the basis for their participation in developing one today. As Maturana and Varela (1987) have argued, internal structures are chiefly responsible for behavior and therefore, external interventions like a computerized GIS are but "triggers" that may cause such internal structures to function.

4.2 Computers and communities

Fig.4.1 Computers at the PRRM-Ifugao office available to the local community.

Historically, computers, satellites, aerial photos, maps, global positioning systems (GPS), and the Internet are products of military hegemony and were thus designed for central disposition as governments exercised protection and sometimes, extension of their territories (Young 1993). They were once regarded as “high-tech machines” that could be operated or understood only by geniuses, but were later put to civilian uses such as banking, payrolls, stock exchange, airline ticketing and the like. There is now a growing chance to transform what was once an instrument of central control, into an extension of human understanding of the environment in which we live. Geographic information systems are being used to tap the continuous supply of data from satellites, from aerial photos, maps and field measurements as instruments of development (Poole 1995). The availability of cheaper and faster computer chips also makes the personal computer a common artifact in various application settings. The opportunity is here to utilize its potential for improving human activity systems by facilitating the understanding and transforming or improving of a problematic situation. As Young (1993:i) writes, “either we can use computers to exploit the natural environment even more, or we can use them to learn more about how to live within the natural environment.” The challenge he poses is this: to transform available environmental information in its various forms into knowledge that could be useful to people in changing their present course to a more sustainable path.

A recent convention of practicing soil scientists and academics emphasized the need for scientists and farmers to jointly “build bridges” (Beek 1997) in the creation of new tools for sustainable land management, and for the information superhighway to “cover the last mile to the farm” (Bie 1997). This is a significant step and sits well with what this research puts forward in creating “joint systems of learning and inquiry.” It also poses a challenge in information systems development within which democratic participation is fast becoming a popular research agenda (Communications of the ACM 1993). Especially credited for the rise in “participatory design” is the so-called “Scandinavian school” (Bansler 1989) which had originally argued for democracy in the workplace. The importance of user involvement, not just in the last stage of testing a protoype, but throughout the system development, has surfaced— an apparent shift from what is “technically possible” (technology-driven) to what is “organizationally desirable” (socially-driven). Participatory technology development is now gaining ground, in terms of practitioners and application settings across the globe (Jiggins and Zeeuw 1992; Clement and van den Besselaar 1993).

Although poor people of developing countries do not own computers and computer accessories, they increasingly belong to organizations that do. These organizations enable the poor to access a new understanding of their territory and participate actively in policy decisions that affect their lives (see Winter 1995 issue of *Cultural Survival Quarterly*). In the Philippines, the People's ACCESS has been a pioneer (since the early 80s) in propagating the use of computers, computerized information systems and electronic communication systems among fellow NGOs. One such NGO is the PRRM, whose computer-literate development workers and partner people's organizations train each other in using the computer to facilitate rural development work. Databases about social and environmental information are shared among these organizations and are used in drawing up local development plans. This research is carried out with PRRM as a pilot study on how GIS technology can be harnessed in joint NRM with communities for local development.

4.3 Changing concepts of participation

It is no surprise that the rise of participatory methods and approaches grew alongside the "sustainable development" debate (Pretty *et al.*1995). The postwar rush towards increased agricultural production and technological advancement to rebuild and feed created a divide between the actions, including experimentation, of scientists and of the so-called "end-users" (Chambers and Jiggins 1987). That pushed the "transfer of technology" model of development to its extreme. But the dire consequences on the environment and the failure to address the needs and conditions of rural small-holder farmers demanded a rethinking of the "unsustainable" mainstream development model. Thus arose such terms as "bottom-up," "participatory," "holistic," and "systems view" since the 60s. Not only that wider participation is demanded, but also a holistic and systems view of the environment is encouraged-- a recognition of the interconnection and interdependence of entities and phenomena on earth. Participation is now regarded as an important component of success in promoting development. A 1986 World Bank sponsored conference in Oslo acknowledged that despite their technical or economic feasibility, many development operations had failed to progress because of the lack of involvement of local communities (Raynaut 1991). Since then, participation had gained prominence in local development strategies.

The term "participatory" can have different meanings. McCall (1988:3) distinguished three reasons why a "participatory approach" would be employed:

1. Participation to facilitate external interventions
    - top-down local development where higher-level authority-imposed policies (*e.g.,* from the state) are promoted locally
2. Participation for mediation between local needs and external demands
    - higher-level general policies are modified and redirected according to local conditions in order to reflect local needs and aspirations
3. Participation to empower the weakest group of people
    - "power" refers to local access and control of resources and social distribution of these resources

and much later, Pretty, *et.al.* (1995:60) listed seven kinds, which are based on local roles in particular stages of the development processes:

1. Passive participation
    - local people are told what is going to happen or has already happened; external agencies announce projects to be (or have been) implemented

2. Participation in giving information
   - local people answer questions posed by external researchers; research findings are neither shared nor checked for accuracy
3. Participation by consultation
   - local people relate their views and an external agency defines the problems and solutions according to people's responses
4. Participation for material incentives
   - local people participate by providing resources (*e.g.,* labor) in return for material incentives from externally generated projects, which stop when incentives end
5. Functional participation
   - local people form groups (after external agencies have decided) to meet pre-determined objectives related to objectives of a project; dependent on external initiators and facilitators
6. Interactive participation
   - local people participate in joint analysis leading to action plans, formation of new, or strengthening of existing, institutions that ensure local involvement, decision-making and continuity
7. Self-mobilization
   - local people take initiatives and develop networks for external support, but retain control over local development processes

While the categorizations suggest a host of activities and relationships affecting the extent to which various people come to participate, both authors seem to recognize a wide spectrum between the "passive" and the "active" kinds of participation. But for purposes of sustainable development, the active end carries more weight because of the need for local land resource managers themselves to carry on and engage with the complex, conflicting processes in NRM.

This research therefore, views participation from the active end; in fact, it views active participation as a pre-requisite for an integrated NRM wherein local and external agencies engage in joint analysis of the problem situation which the local people will ultimately wrestle with. It is thus the weakest group of local people whose participation is being sought because they are the ones who are not able to participate actively in the mainstream development process. Although participation for their empowerment must undergo a process that may initially involve them in joint activities with external agencies for material incentives, the ultimate goal is for them to carry on with themselves at the helm. It will be a detrimental to their development if their participation (of the passive kind) is sought, but only in order to preempt resistance to outside intervention. It fosters heavy dependence on outside agencies and stunts internal capabilities. At the minimum, functional participation suffices while maximum participation calls for empowerment—the ability to manage factors and processes affecting the community's own life, while being aware of the role played in a larger society. This awareness is necessary because participatory methods *per se* cannot guarantee success. They only thrive within an appropriate social and political context.

Biggs and Smith (1997) suggest that a mixed bag of participatory and "conventional" techniques may be appropriate in ensuring flexibility and adaptation to the changing environment. They argue that long-term, coalition-building is a key requirement: "It is important to look at what is going on around the techniques themselves if the main determinants of outcomes lie not with the choice of method, but with the institutions and protagonists in which those choices are made" (*op.cit.:10).* Quite true, especially because this research was done in the thick of the national elections, I learned that *barangay*s' voting results (with respect to the winning candidates or political party) later proved to be the main determinant of allocating project funds. One *barangay* captain was seeking PRRM's help in looking for other funding agencies as he lamented, "It is difficult for our project proposals to get approved because the mayor lost in our *barangay*." "Coalition-building," "networking," and "alliance-building" are some terms that describe local participation in engaging with external agencies towards a common vision and joint action to consolidate and protect their gains, learn more from each other, and advance.

4.4 Participation in GIS

Fig.4.2 GIS in joint learning about the environment.

The wide-spreading use of GIS for decision-support systems raises the alarm that "top-down development planning will be reinforced because GIS hardware, software, and data are expensive, and require a high-level technical expertise" (Chambers, *et.al.* 1998:27). GIS is alternatively seen as a potential tool for empowering communities (Poole 1995) or as a "top-down" technology that gives advantage to computer-literate members of the society while marginalizing others (Rundstrom 1995, Pickles 1991). However, it is my view that whatever technology is being introduced, the kind of social dynamics in which it will operate largely determines whether it will empower or marginalize the local communities. And even if poor farming communities cannot afford the GIS technology, if they are empowered communities or undergoing an empowerment process, they can find ways to access such technology (*e.g.,* donations, joint programs with universities), if they are convinced of the benefits to their development. For example, in 1978, by starting with donations from concerned citizens, the IBON Databank of the Philippines set out on a difficult task of popularizing socio-economic issues at the height of the Marcos dictatorship. Aside from obtaining raw data from contacts in strategic institutions, it involved local communities from different provinces in collecting socio-economic data (through survey questionnaires) for computerized storage and retrieval in order to engage them in alternative analyses of the national situation because information coming out from the computers of the National Statistics Office was state-controlled.

Today, with the advent of the Internet, computer usage has become more widespread as cheaper "cloned" computer chips and accessories abound, and as computers-for-rent establishments and "cyber-cafes" proliferate. The fact is, the technology is here to be explored, and it is getting cheaper, more user-friendly, and more accessible than before. There is much more opportunity and facility to make computers and computerized information systems like GIS, serve communities to jointly learn more about their fragile environment and encourage joint effort in its management. Beek (1991:270) also cited the need to harness new communication and information techniques to make the "products of surveying and mapping", which are widely available and offer a lot in understanding the environment, "more applicable at local levels of decision making in NRM." The challenge that Chambers, *et.al.* (1998:27) pose is to strive towards a participatory GIS which "utilizes the technology in the context of the needs and capabilities of communities involved." I join Harris, *et.al.* (1995:196) in saying that: "Participatory GIS is intended to demonstrate a GIS application where local knowledge, community needs, and specific social histories are appreciated and incorporated into the development process, and 'expertise' is viewed as interactive." My experience with the Ifugaos in delineating meaningful boundaries (in Chapter 6) is a case in point.

The very first article that caught my attention regarding the use of GIS with local communities was *Tribal implementation of GIS: A case study of planning applications with the Colville Confederated Tribes* by Marchand & Winchell (1992), which had to be requested from a library abroad. It was during the literature search for my MSc[1] thesis, which dealt with incorporating indigenous knowledge of soils in a GIS for local development planning. Today, some five years later, the Internet offers a great deal of information on the subject of GIS use with indigenous peoples, be they articles, books, projects, and seminars or conferences. Such proliferation indicates a growing interest in:

1. involving local people in technology development in order to create more "culturally appropriate" tools for managing space (Mark, *et.al.* 1990)
2. reclaiming indigenous territories to exact redress for lost tenure rights (Poole 1995; Harmsworth 1995; etc.)
3. reconstructing boundaries to protect species habitat and preserve bio-diversity (Poole 1995; Sirait, *et.al.* 1994; etc.)
4. involving local people in describing their space in order for government to plan for "appropriate" local development intervention (Lawas 1997)
5. involving local people in describing their space and allowing correlation with other descriptions in order to facilitate co-management (Powell 1998)
6. involving local people in studying the human dimensions of global change in order to influence their local actions (Rindfuss and Stern 1996)

These concerns and many more, together with the philosophical and ethical issues involved, are addressed by a major research initiative (Initiative 19) conducted by the National Center for Geographic Information and Analysis (NCGIA) of the USA in 1996. It focuses on the general theme "GIS and Society" and later expanded to public participation GIS (PPGIS). A major spin-off from this initiative is research and development of "alternative GIS designs (called GIS2) which might better reflect community interests and empower its members" (Project Varenius 1998). Another recent development is the recognition of the need for "collaborative spatial decision making" (CSDM) for ecosystem management (Bennett 1998) and the need for GIS to address this issue. This is a step further in modeling not just space, but also how groups of decision-makers interact and arrive at decisions about the space. A CSDM

[1] GIS for Rural Applications, joint Master of Science program of ITC-Enschede and Wageningen University.

model is relevant to an integrated NRM because of the need for different actors to negotiate and compromise about a common environment. All stakeholders are envisioned to interactively present their proposals on the screen. Scenarios will be created for everybody to imagine the consequences and present their counter-proposals. Minsky's (1986) theory, "society of mind," is being used to model the decision- making process.

The above discussion shows that both participatory development professionals (PLA Notes) and GIS professionals (NCGIA) recognize the potential of GIS in facilitating the understanding and management of the natural resources. But at the same time, they acknowledge the need for GIS (its being expertise-dependent) to better reflect community interests. Among the issues (Project Varenius 1998) which are relevant to this research are:

- empowerment of communities for spatial decision making
- educational, social, political and economic reasons for lack of access, and exemplary ways communities have overcome these barriers
- GIS "distortions" from community perspectives
- conflicting knowledge and multiple realities in spatial decision making
- community information needs and the role GIS could play in meeting these needs

The same issues were raised in a study commissioned by the British Department for International Development (DfID) to "identify and analyze problems, issues, and opportunities in the joint application and integration of GIS and participatory approaches in renewable natural resources research and development" (Quan, *et.al.* 1998:1). It was undertaken in order to help improve the management and assessment of technical cooperation projects in developing countries, which were found to be increasingly using participatory methods and GIS. Relevant findings of the said study will be taken up later in this chapter, but it is noticeable that the range of literature and project information that it analyzed did not mention any case that tried to build on local capacity to perform spatial analysis or trace the development of local information systems. Even ancient peoples have their own kinds of GISs for NRM and are shown in the next sections. I looked back and tried to detect remnants of the Ifugaos' traditional spatial information system in order to learn from its success and find possibilities for local participation in the development of a GIS for the present.

4.5 Changing information medium

Ihulukday dinolayan di payoda;	They climbed the forests above the fields;
Wanna wanna-konday nahudda,	They searched the place,
Di nalagnut ya dullawaon.	For the best of trees.
Pammunguda, kapyaonda,	They felled the trees, hollowed them out
Hopyadanday liting; umday talukuluk,	For channeling water; they make the waterfall
Panipatondah tapon di pumbanngan,	They channeled it to the fields,
Ihidolday pidipidda,	And over the village stone wall;
Ugge naholongan di umal-algon aamod.	His comrades piped the water.
Dawatonday gopgop to taluluk,	They directed the water to flow,
Waday muntikuy hiben,	They found a way
Di bummable on inu-unud di aamod.	The comrades followed it to the village,
Ipagawada gawana,	They did what was to be done—
Ipuhulnah inhohladan di baleda.	They let the water flow into their compound

. Those are thirteen lines from an Ifugao *hudhud* of 1,130 lines in all, entitled *Hudhud hi Aliguyon* (The Harvest Song of Aliguyon)[2]. The early Ifugaos relied on oral tradition, and songs or chants like this *hudhud*, no matter how long, had to be memorized. They were recited in the performance of rituals for specific purposes like harvesting, weeding, marriage feasts, or at the wakes of prominent members of the society. In this way, local customs and local knowledge about managing the environment were conveyed from one generation to the next. Literary elements like cadence, symmetry, parallelism, alliteration, repetition and rhyme helped the singer or chanter to remember the verses. Even so, Castro and others (1983), in their study of the epics of the Philippines observed the proliferation of versions and/or added episodes. They attributed such versions to memory lapses and the need for novelty, as these *hudhuds* were also used for entertainment in a society with neither radio nor television, and were recited to the same audience more than once. Another aspect that could be considered is the changing environment. Later generations must have added new observations that served to update older versions and keep abreast with their changing information needs.

The *hudhud*, which literally means “harvest song,” is sung exclusively by women because it is they who do the harvesting and weeding in the ricefields. On the other hand, the *alim* and *baki* are religious rituals that are performed while chanting, by adult males with the proper training. They are locally called *mumbaki* or priests. These songs and chants, together with the rituals and personages, can be considered the Ifugao’s traditional information system. Locations of important resources were noted (*e.g., forests above the fields)*, analysis was carried out (*e.g., search the place for the best of trees)* and the manner of utilizing and managing these resources *(e.g., piped the water)* was relayed to the society at large. The verses were revised, updated, and recited as the need arose to help the whole community, including the next generations, be informed of such traditional NRM activities. While storage and retrieval relied on human memory, oral rendition served for validation with the whole community in attendance. Different versions proliferate, but these variations may also be attributed to the initiatives of the *tomonás* in adjusting the songs to particularities in their respective territories. In any case, the older versions disappeared with time.

The *tomoná* can be male or female, whose fields may not be the largest, but have the best harvest of all— in terms of quantity and the quality of rice. Being the model or the trendsetter, he/she makes district-wide agricultural decisions (*e.g.,* the planting/harvesting dates, fallow periods, pest-control drives). Informal arbitrators, called *munkalun,* are adult males possessing wealth (possibly chosen due to a belief that wealthy men’s decisions cannot be bought) and great memory with the ability to know the *adat* (customary law) by heart and to trace everybody’s genealogy. The latter is a must because, in Ifugao’s customary law, family unity must be preserved and therefore, family and clan members may not be against each other. Conflicts are easily resolved when family affiliations are established.

It can be noted that there is a distinction between common knowledge-- that which is conveyed to the general public, and expert knowledge-- that which is bestowed to individuals with the proper training. These individuals are therefore the repository of expert traditional or local knowledge and are the ones responsible for

[2] Transcribed and translated by Amador T. Daguio (in Castro, *et al.* 1983).

imparting it to the next generation. Such a responsibility, demanded by tradition, is carried on without fail. The rest of the people look up to them for guidance and are reassured, for as Barton (1919/1969:ix) said, "There is no law so strong as custom."

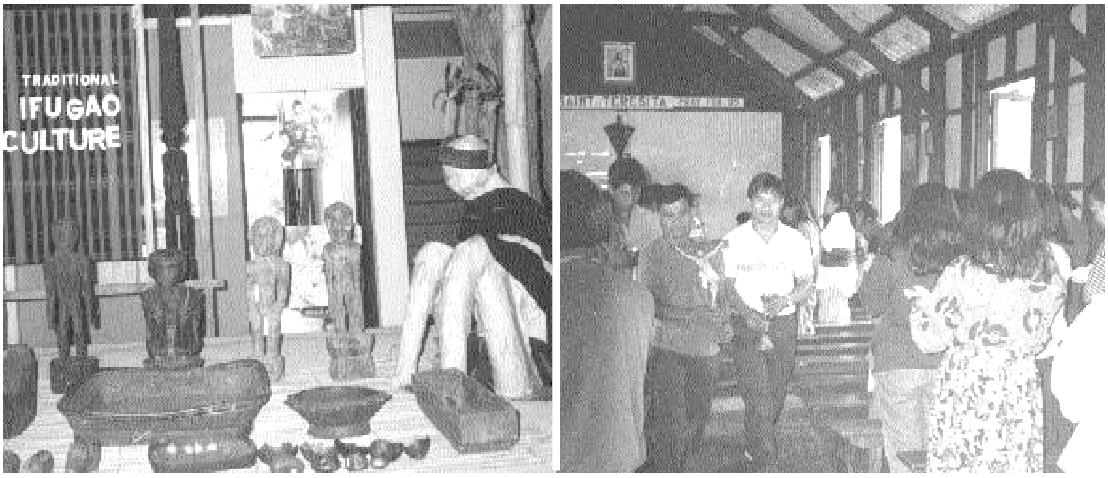


Fig.4.3 Traditional rites and rituals to the rice god gave way to modern congregations which are far removed from local NRM needs.

Following the arrival of American colonizers in 1900, public schools were set up and written forms of communication were introduced. Education and henceforth, information became more widely distributed to the rest of the population. However, the kind of education perpetrated was not attuned to local conditions (Alangui, *et.al.* 1994). Local knowledge and traditions were labeled as "backward" and "uncivilized." Rituals to the gods of agriculture and the ancestors were condemned and Christianity was propagated. "The Lord's Prayer" and the mysteries of praying the rosary were memorized to replace the *hudhud* and the *alim.* People learned to read and write, but textbooks were imported from the United States. The English language became widespread and people learned U.S. history. Until now, some elderly Ifugaos can still recite Abraham Lincoln's "Gettysburg Address." Songs like "Home on the Range" and "My Bonnie Lies Over the Ocean" are still rendered during special occasions. While there is apparent democratization of education and information, there is a shift from a community-centered worldview to the individualistic kind advanced in the opening up of the community to the global economic order. Each person has to strive on his/her own to produce for necessities not previously needed. People educated by American-opened schools replaced traditional NRM institutions like the *tomoná.* The *barrio* captain and the *consejal* who were then under an American Governor, took over the leadership. Top-down information generation and exchange became the norm. Consequently, centers of collective decision making, which made Ifugao's terrace construction and upkeep possible, collapsed during the American regime.

Today, surviving *tomonás* and *mumbakis* have lost their exalted position and responsibility to the whole community, but other central figures for information exchange have developed in the continuing struggle to survive. Take the case of the jeepney[3] plying the lonely, rugged road: It not only carries passengers and loads of farm produce and supplies to and from the town center, but is an important and

[3]A post-war modification of the US army jeep and now a major form of public transport in the Philippines.

reliable medium of information exchange among the barangays as well. Passengers talk about anything and everybody else on board is sure to listen. Somebody flags down a passing jeepney only to tell the driver to relay a message to someone who lives down the road, and the passengers offer more information or suggestions about the matter. The jeepney becomes a venue for community knowledge exchange. The jeepney driver develops into a repository of community information and a medium for information conveyance. Being the one who regularly goes to town, the jeepney driver knows the current pricing of agricultural produce and prime commodities. People come to him to arrange trade and deliveries. He develops into a key figure in community trading, marketing and current events.

On the other hand, the *barangay* captain and the *barangay* development council are the officially recognized body and the people's link to the government. They help solve domestic conflicts and problems among constituents and take charge of the general welfare of the community. They spearhead community development planning in the management of the natural resources. *Barangay* ordinances are promulgated and enforced by this body. Different line agencies, non-government organizations and corporations coordinate with these *barangay* officials in carrying out any project involving the community. The whole community also looks upon local schoolteachers for general advice. A more recent development is the proliferation of different sectoral organizations or people's organizations (POs) acknowledged by the Ifugao provincial government as "potential partners" in developing Ifugao (PPDO 1996). These POs are offshoots of bottom-up NGO work that usually challenge top-down policies with an alternative development paradigm.

These people who embody the newly emerged information channels, together with the local government and non-government organizations are key actors representing possibilities for local participation in utilizing a GIS-assisted learning process. It should equip them in understanding their changing environment and in making more informed decisions regarding NRM. Thus, it could enable the once cosmos-cum-ancestor-assisted *mumbaki* and *tomoná* who relied on their tremendous memory, and whose roles are displaced in the modern setting, to overcome this and participate actively in community development, albeit in a changed function. In the final analysis, Ifugao's changing information media from the *tomoná* and *mumbaki* to the jeepney drivers and *barangay* captains (and from oral to a combination of oral, print and broadcast media) are a reflection of the change in its set of information needs brought about by a changed socio-economic and political environment. The old Ifugaos' primary information needs concerned terrace production and maintenance. These days, they also need information concerning market demands, prices, transport, schooling, and job opportunities in order to cope with the changed economy.

Fig.4.4 The jeepney is also as a venue for community knowledge exchange.

4.6 Rediscovering folk GIS

The foregoing review shows that Ifugao's history of collective NRM had its own information system that was embodied in their rites and rituals, and helped them manage their space successfully. Their successful information system, considering the oral tradition, was largely due to their collective effort. The *mumbaki* and *tomoná*, and the leadership of the *lupun* had relied on the cooperation of their constituents in keeping the tradition— in singing their songs through generations. The old Ifugaos understood and utilized spatial information concepts because (as I had observed), these were important in carrying out their basic activities, such as:

1. delineating territory;
2. determining the highest water source (and thus, highest possible terrace);
3. determining irrigation canal routes;
4. monitoring location and extent of field damage that require maintenance;
5. estimating extent of forest reserved for *muyong* area;
6. locating and sequencing of fallow periods for their swidden farms;
7. locating wildlife habitat.

Their old terrace and irrigation workgroup *baddang* includes a traditional spatial information system that monitors conditions, and disseminate information to decide on quick action (see Chapter 7). The same information remains important today in managing the same terraced ecosystem, but the breakdown of their traditional management system and its accompanying information system aggravate the present problematic situation.

Aberley (1993:13) has a similar observation in his study of "maps in minds" or the "cognitive maps" of the indigenous peoples in Micronesia and their ability to store an "ordered information about a huge amount of physical and ecological detail" in their memory. For example: they know and remember exactly where to hunt, where the enemies are, what plants are edible or medicinal and where they are found, places for protection and lookouts, sources of fuels, etc., which are "compounded by changes through time (seasonality) and migration" (*Ibid.*). Other researches about indigenous spatial analysis such as those of the great Mayan civilization (Cho 1997), the Inuit and Creek Indian tribes (Rundstrom 1995), the Maoris of New Zealand (Harmsworth, *et.al.*1995), and the Bushmen of Namibia (Powell 1998) detail ancient abilities in managing space. Chrisman (1997:3) likewise noted that "human societies have collected and processed geographic information for millennia" and cited the discovery of ancient maps and clay tablets representations describing routes, distant places and territorial boundaries. Gould (1991) explains that spatial reasoning is fundamental to human survival and that "spatialization of the real world" is needed for cognitive processes, whether in the past or the present.

In the face of the today's environmental crisis, I follow Aberley's (*op.cit.*:9) suggestion that we, the people of the world today who all originate from aboriginal cultures, rediscover our "genetic memory of ancient skills." Only the Ifugaos have the know-how, and therefore only they (or those among them who remain rooted), with the help of outsiders who understand their subjugation and value their connection with the rest of the world, can start the process of learning to rediscover their capacity to carve their own development. This research is not an attempt to prescribe a solution to Ifugao's problematic situations, but to facilitate, with the help of GIS technology, to speed up the process of joint learning about such problematic situation of the world they live in which we also live in, whatever our world view is. For as previously pointed out in Chapter 3, the present ecological problem we face is a result of the collective impact of what each of us (with our own worldview) does in this planet. GIS, although apparently a top-down technology, if implemented in a participatory way, can facilitate this process as demonstrated in the next chapters.

Spatial information and spatial analysis is not new to the Ifugaos, but doing it with the computer is. The presence of three computer shops in Ifugao (one of which, even offers computer lessons) is noteworthy. The younger generation is interested in exploring new avenues, including the information superhighway. However, presently, this is but another cause for their exodus to find higher-paying jobs in the cities. Organizations like PRRM can help in bringing the technology to good use in serving local development. This present exploration in harnessing computers and computerized GIS in joint learning for local development is an initial step. Also, the provincial government and the ITC itself have recognized the utility of GIS, albeit as a mapping tool (see Box 5.2 in Chapter 5). The new generation of computer-literate Ifugaos need not go to the cities to apply their newly acquired skills and to earn decent wages. With these new events taking place, sooner or later, computerized GIS will become an integral part of their development processes. This is similar to what Clark (1997:61) says is the human ability to create "artifacts of thinking" and to internalize the external, such that "the external environment becomes a key extension to our mind." I could easily agree with such observation. I realized that before, I used to write down (pen and paper) a rough draft before typing, but I can now directly type my thoughts with the computer. In the case of GIS for joint learning, this "external prop" enables us to share our different views of the world (visualized as map layers), which allows us better to understand the problematic situation and guide us to action.

In the same vein, GIS specialist[4] Joseph K. Berry (1995:174) says, "GIS won't be an important technology until it fades into the fabric of society and is taken for granted. It must become second nature for accessing information and translating it to knowledge." In effect, this envisions computerized GIS as another "artifact of thinking." In the same way, the old Ifugao's oral spatial information system was woven into their way of life. This research is now seeking what is left of it to be shared with the present in order to learn from such success. Other experiences are also studied.

4.7 GIS with communities

There is a growing literature about the use of GIS with local communities. One issue of *Cultural Survival Quarterly* (1995) was entirely devoted to geomatics[5] and its use in protecting indigenous peoples' territories. Peter Poole (1995) surveyed some sixty community-based projects that "used maps for natural resource management and/or land claims" from five continents. They described the use of sketch maps, photo-video coverage, geo-referencing with GPS, remote sensing, and GIS in dealing with external agencies in reclaiming indigenous territories and

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[4] Having 30 years of GIS experience, he was at the forefront of its birth and abreast with developments.

[5] A new branch of digital information technology for acquiring, analyzing, and processing earth images.

defending traditional management regimes. Others (Martua, *et al.* 1994; Laforge and Torrealba 1998; Hatley 1997; Harmsworth 1998) have likewise dealt with reclaiming customary lands and territories in addition to geo-referencing important resources with the view to conserve and maintain bio-diversity.

A similar focus on experiences in mapping with local communities was made in a collection of articles and case studies in *Boundaries of home: Mapping for local empowerment* (Aberley, *ed.* 1993). It espouses bioregionalism— an emerging "reinhabitant movement," which seeks to relate people to their distinct human territories based on the principle that "people's actions bear most fruit when interrelated in an ecologically- and culturally- defined place" (*op.cit.*:12). This movement is in direct opposition to the present single global market paradigm that alienates communities from their roots. Local initiatives in mapping are described in detail and provide the reader with resourceful tips in scouting for data (*e.g.*, photo-copying, sketching, tracing, etc.) especially because maps are often controlled by bureaucracy, which is usually unwilling to share with the general public in the name of "national security." The book also acknowledged the growing availability of maps in commercial enterprises. The highlight of this book is a step-by-step procedure for manually mapping bio-regions as a means to "widen people's perception of the social and physical territory that support them; discuss the result with others, to listen to different interpretations; and work for a consensus of purpose" *(Ibid.).*

Table 4.1 is my survey of literature on GIS use with local communities. It shows that:

1. Most of the efforts are for "reclaiming territories" and for safeguarding of bio-diversity which are being lost to external influences. Demarcation of indigenous territories and species habitat dominates the cases in the literature. This reflects the constrictions being suffered by indigenous peoples and the loss of bio-diversity all over the world.
2. Other efforts are for communicating between "scientific knowledge" and "local knowledge" systems (Tabor & Hutchinson 1994, Martua, *et al.* 1994, van Uffelen 1992).
3. There are also attempts at "incorporating local knowledge" into mainstream resource management planning (Lawas 1996, Harmsworth, *et al.* 1995, Poole 1995). And in such undertakings, Harmsworth (1995) noted the risk of disfranchising local people of access to the developed database and pointed out the necessity of representing "local values" in the organization of the data by protecting information about traditional sacred grounds. He suggested database restrictions to authorized persons in accessing information about "sensitive areas."
4. A few cases show attempts to use geomatics in support of co-learning for co-management and for an *active* participation of local communities themselves in the development and control of the GIS itself (Powell 1999, Weiner, *et.al.* 1995, Beltgens 1995, Harmsworth 1995, Aberley 1993).
5. In general, GIS capabilities in spatial analysis were not fully utilized, as it was used mainly for mapping purposes. GPS and sketch maps were the most commonly used techniques, and may be due to their ease of use and being handy.
6. Most of all, local participation in the development of the GIS remains limited to the "passive" kind as local inhabitants are utilized in data gathering activities mainly as guides to the area being studied.

Table 4.1 Summary of surveyed literature on GIS applications with community participation

AUTHOR/AGENCY	LOCALE	TECHNOLOGY USED	PURPOSE	LOCAL PARTICIPATION
Sirait, *et al.* (1994)	Indonesia	Sketchmaps, narratives, GPS, GIS	Mapping customary landuse for forest management; set boundary lines; negotiation	Guides to important sites; narratives; sketch map
Hatley (1997)	Guyana	GPS, e-mail	Mapping resources; alerting the outside world on deforestation by mining/logging firms	Guides to important sites; training in GPS and e-mail operation
Marchand & Winchell (1992)	Colorado	GIS	Forest management planning	Guides to important sites; training in GIS use (tribal govt staff)
DENR-NAMRIA (1994)	Philippines	GPS, GIS	Mapping ancestral domain	Boundary identification
CART (1994)	Philippines	Sketchmaps	Resolve border disputes	Boundary identification; sketching
OTRADEV (1994)	Philippines	Sketchmaps	Establish boundaries; landuse planning	Boundary identification; sketching
UNAC (1994)	Philippines	Sketchmaps	Establish boundaries	Boundary identification; sketching
DENR (1994)	Philippines	GPS, GIS, sat. images	Preserve indigenous community Conservation; planning	Guides to important sites
Lawas (1997)	Philippines	GIS, aerial photos, sat. images	Local soil classification; landuse planning	Soil classification
Beltgens (1995)	Canada	GIS	Mapping territories and natural resources; community education, management and negotiation	Comprehensive training program
Bird (1995)	Canada	GIS	Studying landuse; reclaiming territories; inventory and monitoring of natural resources	Guides to important sites; comprehensive training program
Kemp & Brooke (1995)	Canada	GIS	Database of resources; landuse planning; conservation	Guides to important sites; training program
Harmsworth (1995)	New Zealand	GIS	Database of local resources for landuse planning	Guides to important sites; area classification
Poole (1995)	Canada	GPS, GIS, sat.images	Alternative earth observation	Training program in operation
Gonzalez, *et al.* (1995)	Panama	Sketchmap	Mapping territory; conservation	Sketching
Nietschmann (1995)	Miskito	GPS, GIS, video	Miskito reef mapping to regain sea territories; conservation	Guides to important sites
Jimenez & Conn (1995)	Venezuela	Sketch, GPS, sat.images	Mapping territories; negotiation	Sketching; comprehensive training
Smith (1995)	Peru	GIS, aerial photos sat.images	Resource management planning	Sketching, validation
Brown, *et al.* (1995)	Brazil	GIS, images	Mapping for conservation	Sketching; validation
Flavelle (1995)	Thailand	Sketchmap, GPS, GIS	Mapping territories, for conservation; negotiation	Sketching, validation
Rocheleau, *et al.* (1995)	Kenya,Nepa	Sketchmap	“Counter mapping” for women	Sketching, validation
Jarvis & Stearman (1995)	Bolivia	GPS, GIS, sat.images	Mapping territories; conservation; negotiation	Guides to important sites; identifying boundary markers
Powell (1999)	Namibia	GPS, GIS, sat.image	Mapping land resources for co-management	Image classifiation, field verification
Tabor & Hutchinson (1994)	Senegal	Sketch maps, aerial photos, GIS	Comparing scientific and indigenous soil classification	Soil classification
Van Uffelen (1992)	Costa Rica	Sketch map	Mapping soils	Soil classification
Harris, *et.al.* (1995)	South Africa	Sketch map, aerial photos, GIS	Post-apartheid redistribution of resources	Land and soil classification

Jordan (1999) had similar observations about the cases presented at the NCGIA-sponsored public participation GIS specialist meeting which was held in October 1998. He noted that in many of the cases, census information was simply mapped and that there was no *active* participation by local communities as the scope of the processes are dominated by elite users. He was also disappointed that virtually all of the delegates were from the north. He cited the availability of GIS at the community level as a serious limiting factor in southern rural areas. However, he found it reassuring that "most of the participants, including those who were from a GIS rather than participatory background, appreciated that the participatory process was of overwhelming importance, and that the technical issues were secondary" (*Ibid.*:16). He observed that there was more common ground than disputes in identifying these key issues:

1. the need to define, identify and adopt best practice with emphasis on participatory process, and consideration of how participatory techniques can be used when spatial information is desired
2. monitoring and evaluation of processes and outcomes because using GIS requires some degree of accuracy which has implications for spatial participatory tools such as sketch mapping
3. importance of the added value in using GIS and the nature of participation
4. whether frameworks for public participation GIS can be developed

Quan, *et.al.* (1998:19) also surveyed the literature and ongoing projects which deal with the various ways in which GIS has been applied in socio-economic analysis and in promoting social development in the context of NRM and development. They summarized four major application areas:

1. GIS in quantitative analysis and/or predictive modelling (decision-making)
2. GIS in incorporating of indigenous knowledge in planning (NRM)
3. GIS in land and natural resource mapping by and for indigenous peoples
4. GIS in decentralized and participatory planning

The constraints and opportunities they identified which are relevant to the trajectory of this research are as follows *(Ibid.*:36*)*:

1. Lack of geo-referenced data and differences in scale between available data and unit of analysis is a big problem. Designing a methodology for engaging in data collection is necessary to help solve this problem.
2. The good use of participatory social research methods is essential to access local knowledge and to develop an understanding of the behavior of complex resource utilization systems over time
3. The constraints in using GIS as a tool in participatory processes do not arise from the nature of GIS, qualitative participatory rural appraisal data, or information about local knowledge, but rather from the mindsets of the researchers who are rarely familiar with both GIS and participatory research. Projects have seldom combined these skills successfully.
4. The fact that GIS is generally associated with highly centralized, top-down management applications that require comprehensive quantitative data sets discourages participatory approaches.
5. Institutional problems in operating and maintaining GIS in the community constrain sustainability of its use.

Of the five items enumerated above, I find (3) the most crucial in operationalizing a participatory GIS with local communities. The others can be overcome more easily, but to engage the technically inclined to participatory processes and the participatory professionals to the nuances of technology requires greater effort. Quan, *et.al.* (*op.cit.*:2) observed that those researchers and practitioners who have attempted to apply GIS to practical development problems are "generally not social scientists, and have not benefited from any methodological guidance about how spatial analysis can help illuminate and resolve socio-economic problems." Also, within the social sciences discipline (notably Geography), there are "more research about GIS itself than research using GIS to investigate specific problems" (*Ibid.*) This can be partly explained by the fact that GIS is still new and is undergoing rapid development. But more crucial is the emphasis on technology rather people. Striving for participatory GIS requires both social science and computer technology professionals to reach out to the other.

Quan, *et.al.* (*Ibid.*) had a negative observation that "physical scientists and technical GIS specialists dominated the studies" that they surveyed (about GIS and participatory approaches in NRM). But such observation can also be viewed positively. These "hard sciences" professionals are very much aware that the so-called "soft sciences" are important in the development of technology which, after all, "develop within the background of tacit understanding of human nature and human work" (Winograd & Flores 1986:xi). This tacit understanding of yesterday has become explicit today. After a long time of working so much on their own disciplines, it is now clear that the "hard" and "soft" sciences must work together for technology to advance. Why would the NATO Advanced Study Institute produce the book (by Mark and Frank 1991) entitled: *Cognitive and Linguistic Aspects of Geographic Space*?

4.8 Computers and cognition

The preceding section touched an important issue about the design of computerized GIS— human-computer interaction. This not only pertains to the "user-friendliness" of a computer program, but also about the way human cognition of space is represented in a computer. This is one issue that "participatory professionals" are wary of. For example, Chambers, *et.al.* (1998:31) reported on a University of Durham workshop held in January 1998 that discussed participatory research and the potentials for a participatory GIS in local NRM. Their discussions addressed three main issues, which suggest general skepticism of the workshop participants towards GIS:

1. whether a top-down technology such as GIS has a place in participatory research
2. whether a technology developed largely by commercial companies in the north can be used appropriately in the south
3. whether local knowledge can be integrated with, and represented in an information system which, by definition, has traditionally rejected such knowledge in favor of spatially-defined 'expert' information

Their worries are not baseless as literature review and conference expositions discussed above show limited participation of the most affected NRM actor— the local managers themselves. However, poor farmers cannot be expected to be adept at computers right away. But their ability to engage in knowledge interaction with other actors in spatial analysis is more important. This is because such interaction in analyzing different images of the space they manage and its surrounding areas helps in jointly understanding more about the greater environment, and is more important than simple ability to click the mouse. This argument is desmonstrated in Chapter 6.

Morever, "participatory professionals" need not worry about so-called "top-down technologies" or those that are said to promote top-down management planning in local development work. Indeed, computers and computerized GIS are externally derived technologies, but as Quan, *et.al.* (1998:31) correctly noted from their survey, "participatory applications of GIS are very much a function of the degree of participation promoted in the planning process, rather than the technology itself." Also, GIS technology is most useful only if "geographic location is an important characteristic or critical to the analysis of phenomena" (Aronoff 1989:1) and if the quantity of data involved is too large to be handled manually. That limits its application to those that truly require its use.

The other issues (2) and (3) have been recognized much earlier and addressed by GIS specialists[6] Mark and Frank (*op.cit.*). In fact, one of the early NCGIA research initiatives (Initiative No. 2) was about "Languages of Spatial Relations" (Mark, *et.al.* 1990) in acknowledging that GIS softwares were mostly designed in English or in German. It thus poses a disadvantage to non-English or German speakers, who will be forced to express their conceptions of space in unfamiliar languages. This concern was inspired by Talmy's (1983) paper entitled "*How language structures space"* which discussed the cognitive basis for spatial language (Mark, *et.al.* 1990). It recognizes the argument that the "objective" structures of the real world are imposed by our conceptual models and categories (another breakaway from the positivist viewpoint), which are determined and revealed by the language we use. The meanings of words are always defined with respect to cognitive models— such as background assumptions that people base on previous experiences and societal norms (again, one's *Weltanschauung)*. This is consistent with Lakoff's (1987) "experiential realism" in his assertion that people make classifications according to their own cultural ideals and experience. Metaphor is a central part of experiential realism because it provides the relation from one situation to another as people try to make sense of a new situation they find themselves in. Lakoff (*op.cit.*) observed that spatial experiences such as journeys (and NRM management) are common sources of metaphors. The use of metaphor in choosing command icons made successful user interfaces for computer programs (*e.g.,* Apple's Macintosh®, Microsoft's Windows98®). Also, observe how kids quickly make out the rules of computer games by simply clicking at icons, without ever reading the manuals.

These research initiatives by GIS professionals are followed by more recent moves to further investigate the implications of GIS use, thus ushered in the 1996 NCGIA's Initiative 19 which concerns "GIS and Society," and later on expanded to PPGIS, GIS2 and CSDM (as discussed earlier in this chapter). They are aware that "the construction of GIS requires knowledge of human cognition throughout" (Mark and Frank 1991:5). The data structures, procedures and functions, especially the user

[6] Being forerunners and responsible officers of the NCGIA, and authors of many GIS reference books.

interfaces must take human cognition and user needs and goals into account. This means that the general theory of spatial relations, which is currently being developed, must be consistent with human cognition (Mark and Frank 1991, Medyckyj-Scott and Hearnshaw 1993). GIS professionals are very much aware that computer systems designers and programmers— those that produce GIS softwares must be able to appreciate the nature of human cognition of space and learn how computer-based systems can be developed along human cognition and not the other way around.

Recent advances in database management systems development see the rise of the so-called “object-oriented” method, which emphasize that: “Object-oriented (OO) analysis should not model reality— rather, it should model the way reality is understood by people. The understanding and knowledge of people is the essential component in developing systems” (Odell 1992, cited in Lewis 1994). Object-oriented analysis and design view the world as “composed of many objects interacting with each other (exchanging messages) to produce a collective behavior” (Nemirovsky 1997:1). Object-oriented design has its roots in the development of programming languages and is said to be the “revenge of the programmers” who have always been overshadowed by system designers (pers.com. Hofstede 1993). In contrast with the previously used procedural techniques (*e.g.,* sub-routines or sub-programs in Fortran programming language) for information systems, OO design “encapsulates” or hides incomprehensible computer programming languages from the ordinary users. Instead, by invoking the principle of abstraction (identifying the most relevant feature of the object or system being modeled), more familiar or natural language for modeling nature is used, for example, through hyperlinks and icons. In OO terminology, “objects encapsulate data and behavior.” The system designer and user are spared of the nuisance of computer language. Their efforts are more focused on simulating natural phenomena as understood by them. White (1994), Nemirovsky (1997), provide more about information about OO techniques. Suffice it to say here that efforts at creating a more humane GIS are ongoing, and the basic structure is in place.

4.9 Towards a participatory GIS

The foregoing discussions show that participatory GIS is in its exploratory stage, and that both GIS and participatory professionals acknowledge the necessity of their collaboration and in seeing it through. The present research explores the use of GIS in reinforcing a joint learning system— that is, the local people actively engage outsiders and other actors in making visible each other’s perception of their common environment, in negotiating its meaning to each other and coming to terms with a common way of doing things in it. The emerging information system can then be thought of as a participatory GIS, in the sense that its conceptualization, creation, and utilization are done using a combination of participatory methods and systems development methodologies. Furthermore, its use provides a means for actors to engage in interactive exploration of their understanding of the environment.

The extent of this research is limited to finding ways to operationalize a participatory GIS— one that gives importance to participation of local farmers in sharing multiple realities of NRM actors. This is in the line of Checkland’s (1991) “soft systems” approach in information systems design given that current GIS software and systems design methodologies are dominated by positivist “hard systems" tradition. Chambers, *et.al.* (1998:32) are correct in suggesting that before embarking on a participatory GIS, "GIS professionals may find value in participatory resource mapping (PRM), where local people make their own maps." Understanding these local spatial management activities is the key in the development of locally relevant improvement using GIS techniques. The same is echoed by Quan, *et.al.* (1998:6) in saying that the "possibilities of success (in participatory GIS) depend upon a closer integration of the skills of GIS practitioners and social scientists in development research and cooperation in using GIS to projects that empower communities."

I draw from my experience with the Ifugaos and from experiences of others who have published what they learned in using GIS with local communities. The insights generated from interacting with local inhabitants promote better understanding of the problem situation, and can be empowering once the causes are traced. One important step is anchoring local people's understanding to their past success and from there, find the pattern of activities that comprise their successful information system for NRM. This chapter has shown that GIS in its crude and ancient form has been used by our ancestors in jointly managing space successfully. Modern geo-information technology is available for the present to enhance our present NRM efforts.

The following are important lessons I learned in my attempt to use GIS technology in facilitating joint-learning about NRM among the farmers of Ifugao. They are not a prescription to any other future attempt, but may be worth considering in similar circumstances. I stand corrected by new experiences and techniques.

1. Local capacity building – for rural development professionals (hereon called staff), a continuous orientation and training programs for learning about national and international issues and developments that affect local conditions, including learning about new tools that apply to local problems
   - if a staff has a knack for computers, strive to learn GIS (or else, find a GIS practitioner who is committed to rural development)
   - orientation on computer usage for all staff, explaining the do's and don'ts to build confidence in the technology (and to avoid problems through misuse)

2. Information need assessment – for GIS specialist or GIS trained staff, an analysis of spatial information use and need of an organization is necessary because GIS is only useful when geographic location is important to the analysis
   - integrate with local community to learn about their past and present NRM practices; determine the changes and the causes of these changes as these can become guidelines for a more socially desirable design
   - use local concepts of boundary to be more meaningful to local people
   - during regular local development planning sessions, analyze NRM activities and take note of those that require large amounts of locational information
   - research about the old community information system for the NRM activity, take note of personalities and decisions involved as these indicate data needs as these are useful hints on the application area of the GIS to be designed

3. Database modeling – for GIS trained staff, organize data for the database model
   - draw an E-R diagram of the personalities, spatial features and NRM processes

involved and discuss it with the responsible persons for verification and suggestions, but also to have a common understanding of the situation;
- discuss together with their leaders the possibilities for their spatial activity to be strengthened by GIS, the necessary data to be collected, and persons in-charge of data collection; this also helps draw out those who can be trained
- basemaps (topographic maps), satellite images and aerial photos, if necessary, are obtained from responsible government agencies; the Internet also offers many alternative data sources; sketchmaps can be geo-referenced using control points obtained by GPS measurements (or else, on-screen sketching)
- involve local people in interpreting these photos and images as they know more about their place than anybody else
- consider the available GIS software to be used as to the required data structure (relational/network/object-oriented) and organize the data accordingly

4. Implementation of designed GIS
   - explain data processing during regular organization sessions (*e.g.,*community development planning, provincial board meeting) for them to have an idea of the transformation processes (what the computer is doing)
   - analyze and discuss the generated maps with the organization for a trial run of the intended activity and to generate new insights to improve processes

The fact that I did this research with poor farmers in a rural setting limited their participation in manipulating the computer. However, they played an active part in the spatial dialogue that ensued. It is noteworthy that they also took the initiative of devising ways to accommodate a personal computer (PC) in their local condition because power supply is irregular in my host community. One of the men suggested using a "power inverter." It was the first time for me to hear of such a thing. He explained that when a "power inverter" is attached to the terminals of a 12volt-jeepney battery, it changes the power to provide 220volts. I learned that this set-up was used for the sound system on several occasions (such as *barangay fiesta*, election campaigns, and wedding celebrations). It proved to be a big help for me during a power failure that lasted for 10 days, when two successive typhoons hit the region. A fully charged battery serves about 4-6 hours of PC time, depending on the application used (image processing consumes more energy than simply typing texts). The laptop computer was utilized in meetings at the *barangay* interiors where there are no electricity. With a 12Volt direct current assembly, it can work for two days as it consumes much less power than a PC.

Fig. 4.5 12Volt DC – 220Volt AC power inverter

A jeepney driver suggested another surprising idea the morning after my battery ran out of charge. I had requested him to help me take the battery to town to be re-charged. He casually replied, “Let us just exchange it with the batteries of my jeepney. Then, when I arrive in the afternoon, it will be fully charged.” After a few minutes of swapping the batteries, several men helped push-start his jeepney. With such a clever arrangement, I was assured of fresh battery to be able to work continuously despite power failures.

The next chapter details my effort in analyzing Ifugao’s NRM and NRM actors to understand their inter-connections and flow of information. This will guide the development of a GIS to support such NRM activities.

Chapter 5

Ifugao's changing landscape: The social base of the terraces

Of ritual plots and basketball courts.

5.1 Introduction

Drawing the "entity-relationship" diagram helps to represent and analyze the organization of a system being studied— *i.e.*, a conceptual model. It is a necessary step to build the database for a GIS. This chapter describes how I also used this drawing technique to visualize the structure (and therefore, the information flow), of the past and present Ifugao society in NRM— from the old "agricultural districts" until it is transformed into the present-day *barangays*. In the process, I found out its usefulness in communicating with informants in tracing the changes in the management of their natural resources. Information from literature was complemented by discussions with elders in order to identify the old NRM institutions, the relevant actors and their roles in managing these agricultural districts. One important outcome of this exercise is the tracing of the old "water districts," which were actually the traditional resource management units. In doing this step, the new generation of Ifugao NRM actors (particularly, PRRM and its partner organizations) was also able to jointly learn with their elders about the old system of management, which had proven its effectiveness. Provincial NRM decision-makers were considering it to solve the growing boundary disputes.

5.2 Village anatomy

Much of my first three months in the field was devoted to observations, confirmation if what I had read about Ifugao tradition is still valid, and integration with the regular community life. I did these in order to understand how local inhabitants actually go about with NRM in their daily life, to put the research problem in its proper context, identify relevant NRM actors and information use, and to be able to relate with the researched. This understanding helped me identify which aspects of local NRM activities have the potential to be strengthened by using a GIS.

The study area is composed of four adjacent villages or *barangays*— these are *barangays* Bangaan, Anaba, Ducligan, and Batad. I also visited the much farther *barangays* of Cambulo and Pula, which could only be reached after four to six hours of hiking, in order to complete the picture of the whole sub-watershed. I was introduced to the local inhabitants as part of the "PRRM family." That I was studying to learn the traditional Ifugao way of life and agriculture made the people somewhat cooperative in volunteering information, like when Bangaan farmers told me the schedule of an *ulpi,* the ritual to signify the end of planting season. It was more like a picnic to me as people flocked near the edge of a terrace to partake of rice, chicken and rice wine, to sing and banter. It seemed that because today's Ifugaos are Christianized, traditional rites and rituals have lost their solemnity. As one informant explained, "There is no harm in doing it, anyway and it serves as entertainment after the hard days of planting."

Growing rice (*Oryza sativa, sp.)* and the upkeep of rice fields on terraces, together with cultivating sweet potatoes *(Ipomea, sp.)* on mountain slopes dominate Ifugao life in general. The Japanese fish called, *jojo (Misgurnus anguillicandatus, sp.),* was introduced in these flooded rice fields of Ifugao during WWII, but has become rare. Mudfish *(Ophiocephalus striatus, sp*.), and various snails in the rice fields used to add to their income, but these have also become rare. Instead, people are cursing the prolific "golden *kuhol*" (*Pomacea caniculata, sp.),* and the Department of Agriculture for introducing it in the late 70s. These yellowish snails were originally intended for human consumption, but were not palatable. Ifugao has far more delicious native black snails, which informants say, are even "friendly to the crops." The introduced variety only proved to be a voracious rice pest and an added burden for farmers who have to manually remove snails and eggs from rice stalks.

The remaining subsistence activities involve cultivating beans and other vegetables like cabbage and carrots on swidden farms (slash-and-burn farms); catching fish in the extensive river systems; hunting and gathering insects in the forest. Raising tilapia *(Tilapia nilotica, sp.* or *Tilapia mossambica, sp.)* is an attractive venture as it fetches high prices in the market; one relatively rich family in Bangaan started tilapia culture in October 1998. Some women weave blankets and tablecloth while menfolk often engage in woodcarving and basket weaving to offer their products to tourists.

Like the rest of the country, extended families comprise Ifugao households, because old parents and grandparents live with and are cared for by their children. Their native houses (called *bale*) are well made of timber and thatch, raised on four posts, and are characterized by their pyramidal roof construction. Galvanized iron

(GI-sheet) roofing is very conspicuous nowadays, and informants say they are stronger and easier to maintain than thatch. Houses are clustered into *sitios* located on hillsides or on slopes along the sides of mountain valleys or near the rice fields. It was locally called *buble* before the government adapted the Spanish word as a standard for the whole country. A grouping of *sitios* make a *barangay*, which is headed by a *barangay* captain who is elected to office together with the barangay council. A town, sometimes called, "municipality," is composed of several *barangays* (see Fig. 5.1).

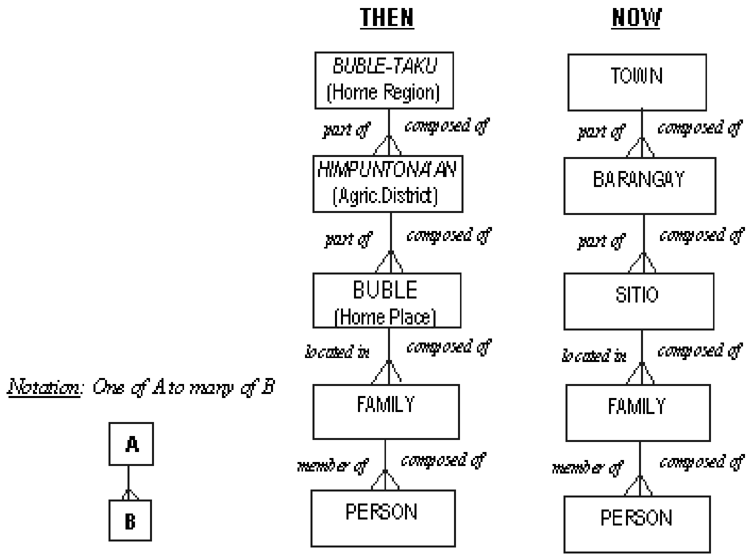

Fig.5.1 Approximate nomenclature in the organization of Ifugao village then and now.

I used the entity-relationship (E-R) diagram (Chen 1976) to understand the organization of an Ifugao village then and now (Fig. 5.1). It also serves in organizing the database for the GIS we are designing (see also Chapter 6). The E-R diagram is a special diagrammatic technique for database design, which includes the most important semantic information about the system being modeled. It is based on the view that the "real world consists of entities and relationships" (*Ibid*:9) that are important for the functioning of that system An "entity" is anything which can be distinctly identified, like a person or a village. A "relationship" is an association among entities. For example, in the direction of the arrow between two entities, the notation is read thus: "a family is composed of many persons" and "a person is a member of a family"; "a town is composed of many *barangays*" and "a *barangay* is a part of a town." A more complete description of this organization emerges (Fig.5.7a and Fig.5.7b.) as the study progresses and more information about the relevant entities and relationships are understood. I borrow from this modeling technique with clarification that the E-R diagram is just an "epistemological device, a coherent means of investigating the problem domain" (Lewis 1994:143) rather than being an objective description of the real world.

5.3 Watershed and family

Figure 5.2 illustrates the typical Ifugao stable pattern of land use and its E-R diagram. The *payoh* (terrace farm), the *muyong* (private woodlot), and *uma* (swidden farm) together with the *alá* (irrigation canal) and *latangan* (residential lot) are all intertwined and represent the totality of the Ifugao farming system. The *uma* are usually planted to *camote* (sweet potato). Rice is only grown in the *payoh*.

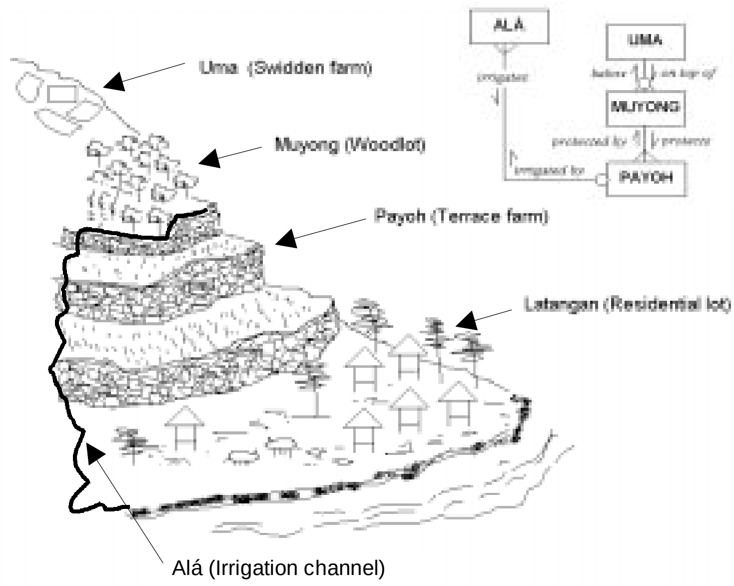

Fig. 5.2 Profile of an Ifugao "water district."

The *muyong* is sometimes called *pinugo* or *hinaob* (communal forest) in other *barangay*s. It consists of second growth forests that serve as a backyard source of family timber needs and firewood. Its maintenance system prevents soil erosion and provides the moisture necessary for terrace cultivation. It has a unique law of inheritance: the *muyong* is not parcelized but is wholly inherited by the first child to encourage a total forest protection. Inheritance, as mentioned earlier, is more of a nature of trust ownership, and owners recognize the right of the other members of their families to benefit from their *muyong*s, even if those family members have emigrated. This is one of the reasons for remembering one's genealogy in Ifugao.

Emphasis on the family can also be noticed in the names of many business establishments in town with the word in it, like: Family Drugstore, Family Video Shop, and Family Mart. The Bangaan Family Inn has become a *barangay* landmark. One used to memorize his/her family tree to the 4th degree of consanguinity. Barton (1930:121) met some that did it "up to the 7th or 8th degree". Migration and cessation of ancestor worship has made people forget. Following is a list of "basic postulates" (Hoebel, in Barton 1919/1969: xiii) of legal significance to Ifugaos then, but at the same time summarizes their basically family-centered social and cultural system before being overtaken by modern influences:

Postulate 1. The bilateral kinship group[1] is the primary social and legal unit, consisting of the dead, the living, and the yet unborn.
Postulate 2. Men and women are of equal social and economic worth.
Postulate 3. Supernatural[2] forces control most activities, and the actions of human beings are either compatible or incompatible with the predilections of the supernatural.
Postulate 4. Capital goods may be lent at interest.
Postulate 5. Rice is the one good food.
Postulate 6. Propinquity of residence ameliorates the absoluteness of the primacy of kinship ties, while outside kinship group responsibility to others diminishes with distance.

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[1] The "clan" in this research.
[2] Barton (1930) counted 1,200 Ifugao gods, with designations comparable with those of the Greeks.

The corollaries are also important to understand their influence on present-day NRM practices and conflict resolution (*Ibid.*):

Corollary 1. An individual's responsibility to his kinship group takes precedence over any self-interest.
Corollary 2. The kinship group is responsible for the acts of its individual members.
Corollary 3. The kinship group shall provide protection for its members and punish outside aggression against them.
Corollary 4. The kinship group shall control all basic capital goods.
Corollary 4.1 Individual possession of rice lands and ritual heirlooms is limited to trust administration on behalf of the kinship group.
Corollary 5. Marriage imposes strict and limiting reciprocal obligations on husband and wife, but the obligations of each to his own kinship group take priority.
Corollary 5.1 Sex rights in marriage are exclusive between husband and wife.
Corollary 6. Because children provide the continuity essential to the perpetuation of the kinship group, the family exists primarily for its child members.

The Ifugaos of old days demonstrated a life of peace and harmony among themselves through strict observance of these basic tenets. Except for Corollary 1 (self-interest seems more important today) and Corollary 3 (aggression-protection cycle is not part of their daily fare these days), the same beliefs are still generally observable.

5.4 Of rice and men

For its being my home office while doing this research, I did an in-depth study of NRM in *barangay* Bangaan, and compared my findings with those of other *barangay*s. Bangaan's central *sitio,* Bangaan Proper, has three souvenir shops which display the ubiquitous statues of *bulul* (rice god) in various sizes. Since the introduction of Christianity, these *bulul*s have lost their sacred intent and have become curio items for tourists. The significance of these statues in the past reveals strong cultural traditions that revolved around them and governed all aspects of daily life and agriculture of the Ifugaos. Rituals accompanied all stages of rice cultivation to please this rice god for a bountiful harvest. Fermented rice produces a native wine *(tapuy* or *bayah)* which was essential for most of these rituals and other special occasions.

"Rice is the staff of life of the Ifugao and also his main wealth" (Angiwan 1984 in Cardenas, *et.al.*1995: 76). Asians in general, celebrate rice as an important staple and as the basis for many of their traditional practices, myths and beliefs. It has a deity, for example, the *bulul* of the Ifugaos who had also believed that rice culture is a "partnership between them (being descendants of *Balituk and Kabigat*) and the gods of agriculture" (Dulawan 1982:17). Each step in rice cultivation had a special sacrifice in which the *bulul* was called upon to bless the rice in each stage of growth to become robust, drive away pests and ensure a bountiful harvest. For centuries, rice cultivation in Ifugao and its accompanying rituals have dictated the life tempo of the individual, the family and the community the whole year round with the following working seasons (Dulawan *op.cit.*):

Lukya	-	taking out the rice from the granary
Hipngat	-	general field cleaning
Panal	-	sowing
Bolnat	-	transplanting

Ulpi	-	end of planting season
Hagophop	-	weeding and replacing stunted seedlings
Bodad	-	terrace wall-cleaning
Paad	-	rice-maturing time
Ngilin	-	harvest day's eve
Ani	-	harvest day's morning
Upin	-	after harvest season
Kahiw	-	thanksgiving and replenishing granary

I asked around and found out that the relevant activities and rituals slightly vary in other areas of Ifugao. In any case, strict adherence to the performance of rituals as integral to rice terracing activities was necessary in the early days. According to Ifugao beliefs, these are done to avoid bad harvests, to drive away pests, to prevent sickness in the family, or even death. After being Christianized, the Ifugaos have generally lost the consecration aspect of these rituals. Only the main events like taking out rice from the granary, transplanting, and harvesting are now observed, but have practically become events for picnics. The other activities are routinely carried out.

Another thing that puzzles many is why Ifugaos choose to engage in just one cropping season when there is general abundance of water supply for irrigation (Osman 1990). One reason is the generally cold weather, because warmer areas in the province, like Ducligan and Lamut, are engaged in double cropping. Agro-technologists from the IRRI (International Rice Research Institute) developed a cold-resistant rice variety in order to accommodate a second crop in the colder months, but farmers say it easily shatters— the grains easily fall from the panicle, which is not suitable to the per-panicle harvesting practice on this mountainous terrain. In 1994, IRRI left its station in Banaue after more than 20 years without being able to introduce a single rice variety appropriate to the adverse environment and Ifugao sensibilities (Dulnuan 1998). In 1996, PhilRice (Philippine Rice Institute) introduced two "enhanced[3]" native rice varieties but after 2-3 cropping seasons, local farmers dropped these varieties which required fertilizers; a 3% acceptability rate was calculated.

However, during the harvest time, I joined an *ubbu* in Sitio Batwag and noticed that farmers planted different varieties. I was told that they do so to determine the relative performance of these varieties and to decide which ones to plant for the next season (pers.com. Manang Rosa 1998). The so-called "California rice" is a favorite because of the many grains that develop. The native variety, called *tinawon* is a must, because of its desirability in making *tapuy*. The *dikit* (glutinous rice) is necessary in making rice cakes. Palatability of rice long after cooking is another consideration because farmers cook rice for the whole day early in the morning to save on cooking time (and fuel) for the rest of the day.

There are other varieties in use, but Ifugao farmers do not know the names, as they only got the seeds from their relatives who have migrated to the lowlands and have recommended these varieties to them. Could this mean that Ifugao farmers

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[3] *Gohang* and *Sumadel*, which can yield 3-4 tons per ha. compared to traditional 2 tons per ha.; *Sumadel* can produce 2 cropping in lower areas.

believe their relatives more than they do agro-technicians? I could only speculate that "family" bond is at play. Osman (1990:47) studied Ifugao rice cultivation and found out that despite the fact that Ifugaos grow rice in the traditional way, "one component of their technology is subject to change: the rice variety. However, it was the cultivators themselves who made the decision to try and eventually adopt these varieties." He pointed out that these initiatives have been done since the arrival of the Americans, when Ifugao's isolation ended and exposed them to other varieties from the other provinces. Adoption or non-adoption of a variety is a complex issue and is beyond the scope of this research, but there is no doubt that Ifugao farmers do experiment on rice varieties to plant and they definitely plant different varieties at the same time for various reasons.

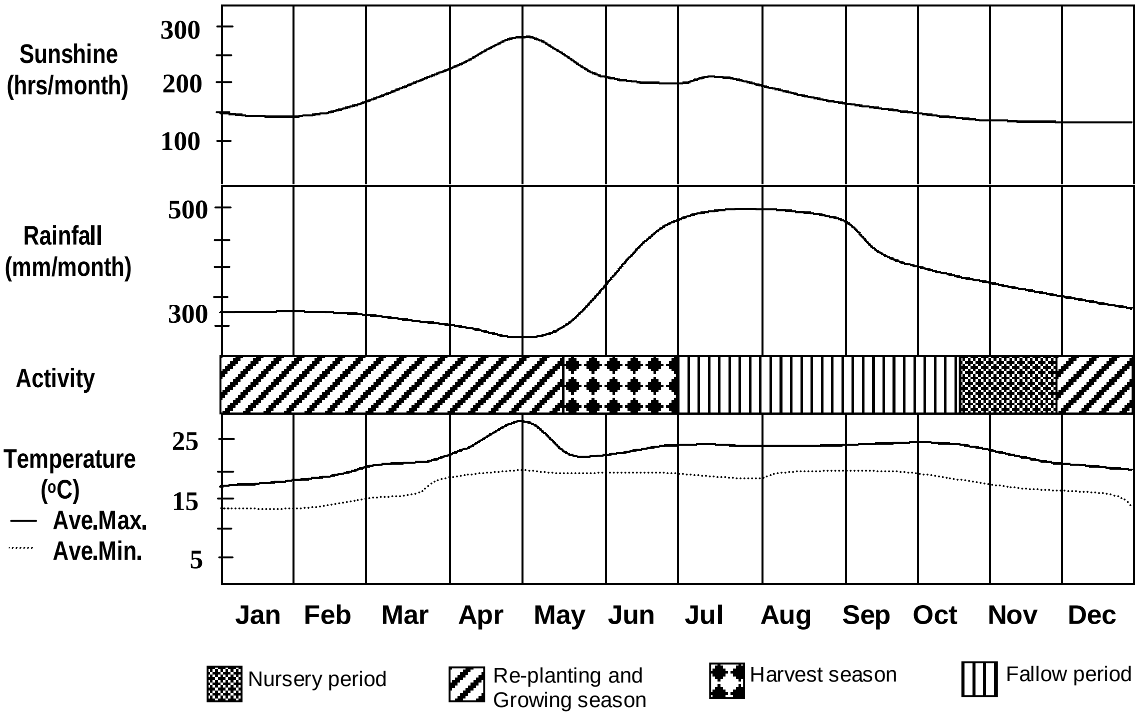


Fig.5.4 Ifugao agricultural calendar *(adapted from ITC 1994)*

While maximization of production is the most common objective in many agricultural activities, the Ifugaos traditionally maintained a timetable that also considers the climate and management practices like fallowing and other social practices like rituals that were simultaneously observed during the agricultural cycle. As informants say: "*The land also needs to rest!*" Their main consideration is for the soil to recover its nutrients and secondly, avoidance of the wet season because of the oversupply of water that, according to farmers, can cause the rice panicles to rot. An inspection of the Ifugao agricultural calendar (see Fig.5.4) reveals that "vegetative growth is timed to coincide with the height of sunshine availability to enhance maximum photosynthetic activities since rice is sensitive to photoperiodic fluctuations" (ITC 1994:51). Indeed, the intelligence, vision, patient labor, stamina, and constant piety that transformed steep mountain ranges into artistically sculptured shelves of terraces just for growing rice stagger the imagination.

I inferred a revelation of sorts from this narration of Manong Amando, a 50-year old jeepney driver:

> "These days rice is eaten three times a day. But when I was small, we ate sweet potatoes more than rice. Rice was mainly for special occasions and rituals. We practically survived on sweet potatoes, fish, snails, fruits and vegetables. Pigs and chickens were also for special occasions. Our *uma* produced a lot of sweet potatoes and we also ate the sweet potato tops. Even our snacks were sweet potatoes! Bananas and other fruits provided variety. Also in those days, the rice fields and the rivers teemed with fishes and edible snails. I remember how each day, my classmates and I eagerly waited for dismissal time so that we could go and catch fish or gather snails from the rice fields— there were the *jojo, birabed, bisukol* and the most priced catch of all, which is the mudfish. Anybody could catch fish at anybody else's rice field. There were fishes everywhere because, you know, they were transported from field to field. The rivers yielded eels in addition to these fishes. On Saturdays, my father and I would sell our catch in the market."

This recollection was corroborated by other elderly informants from Barangay Anaba and Barangay Ducligan, and explains Conklin's (1980:10) observation of the "tremendous everyday nutritional importance of the swidden-grown sweet potatoes despite the prestige and greater cultural focus on pond-field rice." He noted that only the richest people then were able to maintain a 5:1 ratio of rice to sweet potato intake while the poor ones had the opposite ratio of 1:5. During my dialogue with the Ifugao Provincial Board, they confirmed that indeed in poorer towns (with more steep slopes and less area for rice production), sweet potatoes played the dominant role in the diet. The gently sloping terraces in the towns of Mayoyao and Hingyon produced more rice and provided enough to sustain everyday rice supply.

The ITC (1994) also noted that the Ifugao's timing of harvesting coincides with the wet months, which is consistent with their objective of fermenting *tapuy* for their rituals. The terraces can be thought of as their cathedral. Rice cultivation used to be a religious and cultural function (that needed *tapuy*). If this was so, drying rice was indeed the least of their worries in those days. The early Ifugaos considered rice culture as a "partnership with their gods of agriculture" (Dulawan 1982:17), but today, it is mainly for subsistence and economic needs. This is noteworthy in understanding snags (*e.g.,* double cropping) in the present efforts to increase rice production on these terraces. The old pious drive to produce rice has been overtaken by economic concerns which can be better satisfied somewhere else. Increasing rice production is dependent on increasing farm hands, and as discussed here and in Chapter 1, the younger generations are not inclined to lend their hands.

5.5 Faded glory

Aside from maintaining a frugal lifestyle in their harsh mountain environment, the most remarkable Ifugao means of sustaining their unique habitat is their strong social network consisting of definite leaders, definite territories, work organizations, and a system of law based entirely on custom and taboo that regulated their society. A comprehensive documentation of the *Ifugao Law* (Barton 1919/1969) details how this ancient, oral society administered justice and order to preserve itself and its environment. It included provisions for Family Law, Property Law, Irrigation Law, and Penal Law. Even animals had rights in their customary law, because malicious killing of animals, however wild, constituted a serious crime. Animals (even insects) were killed only for food and for ritual purposes. The *lupun*, or council of elders formulated these laws and ensured that all families know the policies resulting from these customary laws. The families in turn, inculcated obedience of the law to their respective members, or else, their whole clan would lose face and their departed ancestors would be angry. Such anger meant misfortune to the clan.

Kinship had determined leadership patterns and functions among Ifugaos before the introduction of present day *barangay* captains and *barangay* councils. Local governance used to emanate from the clan *a-ammod* or *lallakay* who, together with other village experts are collectively called *lupun* (council of elders). They were the "wise men of the village" as they knew all their customary laws, their clan's genealogy, and village history. The *lupun* converge for the interpretation of significant events, formulation of laws and policies governing various concerns like land use planning and zoning, declaration of watershed areas, and water rights.

The *lupun* also helped settle disputes between clans, but services of the *munkalun* (mediator) were resorted to when things got difficult. Today, settling of disputes among *barangay* constituents are first referred to the *barangay* captain, as stipulated in the Philippine Local Government Code (Republic Act No. 7160). When nothing comes out of it, matters are referred to the *lallakay* for arbitration instead of taking the case directly to the courts as practiced in the lowlands. Efforts are still exerted to settle the issue within the *barangay* before outside intervention is sought. Other traditional leaders in the village and their respective expertise were:

mumbaki	a full-time ritualist
num-pangila	knows all customs and traditions but cannot perform rituals (because only those with the required preparations can)
mailog	an elder with grandchildren of second to third generation considered having knowledge of village history

The *mumbakis*, or priests, were adult males who underwent the required training. They used to be well sought for the performance of various rituals, and were consulted for advice on every significant decision. They virtually lost their revered position in the present set up, but in times of desperation, like uncured and lingering illness or big accidents, people come to them for much needed advice and peace of mind. Even at the PRRM office, whenever things go wrong, like a series of accidents involving the staff, they joke about the necessity of performing the *baki* ritual. Regard for evil spirits and the countervailing power of the *mumbaki* still persists.

5.6 A lost command

One traditional village leader that got totally displaced in today's set up is the *tomoná*, who used to be the duly acknowledged rice-agriculture leader. He/she usually had the largest field used as the ritual plot, but more importantly, he/she had the record of obtaining the best harvest of all— in terms of quantity and quality of rice. The role of the *tomoná* was passed on to the first child, who would undoubtedly inherit the ritual plot and would have been taught the techniques that go with it. Today, some *tomonás* are still living, but they have lost their leadership. The institution of the *tomoná* was successful in managing their space, so it should offer good leads for the present research.

Lakay Ambojnon, Bangaan's *tomoná,* is a widower and estimated to be 85 years old. He is too weak to farm and lives with the family of his only child, a daughter who died in the late 80s. When asked what he could say about the present state of terrace farming, he said: *"Mas maphod nan ani u mo he a ngim chaor chi titit nangan hi payoh."* (They have better harvest today, but rats have become plenty.) His son-in-law works at the Banaue Hotel. His grandson, who is the inheritor of the ritual plot, is a shopkeeper in Banaue. The ritual plot is now being sharecropped with a neighbor, Chutog Helong, who owns a carabao and thus can cultivate more area.

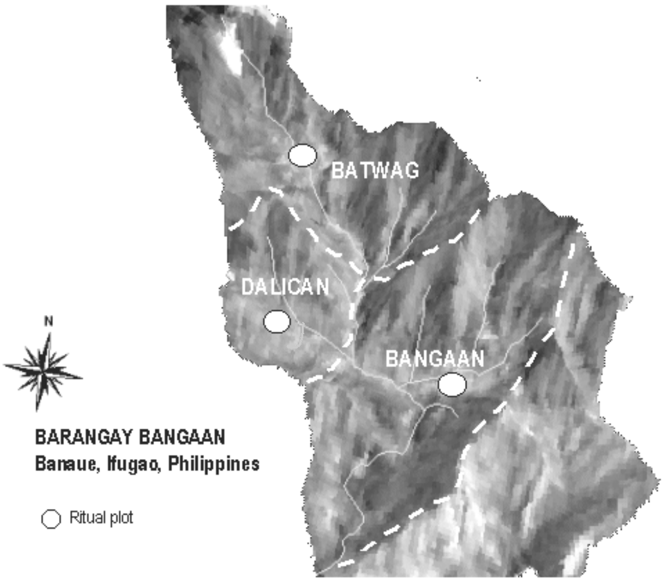


Fig.5.4 Apparent independent water districts following delineated water catchment boundaries

Conklin (1980:6) called the *tomona*'s area of jurisdiction an "agricultural district" and observed that in "cultural, social, technical and environmental terms, these agricultural districts are both the largest and the most functional territorial units in Ifugao." Its ritual field, *puntona'an*, is the first to be planted and harvested each year. Using his descriptions, present verification showed that these "agricultural districts" approximate today's *barangays.* It appears that Bangaan used to refer both to the whole "agricultural district" (now called Barangay Bangaan) and its central hamlet (*sitio* Bangaan) where the ritual plot is located. Probably to make the distinction, this central *sitio* is presently called "Bangaan Proper." The same is true for another *barangay,* Barangay Ducligan, and its *sitio* called Ducligan Proper. A ritual plot can still be found at its center.

However, informants say there used to be three (simultaneous) *tomoná*s for Barangay Bangaan: Lakay Ambojnon, Lakay Hipog, and Ina Chulimay, who were in charge of *sitios* Bangaan Proper, Dalican, and Batwag, respectively. I was puzzled, but I could not get any other explanation aside from this: *"Because of their proximity, today's modern political- administrative subdivisions must have lumped these three together to form one barangay."* However, after I looked at their locations in the 3-dimensional or 3D-view of Bangaan (3D-view production is discussed in Chapter 6), it appears that they represent three different catchment[4] areas (see Fig.5.4). Batwag is located at the uppermost-stream region, while Dalican and Bangaan Proper branch in two opposite directions. They have independent irrigation sources. This makes them what could be called independent "water districts." It seems that the Ifugaos of old demarcated their management units in terms of these catchment areas. The same is true for Conklin's study area, Bayninan, which is a *sitio* in the next *barangay,*

[4] The smallest watershed unit that make up a micro-watershed.

Barangay Kinakin. It used to have its own *tomoná* and ritual plot as well, aside from those at Barangay Kinakin itself. It becomes evident that independent irrigation sources were the basis for delineating management units in old Ifugao.

With their own *tomoná* and ritual plot, it follows that these "water districts" correspond to Conklin's "agricultural districts." His choice of the term is apparently with respect to his concern for documenting terrace rice production and its rituals, which were all performed by the *tomoná*. The present research is more concerned with tracing the organization of past and present Ifugao society in managing its environment. Thus, the term "water district," which represents the old Ifugao's natural management unit, is more appropriate to use in this research than the term "agricultural district."

During the full agricultural cycle, the people of the whole water district are enjoined by the *tomoná* to pledge concerted action in all their agricultural activities. Fines are imposed on those who break the solemn vows and that entails providing for the sacrificial animals for a repeat of the rituals. In today's modernized agriculture using hybrid varieties, an altered agricultural calendar, and a religion totally alienated from it, the institution of the *tomoná* has ceased. This can be seen in the various stages of rice growth on the fields at any one time due to different planting dates. This is also seen in the big areas destroyed by rats as harvest season nears. In Sitio Batwag, rats consumed almost two-thirds of an approximately 100-m^2 terrace. We were only able to gather 14 bundles from what remained at the edge of the terrace and that was about 28-30 kilos— such measly amount that does not compensate for the back-breaking days of tending them. When queried about this, Manang Rosa simply shrugged, "There's nothing that can be done about it." Other studies in pest management show that its control has to be undertaken at community level (Schoubroeck, 1999). Even lowland farmers of Central Luzon also coordinate with one another when they would spray insecticides (pers.com. Tata Mele 1998). The disappearance of the *tomoná* made the Ifugaos vulnerable to pests that require collective action to control. Institutions are a crucial ingredient in productive agriculture.

5.7 The *ubbu*'s ebb

People of a water district used to organize themselves into workgroups called *ubbu*. The *tomoná* had commanded their cooperation from setting the first day of planting up to post-harvesting rituals. A schedule was decided upon to attend to each member's (*mun-uubu*) rice fields to meet the agricultural calendar. Computation of work was done by the number of days of services rendered, regardless of activity. Failure to comply with the schedule was considered a disgrace, and it also meant providing an equal number of day's food provisions for the group.

Only the women's *ubbu* are active these days. These workgroups are still significantly practiced because of the obvious tediousness of terraced rice production. They are helpful when planting, weeding, and harvesting of rice, and in clearing terrace walls and *uma* of weeds. Manang Virgie C. enthused, "The *ubbu* makes work easier. You get surprised when you see everything finished in only a day!" Manong Amando explained it this way: "If there are ten of us in a workgroup, the strength of one is increased ten times. Then, we are like one hundred people working together."

The men's *ubbu* were for the construction and maintenance of rice terraces, field preparation, and for constructing or moving a house. They also coordinated with the *tomoná* in having the terraces ready for sowing time. This involves manually turning the soil using a wooden spade or hoe, repairing broken walls, reshaping and maintaining spillways, and bringing in water from the irrigation canals. Another voluntary male workgroup, called "*baddang,*" were organized for the construction and maintenance of irrigation canals, and will be discussed in Chapter 7.

In the waning practice of men's *ubbu*, these activities are now being done individually, or by paid labor. However, menfolk in Barangay Bangaan are now "disappearing" because of employment in off-farm jobs. With five jeepneys, Bangaan has the largest number of drivers in the study area or even along the Banaue-Mayoyao route in general (Anaba has one, Ducligan has three and Batad has none). Aside from the drivers, jeepneys have conductors, and so that easily means ten men out of the field. Others act as tourist guides in town, have migrated or sought wage-earning jobs in the lowlands or abroad. Informants counted only ten male experts left in terrace wall construction. This explains the unmaintained state of many terraces, which the remaining men could not cope with. This also explains why ITC imported workers from other *barangays* like Batad to repair the terraces in Bangaan.

5.8 Water rights and wrongs

Fig.5.5 Thirsty soil at the height of El Niño.

I encountered two extremes in water availability during the fieldwork: the El Niño[5] and the La Niña[6]. The El Niño phenomenon swept the country from October 1997 until May 1998. Ifugao has an average annual rainfall of 3,700 mm and is considered a wet region (PPDO 1996) but during those El Niño months, the river beneath the PRRM field office in Bangaan dried up, and residents say it was the first time it happened. With a many rivers and streams dry, the terraces became waterless and developed cracks. These cracks gave way to landslides when the La Niña rains started in October 1998. Two major terraces in Bangaan were destroyed after two major landslides occurred during the fieldwork.

Compared with other *barangay*s whose rivers all ran dry during the El Niño, Bangaan was lucky to have one very reliable stream that runs from Sitio Batwag. It continued to flow despite a reduced volume. However, it only provided water to

[5] A global weather phenomenon characterized by high temperature and severe drought.
[6] The opposite effect of El Niño, when heavy rains and flooding occur.

terraces that benefit from the irrigation canal running through the Sitio Dalican side. The canal that goes in the direction of Bangaan Proper (see Fig.5.4) was unmaintained, and it left the terraces on this side dry. Even the former ritual plot had no water. In the old days, it was a great offence to the rice god to allow it to dry and it was believed that the whole village terraces would dry up, too. Manang Virgie H. recalled a story of one poor Bangaan farmer who sacrificed his water supply in order to irrigate the ritual plot— he gathered bamboo poles to be able to channel the water from his terrace. Such a heroic act earned him the respect of the whole village and that extended up to his descendants. Long after his death, his grandson became of age and was enamoured of the granddaughter of the *tomoná*. The sacrifice that his poor forebears made earned this grandson the permission to marry the *tomoná*'s granddaughter without any dowry. Such was the Ifugao consideration for water in the ritual plot. Such was the Ifugao consideration of sacrifice for the community.

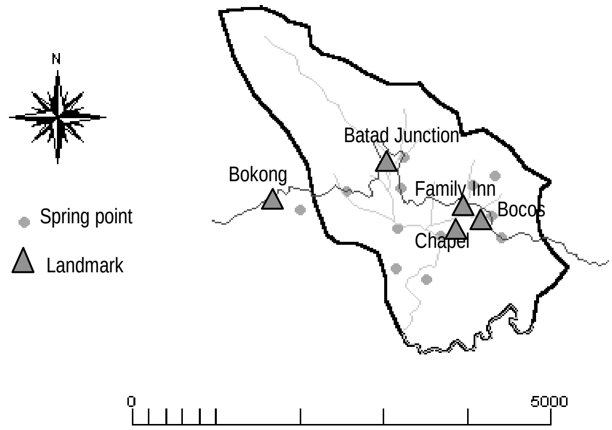


Fig.5.6 Location of the reliable springs of Bangaan

Even these days, water for the terraces has priority. During the El Niño, this caused some disputes between the owners of the tourist inn who needed continuous water supply, and the terrace owners. There were many times when the plastic hose that connects from upstream to the inn was intentionally disconnected by disgusted neighbors. The jeepney drivers went to fetch water for the inn from some other points toward town. Twelve spring water points along the road and mountain sides provided household water supply. Plastic jars and pails in line were often seen on these spring points. Even people from other *barangays* fetched water from those which are along the road. The jeepney would be stopped to give people time to fill plastic bottles they carried. During one of our meetings, Manang Virgie suggested mapping out these points using the GPS so that they could be given the proper attention by the municipal government. Informants complained about road-widening projects that destroyed these spring points when covered by excavated soils. Fig. 5.6 shows the map which the CB-NRM council submitted to the municipal government for proper attention. Excavation was stopped, but it was not clear whether the map had played a role in this decision.

5.9 Family and community

Regard for one's family and clan still remains, but neighborhood alliances have largely weakened. Administration from the town mayor and the *barangay* captain is evidently top-down as compared to the former way of having clan representatives in home region decision making. External agencies (including the local government) are working to remedy the problem, but they concentrate mainly on propping up the terrace structure without regard for strengthening the social organization on which the structure depends. This is manifested in the following observed changes that are not being addressed:

- waning practice of men's *ubbu*
- a stop in men's *baddang*
- "declining" male farm-population
- unorganized "water districts"
- absence of a relevant "rallying point"
- reliance on project "dole-outs"

All these factors eventually lead to unmanaged erosion of terrace walls. People rely on project contracts to hire them for doing terrace and irrigation maintenance work instead of voluntarily repairing their portions, as they did before. Worse, the quality of work diminishes, as one's objectives center on the wages. Manang Rosa talks about some individuals who work haphazardly to finish the day's work. Ifugao tradition had demonstrated to the world the power of collective action at every level of decision making— from the family, to the clan, to the water district, to the home region —but the present set up lacks the mechanism to do the same.

Table 5.1 shows the corresponding area of responsibility for each social unit in the old and new Ifugao set-up. The old social organization provided clear management roles and areas of responsibility emanating from collective decision-making capabilities at each level—from the family up to the home region's council of elders. In contrast, the present set-up is a picture of top-down policy-making bodies of governmental offices and a wide gap can be seen between the family and the community management organization (see the absence of responsible NRM bodies at the level of terrace cluster and the *sitio*).

Table 5.1 Comparison of Ifugao's old and new set-up of resource management

O L D		**N E W**	
Spatial divide	**In-charge**	**Spatial Divide**	**In-charge**
- xx -	- xx -	Province	Governor
Home region *(buble-taku)*	Council of elders *(lupun)*	Town	mayor
Water district *(tona'an)*	Agric.leader *(tomoná)*	*Barangay*	captain
Home place *(buble)*	Clan leader *(apú)*	Sitio	*lupun*[7]
Terracecluster *(payoh-cha)*	Irrig. leader *(mun-unod)*	- xx -	- xx -
Terrace *(payoh)*	Family[8]	Terrace	family

[7] Functions differently from the old concept of *lupun* (council of elders for NRM); the new concept is mainly directed at settling disputes (*lupun tagapamayapa* or "peace-keeping"*)*.
[8] I asked around, but I was surprised to know that there is no Ifugao word for "family" despite the importance that Ifugaos give to the family. They only have these terms: *hinna-ama* and *hinni-ina*, which pertains to paternal and maternal lineage, respectively. However, this is consistent with Barton's (1919/1969:18) observation that "husband and wife are never united into one family. They are merely allies" (see Chapter 1).

5.10 Tight coupling

The disappearance of old institutions and the creation of new ones in the management of Ifugao's fragile environment can be represented by the final entity-relationship diagrams shown in Fig.5.7a and Fig.5.7b. I used them to analyze the coupling between the social organization (soft system) and the physical environment (hard system) it purports to manage. Frames having similar patterns around corresponding entities indicate such coupling between the social and bio-physical systems..

The old Ifugao's terrace ecosystem management (Fig.5.7a) suggests what Röling (1994) calls "platforms for decision making." In this case, "interlocking platforms[9]" can be discerned in terms of the dual or multiple-responsibilities that rest on a person as he/she performs duties expected of him/her as an individual, as a member of a family, a clan, a *buble,* and if applicable, as a member of the *lupun* or village experts. Traditional rites and rituals also served as venues for disseminating information to the rest of the community. A local environmental monitoring system for collective action was at work in that way. Their development had essentially rested in their hands.

In contrast, Figure 5.7b shows how the present *barangay* is loosely organized in the management of its space (and as discussed in section 5.4, this is a much bigger space, because several water districts are lumped together in the present political-administrative set-up of the *barangay*). Moreover, local knowledge is being side lined as external line agencies provide top-down development plans that replace the efforts of the local experts' pool of the *lupun*. External agencies, through the *barangay* council, have introduced new technologies like high yielding rice varieties. However, ask any Ifugao in the field about the "golden kuhol" and he/she would surely express misgivings with the Department of Agriculture, which introduced this variety of supposedly edible snails that is now a pest in their terraces. Most of all, the waterways, which are the lifelines of the terraces, and which have been meticulously monitored and maintained before by the local workgroups, are now left to the responsibilities of politicians (*barangay* council) and line agencies, notably the National Irrigation Authority (NIA). Clearly, the Ifugaos are now being subjected to top-down policies. And the inefficiency of the present system is indicated in seeing individuals making the most of their time and effort and means in channeling water to their own terraces. NRM concerns have evidently focused on the family to the neglect of community— the opposite of what they used to do to succeed.

With the help of elderly Ifugaos and information from their written history, I was able to draw the E-R diagrams (Fig.5.7a and 5.7b). They provided me an understanding of how Ifugao's traditional NRM system operated and how the present system copes with the changes. The E-R diagrams also helped me identify the relevant spatial and non-spatial entities that describe the NRM system. Spatial entities are those that can be represented on a map as either point, line or area feature (*e.g.,* forest, rivers). Non-spatial entities are those having no spatial character. Their identification is important in determining the needed data and possible data sources

[9] A person's interlocking membership in different platforms is redundant, but seems to have worked advantageously in the old Ifugao setting by providing a consistent goal and flow of information at each level of decision making. It can also be called "nested platforms" (Röling 1997).

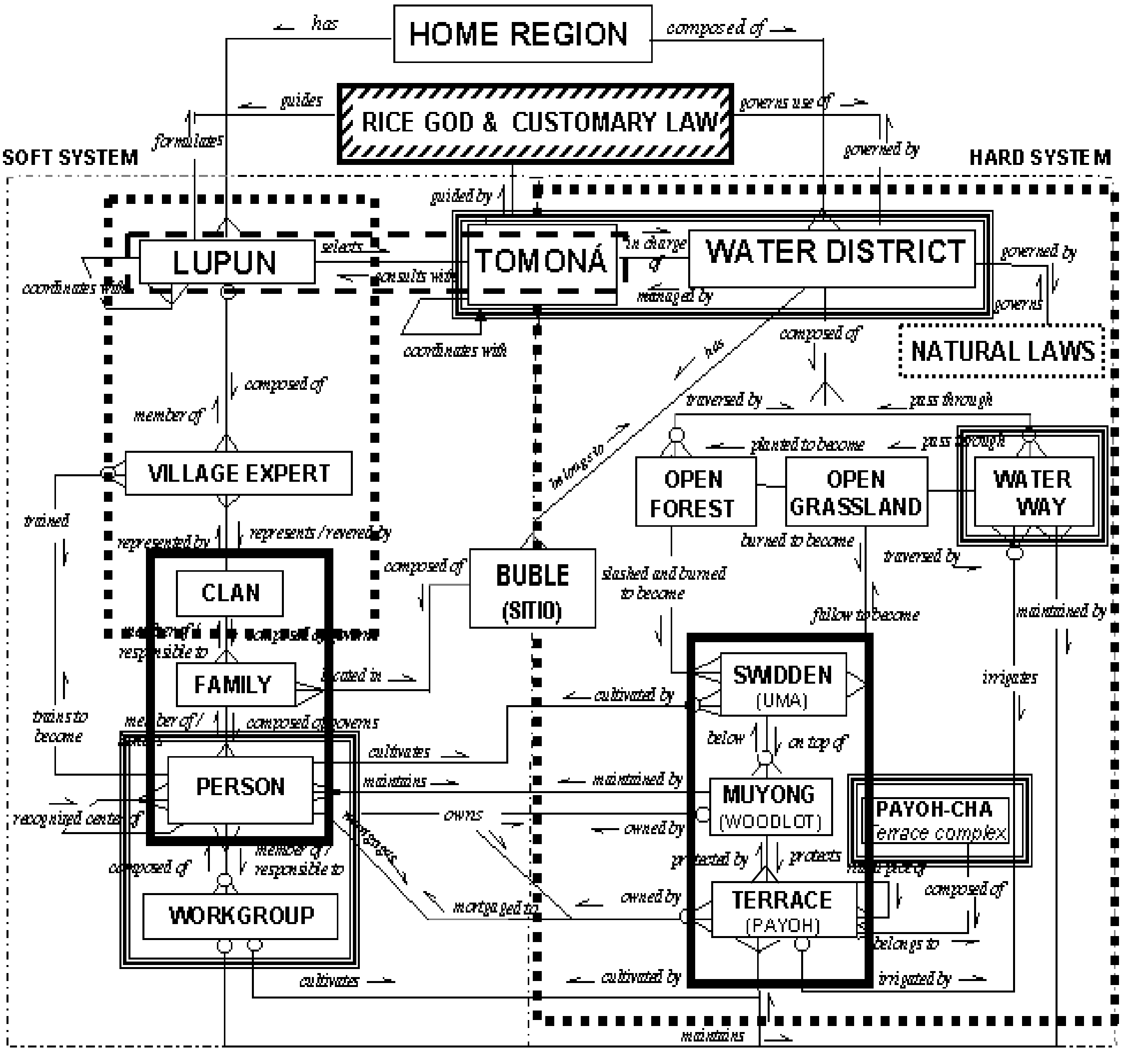


Fig.5.7a Hard and soft systems in old Ifugao

for the spatial database to support a GIS. Table 5.2 is the list of these entities and the available data sources. The development of the database that organizes the data regarding these entities for into a GIS is discussed in the next chapter.

Table 5.2 Identified spatial entities

Entity	Definition	Geometric feature	Data Source
Water district	Traditional NRM unit	Area	SPOT image, interview
Open grassland	Area covered by grass	Area	SPOT image
Open forest	Unowned forest	Area	SPOT image
Muyong	Private woodlot above the terraces	Area	SPOT image, interview
Swidden farm	Upland area planted to sweet potatoes	Area	SPOT image, interview
Terrace	Raised level of field for planting rice	Area	Sketchmap
Payoh-cha	A cluster of terraces on one side of the watershed	Area	Interview, sketch map
Sitio	A cluster of houses	Point	Interview
Waterway	Water channels	Line	Topographic map

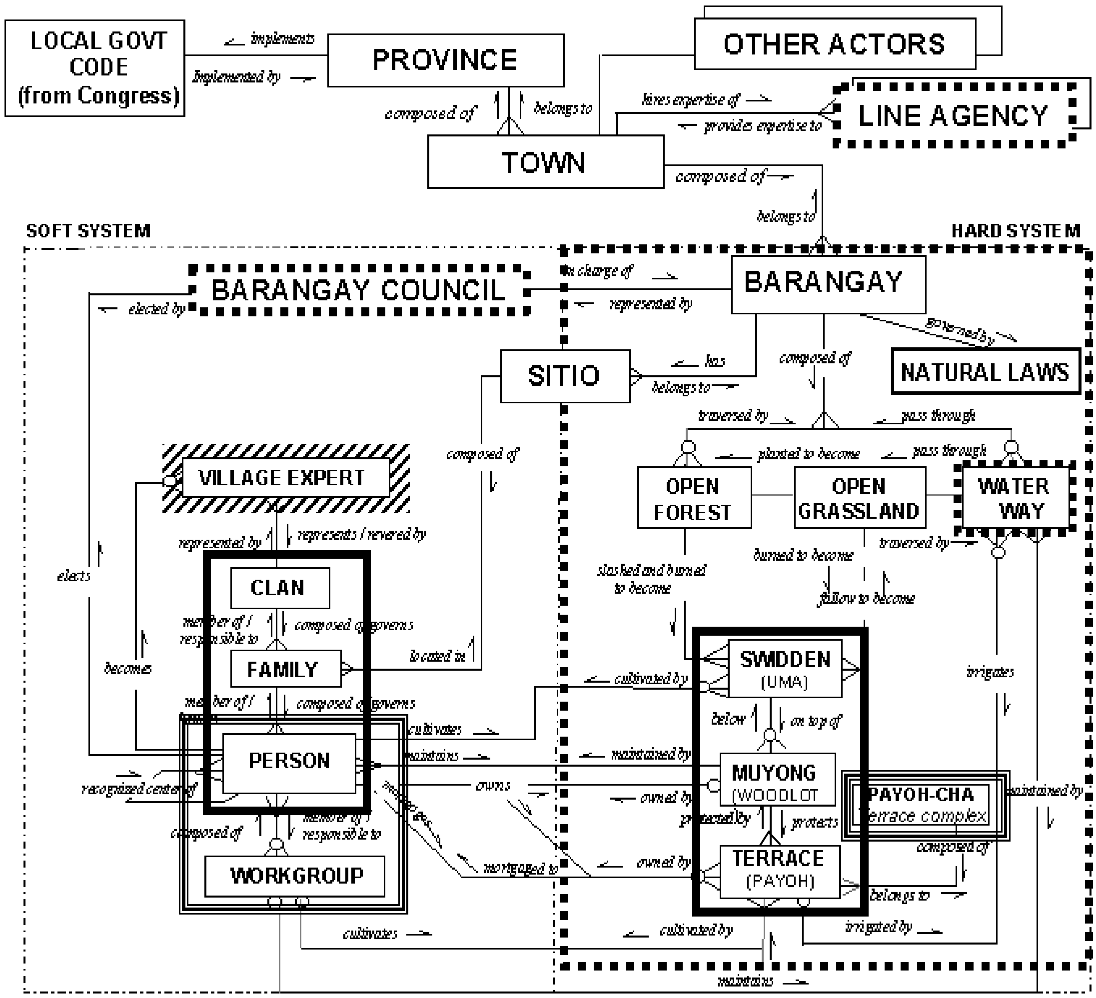


Fig.5.7b Hard and soft systems in present-day Ifugao

5.11 A day on board

I presented the E-R diagrams (Fig. 5.7a and Fig.5.7b) showing the configuration of the old and new Ifugao society in the management of their watershed to the Ifugao Provincial Board during a special session for discussing the results of this research. The older members of the board had not realized what appears to be a "nested platforms" configuration before, but they clarified that collective work was just the norm— it was expected of them. Everybody recognized the significance of the term "water district" as water is regarded as the key to life. They cited the need for irrigation canal watchers in the summer. The water catchment was indeed the determinant for the district boundaries. The board members were seriously considering GIS to help in the growing boundary disputes.

Traditionally recognized boundaries and present political-administrative boundaries are generating confusions among some adjacent *barangays*, especially now that resources are getting more and more scarce. I told them about the dispute between Bangaan and Anaba, and showed the 3-D view of the SPOT image which

Fig.5.8 Discussion with the Ifugao Provincial Board.

reveals Anaba's right to the claim by virtue of the "water district" concept. The municipal officials left its settlement to the two *barangays*, but was not particularly happy that it resulted in having the *barangay* captain punched by his son for surrendering[10] a piece of their village. They also cited other cases of boundary disputes and the necessity to devise ways other than taking after the traditional conflict settlement schemes[11] commonly used by adjacent terrace owners, and which rely on the physical prowess of representatives from contending parties. They said these traditional "water district" boundaries derived from the DEM may be another option for conflicting *barangays.*

The diagrams also helped the board members recollect the big changes that have taken place in their life, and the lessons from the success of their ancestors. For example, they said planting rice (thus, harvesting) at the same time really resulted in higher harvest as it limits the period for rat attack. Also, vigilance in irrigation canal maintenance is a must in the erosion-prone Ifugao environment. But they pointed out that their changed lifestyle makes it difficult to implement these practices today—there are more off-farm activities, and there is the indifference of the younger generation. They also joked about the way they dress— that their g-strings are now worn over their necks (tie) and that they now have to wear shoes. This not only shows the extent of external influence in the Ifugao society, but the expenses entailed by present-day necessities. By comparing the past and present conditions, they were able to trace the root causes of the present difficulties in coping with a changed life style.

Box 5.1

Philippine Daily Inquirer— 8June1999

Regaining Ifugao's Fading Cultural Glory

"… Educators have finally reckoned that the ancestral knowledge and ingenuity that built the rice terraces and the whole way of life that revolves around the land should not vanish. The DECS in Ifugao has come out with what it calls 'Indigenized Learning Guides' for Grades 2 and 6 pupils in the province. Learning guides for other grades would follow…. Through the 'indigenized curriculum,' the pupil, for example, gets to appreciate that it was not only ingenuity and engineering skills that built the rice terraces. Equally, if not more important, was the Ifugao's cooperative tradition called *baddang* or *dang-a*, which other Filipinos call *bayanihan.*

[10] Barton (1919/1969:113) reported similar cases (sometimes even ending in murder) regarding the squandering of family owned fields, thus rendering the father as a "traitor to the welfare of the family and the future generations."

[11] The *ug-ugub* entails throwing of reed shoot arrows at a target. The target may be each other's back or the fields concerned. The *bultong* is a wrestling match between the representatives of contending parties.

I also pointed out the general need for Ifugaos to learn their history in order to gain lessons from their successful ancestors, because the younger generations do not know their history anymore. They agreed with me, and told me that there are efforts along this line already being done by the provincial office of the Department of Education, Culture and Sports (DECS). An excerpt from a recent newspaper article shows some developments about the matter (see Box 5.1).

The board members realized the facility of using satellite images for monitoring the forest condition and appreciated the possibility, by using GIS, of aggregating information about *barangay* terrace conditions for the whole province (see Chapter 6 and Chapter 7). They were surprised to learn that the SPOT image was classified with the assistance of local residents in the study area. I told them about the orientation and identification of familiar landmarks, the local inhabitants were able to recognize their area, and actually helped me interpret it and refine the result of machine classification (see Chapter 6). The vice-governor asked me where I got all the data. He saw the facilty in provincial forest management, "Without having to go to each of those mountains, we can easily monitor the progress of our reforestation projects." I referred him to the national mapping agency in Manila. He asked about the accessories to be considered in the preparation of their budget.

They clarified some matters about rice being eaten occasionally in the past (as I reported in section 5.4)— they said that "it only happened to those villages with very steep slopes and therefore less field areas." The wider valleys in the towns of Mayoyao and Hingyon could grow more, and so they had surplus rice which were bartered with other villages that experienced shortage. Aside from minor corrections on some spellings and pronunciations of local terms, they appreciated my effort to make a study of their situation and of introducing a new technology to do it. They wished me luck and hoped that I would return to carry on. One board member pointed out the possibility of offering GIS courses at the Ifugao State College of Agriculture and Forestry. They also hoped that PRRM would continue with GIS use in the province and expressed their support in it.

Apparently, these discussions have been given consideration because recent news heralds GIS acquisition for Ifugao (see Box 5.2). However, it reveals that GIS is seen simply as a mapping tool. Its strength in spatial analysis is not yet appreciated or understood, but this can be a good start for them to use the technology for thinking and understanding their environment. The next chapter is about preparing the GIS database following their NRM organization that I established using the E-R diagram.

Box 5.2

Philippine Daily Inquirer—22 February 1999

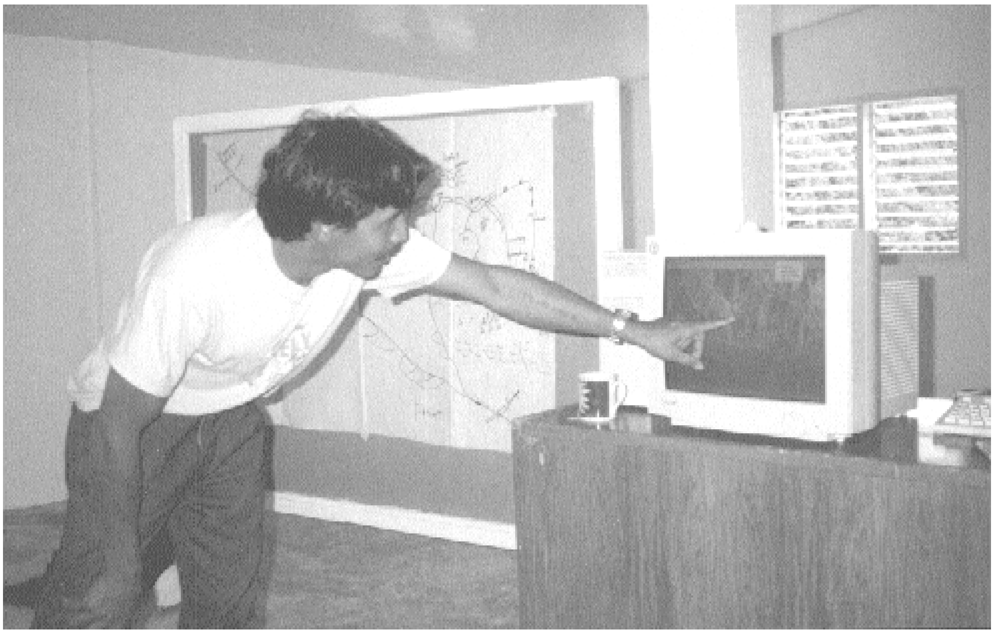
Mapping project

…. Aside from the land-use plan, Dait said UNESCO had approved an initial fund of $50,000 for a "geographic information system" (GIS) mapping project for Banaue. Using computers, the GIS can be used to monitor, for example, what area of the terraces was eroded or converted into residential zones.

Dait also revealed how the ITC helped encourage the Ifugao State College of Agriculture and Forestry (ISCAF) to motivate its agriculture students to learn the art of terracing from the Ifugao farmers. "This is to ensure that the age-old engineering skill that built the rice terraces won't vanish," Dait said. …

Chapter 6

Beyond pixels:
GIS with the Ifugaos



"We see because we know."

6.1 Introduction

The starting point in developing an information system is understanding the process it will strengthen. Then, a database is created to support it. In Chapter 4, it was shown that most of the previous efforts at harnessing GIS for local communities limited people's involvement to 'data gathering,' and stopped short of involving the people in the design process. However, Chapter 3 clarifies that this stage is crucial as it determines whose worldview is served by the created information system. In the case here, Ifugao farmers' knowledge was used intensively in jointly constructing a model to understand how their NRM works (Chapter 5), and that became the basis for designing the database to support a GIS.

This chapter discusses how I developed this database with the help of Ifugao farmers, and highlights the joint learning that ensued in the process. A spatial dialogue between the researcher and researched facilitated the design, analysis and utilization of information for monitoring their watershed. It shows that limitations in computer know-how are not a deterrent to engage in a GIS-assisted joint-learning, in channeling efforts towards new platforms to debate about Ifugao's future.

6.2 Shifting boundaries

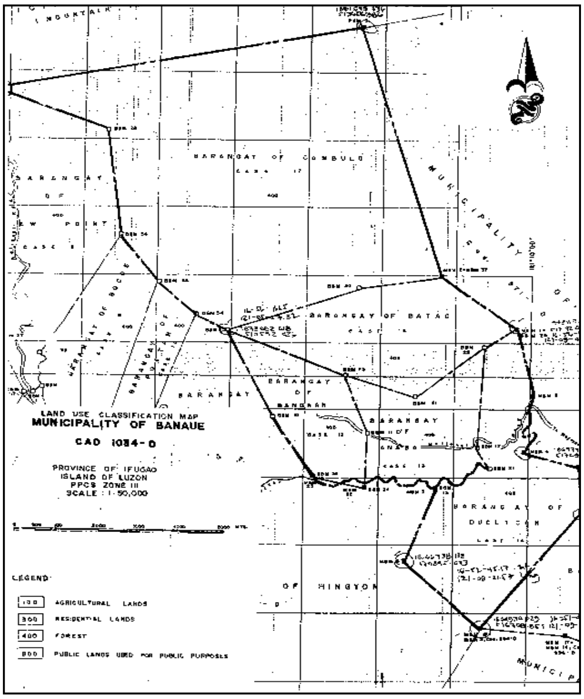


Fig.6.1 The official landuse map showing straight-line *barangay* boundaries

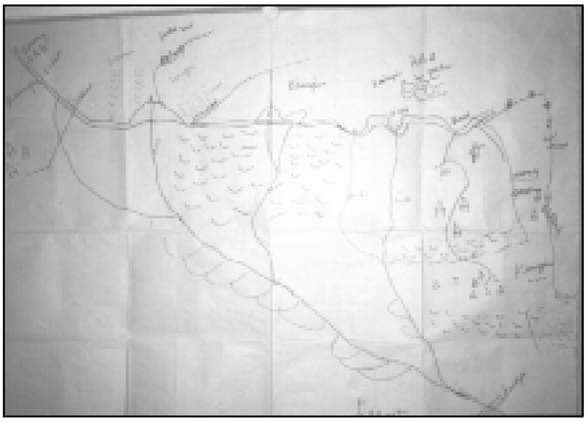


Fig.6.2 Local farmers' sketch map showing natural divides as boundaries

My first experience in involving the Ifugaos in designing a GIS was in delineating the boundary of the study area. I had a topographic map at 1:50,000 scale, but it did not indicate boundaries. The official land use map (from the DENR 1987) of the same scale had boundary lines for the *barangays*, but these lines were simple straight lines (see Fig. 6.1). I requested the local farmers to sketch a map of their *barangay* in order to have an idea of how they themselves delineate its boundary (Fig.6.2). I had earlier observed that pointing and oral descriptions are the common ways of communicating directions among the local people. However, I chose sketching for this matter because a sketch would contain things they consider significant in describing their place. Then, it can be my basis for inferring not only how they set its boundaries, but also what they consider as the resources to be managed. They drew landmarks such as bridges, schoolhouse, *barangay* hall, waiting sheds, road junctions, and rivers. Although at first, I had some difficulty in understanding the resulting farmers' sketch, their oral descriptions, as they pointed at both the sketch and the physical feature it represents, made the demarcation clear to me: "At the other side of that mountain is Barangay Batad; at the other is Barangay Anaba; and the other side of this river is Hingyon already. We can only make our *uma* (swidden farm) within this area, or else, the other *barangays* will be angry." That is how the Ifugaos determine the boundaries of the area that they utilize and manage to sustain their lives. They identify a catchment[1] area and protect it against incursions.

Clearly, the Ifugaos use natural boundaries to demarcate their territories. Territories are "the portion of space which a given society lays claim to… the domain of a particular group of land users" (Godelier 1984, cited in Powell 1997:17). It is important to understand the local concept of boundaries and territories because they

[1] A catchment area is the smallest hydrologic unit— a natural drainage system, and can be aggregated into sub-watersheds, and finally, the watershed. A watershed is an area that drains water to a common outlet (usually a river) as concentrated runoff (Lal 1980).

define the way people use it to survive (*e.g.,* a land-locked vs. a peninsular domain); it may help to understand their present problematic situation.

The early Ifugaos were said to have "shifting boundaries" (Barton 1930:114) because, as a person settles into a village (for example, after marriage), both his/her home region and the other zones shift as well. An Ifugao is born into a home region (see Fig.6.3), the center of which is a neighborhood or *buble* (the present day *sitio*). A common ethno-linguistic grouping, wherein people are speaking the same language, wearing the same costumes, and performing the same rites and rituals characterize the home region. Ifugao has four major ethno-linguistic groupings, namely: *Ayangan* (where this research was conducted), *Tuwali, Kalaguya* and *Kalinga*. Encircling the home region are other regions that Barton (*op.cit.*) called: "neutral zone," "feudist zone," (or feud zone) and "war zone." Mobility and security decrease as a person ventures far from the home region. The "war zone" is where all the people, being so different (*i.e.,* the lowlanders), are considered thoroughly bad.

Fig.6.3 Boundaries of old Ifugao (Barton 1930).

These early Ifugao notions of boundaries are "social boundaries" (Dyson-Hudson and Smith 1978, Cashdan 1983) that restrict movement, and therefore, use of resources. Social acceptance is a form of control of access to resources in a given territory. Today, this can be equated to exclusive clubs and organizations that offer services and benefits to members and friends only. With respect to hunting and gathering food in the forest, the early Ifugaos seemed to have observed the "social" rather than physical boundaries. They ventured as far as others could accept them. But with respect to terrace agriculture, the *tomoná*s utilized the *chang-la* (marker) around "water districts" to demonstrate strict observance of the physical boundaries. Today, there are no more friendly-unfriendly zones or social boundaries to worry about, but boundary disputes between *barangays* (even in the same home region) are getting common. During my stay in the study area, Barangay Bangaan and Barangay Anaba were disputing a swidden area; Barangay Cambulo was protesting forest encroachment by woodcarvers from adjacent Barangay Bocos; and Barangay Guihob and Liwang were contesting where to erect the road boundary marker between them.

As shown by the early and present-day demarcations, territories are a creation of society, and so, when "modelling the real world" in GIS, we are actually modelling "societal constructs" about the real world. As Capra (1996:271) explains, "There is no pregiven territory of which we can make a map. The map making itself brings forth the features of the territory" as people define and agree or object to such territories through language and action. That is, "territory," "*barangay*," or "country" are not tangible objects in the real world, but are ideas which are socially and politically decided. They become visible only after they are mapped. The Ifugaos used watershed divides in mapping which is more meaningful to them than the government's straight lines to define the *barangay* boundaries. I followed the local boundary concept as I had to understand local ways of managing space, and see where GIS can play a role.

6. 3 To DEM it or not

The Ifugaos' reference to mountain divides that form small watersheds, and define their village boundary limits, made me consider making a digital elevation model (DEM). A DEM is a digital representation of relief or the "contour variations of a land surface in relation to the surrounding land" (ILWIS® 1997:536). It can be displayed on the computer screen to visualize the mountaintops that form the watershed. When this is done, the mountaintops can be manually traced by on-screen digitizing to yield the boundary lines. Creating a DEM is time-consuming, but I decided to do it because, aside from adhering to local boundary concepts, I also know that using the DEM can facilitate other activities, such as:

- aerial photo interpretation, slope calculation, and spatial analysis operations requiring height information;
- inferring and understanding relations between spatial features in 3D.

I made the DEM by myself (off-field), but not without problem. As Ifugao is a mountainous province, the contour lines on its map are printed very close together, and so, digitizing each of those lines would be too difficult. My last resort was to scan the topographic map, and use the zooming-in functionality on the screen to facilitate tracing the densely plotted contour lines of steep slopes. After digitizing was completed, the computer easily accomplished the rest of the procedures to generate the DEM (see ILWIS® Users' Guide 1997:512 for the details).

Once the DEM is created (Fig.6.4a), a 3D hill-shading view (Fig.6.4b) that simulates one light source was displayed (see ILWIS® 1997:377 for the procedure). This served as background image when I manually delineated the mountain divides[2] on-screen (see Figure 6.4a and Figure 6.4b). I realized why the local people often say that Barangay Batad is just close by Bangaan, when in fact it takes at least two hours of hiking to get there. The DEM indeed shows the proximity— it simply lies at the other side of the mountain! The final map of the study area, overlaid with the official boundary lines, is shown in Fig. 6.5. For me, it gives more meaning than what may seem to others as arbitrary straight lines of the official map. They also helped make sense of what is viewed on foot— isolated clusters of houses became interconnected *barangays* of a larger watershed.

When I got back to the field, I demonstrated how to digitize a contour line. I allowed them to touch the computer, click the mouse, type on the keyboard, but I forbade them to touch the ESC and DELETE keys. I explained the consequences of pressing those keys. During the demonstration, I showed the elevation at any place on the map by simply clicking the mouse on a point of interest. With my assistance (our hands together on the mouse), a volunteer traced one contour line continuously across the screen over the map. At one point, she said, "So, Sitio Bocos is just as high as Barangay Kinakin!" I thought it was important for them to experience touching the computer and trying out some of its easy functions in order to view it as another drawing tool that I was able to use in making the DEM and the succeeding maps. The pencil-icon of the software helped show this drawing functionality.

[2] Note that in delineating the boundary lines (Fig. 6.4b), Barangay Bangaan does not form part of the emerging sub-watershed as its catchment area drains to a different river. Nevertheless, Bangaan was included in the study because it was my host community (where the PRRM field office is located). This offered closer interactions with the inhabitants and more opportunities for in-depth study.

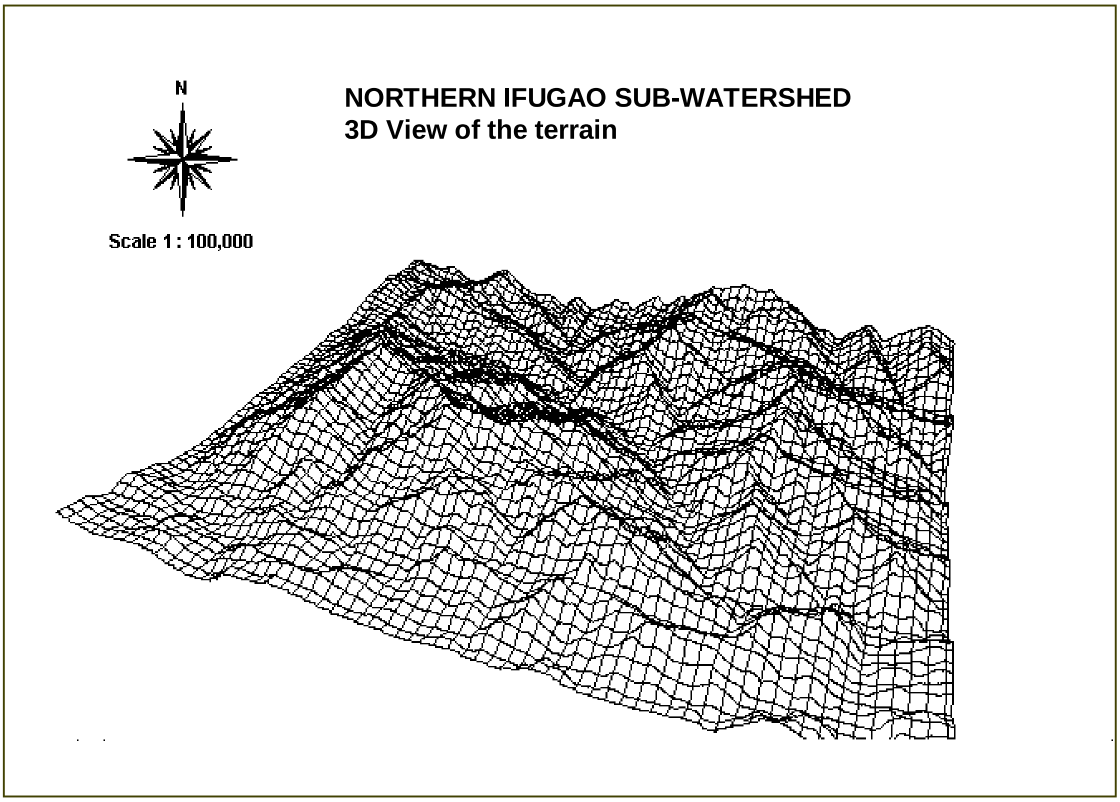


Fig. 6.4a 3-D view of the study area

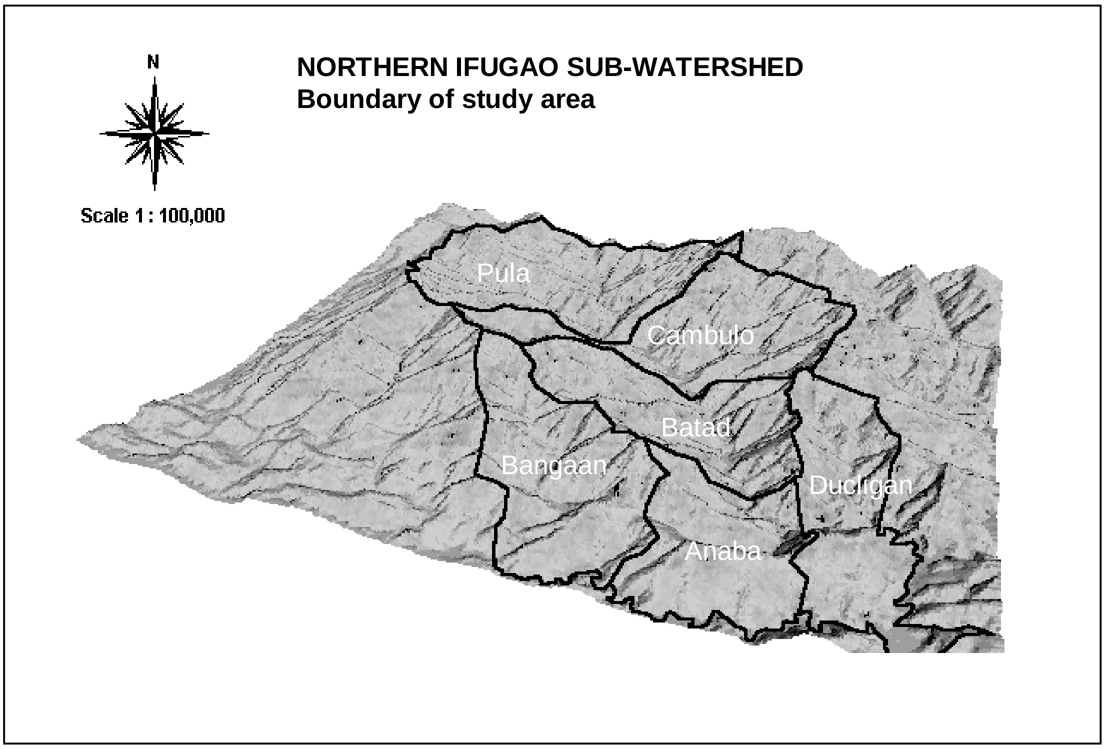


Fig. 6.4b Hill-shading view and boundary lines.

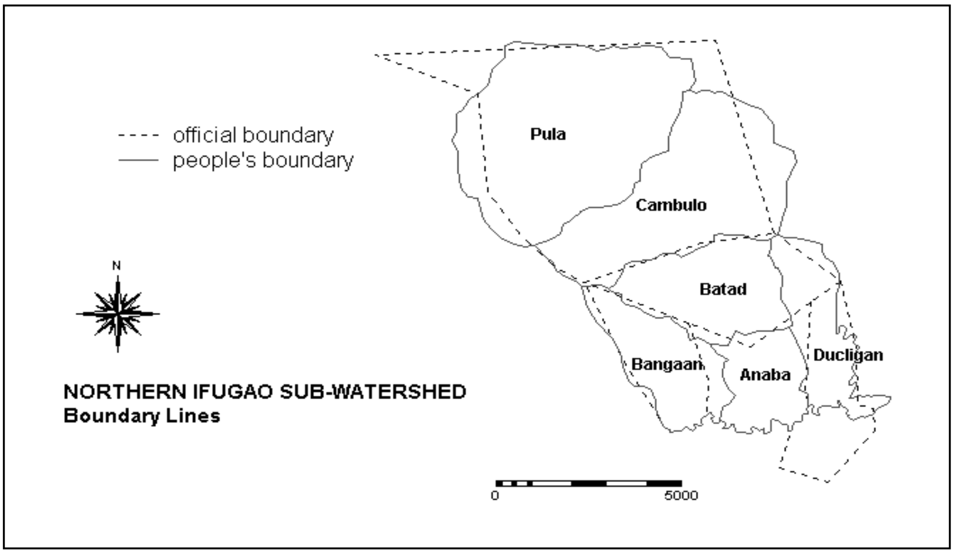


Fig.6.5 Present-day Ifugao boundaries.

6.4 Developing a GIS with the Ifugaos

Delineation of boundaries was just one of the many joint learning experiences between the Ifugao farmers and me, which involved analyzing their space. The next learning experience happened when I joined their "community development planning" (CDP) sessions to analyze their present activities that have the potential to be supported by GIS. The *barangay*'s community-based natural resource management (CB-NRM)[3] council, together with local PRRM organizers and staff, undertakes the CDP. While observing how they carry out these sessions, I was recalling the necessary steps I learned in developing an information system (see Date 1990)

1. Information analysis
   - analyzing information need (information requirements)
   - data check (data availability)
2. Database modeling
   - conceptual modeling (data abstraction)
   - logical modeling (database structure)
   - physical modeling (data storage)
3. Implementation (system test and improvement)

I also looked for stages when local participation is possible: mostly during information analysis stage and data processing during implementation. The CB-NRM council members knew that I was studying their NRM practices and finding out ways to support them using the computer. They were doing their usual work. I was consciously looking for their activities that actually use spatial information, because GIS is only useful if geographic location is important to the analysis. The following describe each of the steps in the development of a GIS with the Ifugaos:

[3] A PRRM-initiated organization at the *barangay* level. This is different from the official Barangay Council, which is a duly elected body. In areas where relationship with local officialdom is harmonious, CB-NRM initiated projects may also be officially taken on. Mainstreaming of such activities is actually the essence of PRRM development work. In other areas, various problems occur.

6.4.1 Information analysis— analyzing information need

I joined the two-day community development planning (CDP) in Bangaan to understand how it works, to find out its information need, and how information is used. In information systems design, this is called "information analysis" (Date 1990). The output of this stage is an initial list of system requirements (the required data). This is compared with an assessment of the availability of these data, and which may call for alternative sources. "Data" are those facts about the world which an organization or individual appreciates as being meaningful to their concern; while "information" is data which may have been processed, and that is appreciated as useful within a particular decision-making process (Lewis 1994:98). The use of the term "facts" suggests neutrality, objectivity or absoluteness of the data. But data is collected precisely because it has meaning for the person or organization that collects it, and this depends upon the "world view" and the intentions of the data collector who describes this world for a purpose (see Fig.3.2). Thus, the resulting collection ('database') is embedded in a context. In GIS, data sources are usually mapped data (*e.g.*, paper maps, digital images) and tabular data (*e.g.*, census, field observations).

I focused on what the CB-NRM council calls 'environmental scanning and mapping,' because it says something about gathering spatial information and I was told that it is used in their planning. It took off from the baseline survey conducted at the start of PRRM's work in Banaue in 1989, and has been done annually each time they conduct the CDP meetings. The following were present at the meeting:

- five community-based community organizers (CB-CO),
- PRRM's area team leader[4],
- the *barangay* captain,
- the head of the Bangaan Farmers' Organization.

This environmental scanning and mapping activity produced a sketch map drawn by the participants, showing the relative locations of different resource and land use activities of the community (*e.g.*, terrace farm, swidden farm, forest). This map differed from the earlier sketch, first of all, in the absence of *barangay* boundary lines. It also emphasized problem areas that their projects hope to improve— *e.g.*, reforestation areas, SALT (see Appendix A), nursery, irrigation. I observed that this map served as a basis for the discussions in lining up activities that the community hopes to undertake for the rest of the year. From their discussions, I identified the following application areas as potential activities to which GIS might contribute:

1. Resource inventory
   - forest, irrigation, and terrace status
2. Project site selection
   - reforestation, SALT, micro-hydro, irrigation canal

I elicited additional information as the research progressed, and as the participants recalled traditional NRM practices upon my querying. While I was drawing a DFD[5] to represent and analyze these application areas, the participants asked several questions about the capability of the resulting information system:

[4] PRRM's area of operation in Ifugao is divided into two— the northern and the southern areas.
[5] The Data Flow Diagram (DFD) is a drawing technique in systems design that keeps consistent notation of representations for system process or function, the flow of data or materials, etc., that communicate about the functioning of the system being modeled (see Yourdon 1989).

Can it determine the elevation of the highest terrace in our *barangay*? [4]
Can it determine how much forest is left? [1]
Can it determine where it is best to locate our SALT project? [5]
Can it determine the area of our SALT project? [1]
Can it determine the height of our waterfalls? [1]
Can it determine how many *muyong*s are intact? [2]
Can it determine the distance of our *barangay* to the *poblacion* (the town center)? [4]

As suggested by Berry (1995:43), these questions can be grouped into seven query categories that GIS can deal with, and which encompass most implementations:

1. *Can you map that?* (cartographic)
-- *e.g.,* delineating boundaries, area, elevation
2. *Where is what?* (cartographic)
--*e.g.,* indicating present land uses; eroded areas
3. *Where has it changed?* (temporal analysis)
-- *e.g.,* tracing historical land uses/changes for ancestral domain claim
4. *What relationships exist?* (spatial analysis)
-- *e.g.,* measuring elevation; distance; slope
5. *Where is it best?* (suitability analysis)
-- *e.g.,* identifying project site
6. *What affects what?*` (system models)
-- *e.g.,* improving water supply; rat infestation; erosion problems
7. *What if…?* (simulation)
-- *e.g.,* understanding impact of water impounding

The first three query categories are inventory-related (monitoring the environment), while the last four are spatial analysis-related (investigating interrelationships among mapped data). Using these categories, the questions posed by the CDP participants were clearly about inventorying their resources and analyzing suitable locations [numbers in brackets]. They show that GIS can play a role in their activities, but I had to understand how, by analyzing the flow of information usage.

There was a long discussion about the status of the terraces: some are abandoned, some are eroded, some are not irrigated, and some are not cleaned of weeds around them. Among others, these are indications of the decline in workgroup activity and the decreasing number of expert terrace wall builders. However, the extent of the problem is not exactly known. For example, where is the worst damage located and how much area are affected? If the erosion of that area continues, which other areas will be affected?

The ITC's Assessment Report and 6-Year Master Plan for the Restoration and Preservation of the Ifugao Rice Terraces (ITC 1994) do not contain exact information on the condition of the terraces. It only gives problem categorizations in the form of an erosion map, and the derivation of which is not clearly indicated. It is a map[6] of 1:250,000 scale covering the whole province. Thus, information regarding the extent of erosion on the terraces itself, the amount and location of abandoned terraces, and the extent and location of non-irrigated terraces are not available for proper allocation of efforts and project resources.

[6] see Appendix B for a portion of ITC's 6-Year Master Plan

My earlier consultation with a municipal councilor clarified some aspects of the implementation of terrace rebuilding projects. The national government lays down the general policy (the criteria) for priority projects in terrace restoration, which is relayed to the provincial government, and then the municipal government inspects and decides where the projects will go (pers.com. Munar 1998). Oftentimes, the budget comes from some particular donor agencies that have particular areas in mind, in which case the local government merely becomes the implementing agency. For example, the ITC's priority areas are the towns of Banaue, Hungduan, Kiangan and Mayoyao. However, it is my view that donor agencies need to be properly informed of the real condition of the terraces to better direct their priorities. As the ITC, the provincial government, and the municipal government allocate funds for "priority projects" and "priority areas," it is essential that they be informed of the terrace conditions on which to base such priorities considering the point of view of the *barangays* inhabitants. This information is available at the *barangay* level, but is not being tapped. Thus, *barangay* constituents have grown used to externally driven terrace rehabilitation projects.

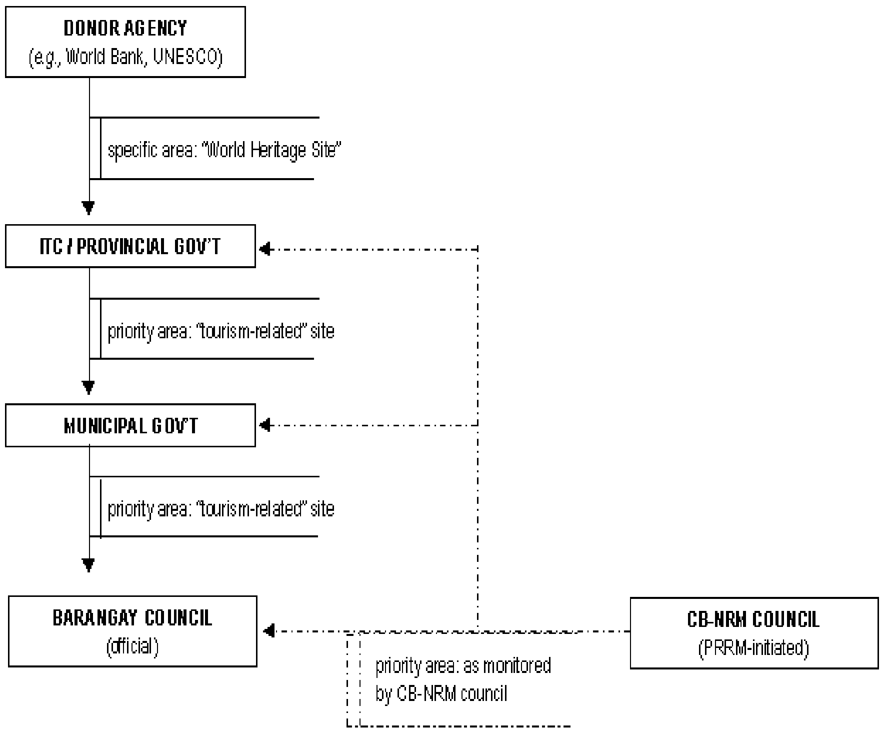


Fig. 6.6 Present set-up in prioritizing areas for terrace rehabilitation.

Figure 6.6 illustrates this existing set-up, which is evidently a top-down approach in prioritizing areas for terrace rehabilitation. The dotted lines represent steps that I thought the CB-NRM council could do to negotiate their view since they are already engaged in "environmental scanning and mapping." They can also inform the municipal and provincial NRM actors about their own priority areas. However, the CB-NRM council members themselves must be able to effectively articulate a common view of their priorities to be communicated with other agencies. From my experience, having a common view strengthens a group's stand in negotiations.

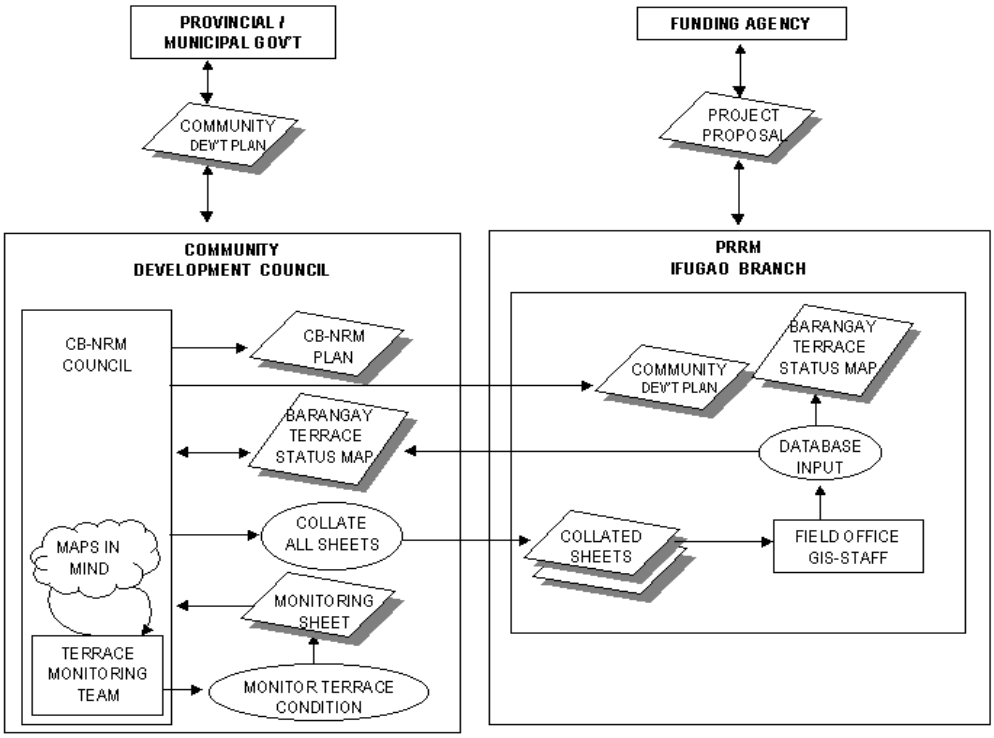


Fig. 6.7 Proposed GIS-assisted CB-NRM planning and terrace monitoring scheme

After the CDP meeting, I drew what I thought would be the set-up using GIS (Fig.6.7). It occurred to me that the present-day “environmental scanning and mapping” exercise runs parallel to traditional NRM institutions (*e.g.*, *baddang*, *ubbu*), but does not emphasize monitoring of individual terraces and irrigation canals as was the case before. Hence, I included terrace monitoring in the set-up. In this case, PRRM’s field office requires a GIS-trained staff who will be in charge of building the database from collated monitoring sheets, and printing out the aggregated terrace status map of the whole *barangay*. Together with the CB-NRM plan, this can be used to inform the municipal and provincial governments about local terrace problems and *barangay* micro-watershed status, and can be considered for the overall Ifugao watershed management plan (more details in Chapter 7).

I showed the diagram to the PRRM area team leader and CBCOs to check my understanding of the process. I chose to discuss it first with them because they are the ones responsible for this process. They could decide on the correctness and appropriateness of the DFD based on their priorities and the tradeoffs resulting from computerization (*e.g.*, organizing a monitoring team, staff training in GIS). The first reaction from the team leader was, “Yes! Then, we can have more beautiful maps when we submit our project proposals.” The team leader recognizes the strength of GIS-generated maps in visualization and communication with other agencies. Monmonier (1993) notes that efficient and lucid communication often requires maps, and that computers give visually effective maps by their crisp, uniform symbols. Moreover, I told them the advantages of a digital map over its paper counterpart:

- it offers greater possibilities for analysis when handled in a GIS environment;
- aggregation of data is possible, and this means the data collected at *barangay* level can be consolidated to give information about the whole watershed.

The area team leader, the CBCO's, and I listed down the following spatial features that are relevant for the information system (Table 6.1). This list concerns basically the same data which I identified earlier (see Table 5.2) in analyzing the traditional watershed management in Chapter 5. In this case, I was able to verify the information needs for a watershed monitoring system by observing their CDP meeting to determine what they currently do, and as they expressed what they needed. Finally, I proposed a GIS-assisted approach in carrying out their "environmental scanning and mapping" tasks. Except for the terrace map, most of the needed data are available.

Table 6.1 Spatial data requirements for a GIS-assisted CB-NRM planning

SPATIAL ENTITY	DATA SOURCE	AVAILABLE SOURCE
Barangay	Map of barangay boundaries	DEM
Terrace field	Map of terrace boundaries	Sketchmap, GPS field notes
Swidden farm	Landuse / land cover map	Satellite image
Muyong	Landuse / land cover / ownership map	No maps, interview notes
Forest	Landuse / land cover map	Satellite image
Grassland	Landuse / land cover map	Satellite image
Waterway	Topographic map	Topographic map

Figure 6.8 illustrates the possible communication flow among Ifugao's NRM-actors using the proposed approach in Fig.6.7. In this set-up, the national mapping agency will be PRRM's source of relevant maps, aerial photographs and satellite images. PRRM's field office in Ifugao, a temporary entity in the area (dotted box) will work closely with the CB-NRM council in GIS-training, and in monitoring and updating the database about the status of the micro-watershed using the *barangay*-generated terrace monitoring sheets and landcover map. The generated maps, will serve the agenda for action of local workgroups, and will also serve in communicating with other NRM actors. As this is still only a proposed set-up, the implementation stage is yet to be carried out, and it is a subject for another research. At present, I focus on the organization of the database to support the information system for this set-up.

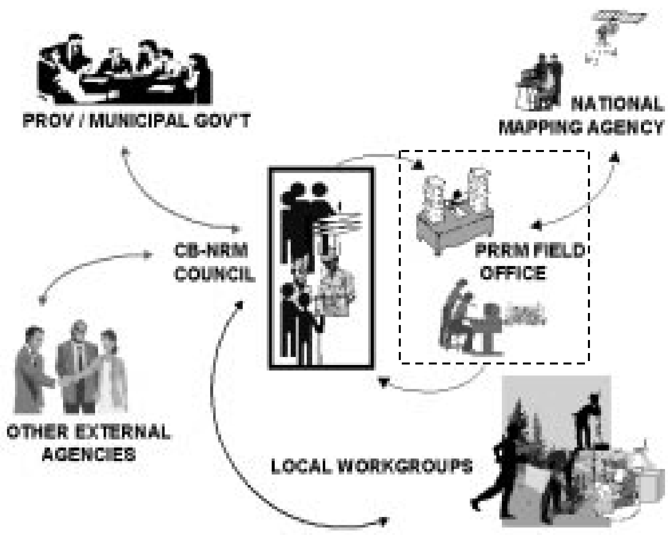


Fig.6.8 Communication channel for proposed GIS-assisted CB-NRM planning and watershed monitoring .

6.4.2 Database modeling— model for a data: data for a model

A database can be regarded as a kind of "electronic filing cabinet" because it is a "computerized record-keeping" of inter-related data that can serve one or more users (Date 1990:3). The data can be spatial (representing space, *e.g.*, coordinates) or non-spatial (representing description, *e.g.*, landcover type). My own “data collection” was carried out in direct interaction with the Ifugaos for the purpose of supporting their local “environmental scanning and mapping” activity. The data is a result of this interaction. For example, in finding out the boundaries, the meaningful landmarks such as ritual plots, and the *muyong*s (which lie there unnoticed unless explicitly explained). I had to interact to understand local constructs in order to bring out, and see those features and data about them. In database design, this is called “conceptual modeling.”

- ***Conceptual modeling***

- is the first step in designing a database. It involves the recognition, abstraction, definition, and recording of features of the “real world” which are relevant for the purposes of the database. The output of this stage is the “universe of discourse” (Avison and Wood-Harper 1990) or the “universe set” (Molenaar 1998b), which contains the selected “objects” of interest or concern and their definitions. This selection process and the attendant descriptions create a “conceptual model” of this world— an understanding of what it is and how it behaves. This further clarifies the discussion in Chapter 3 that in GIS, we are actually modeling societal constructs of the real world— a world model. This could explain why the term “universe” is commonly used in GIS design to refer to this model.

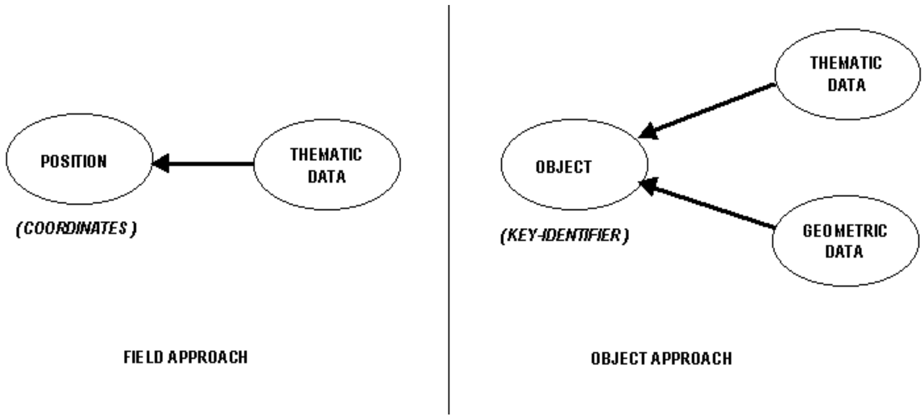


Fig.6.9 Two ways to approach conceptual modeling in GIS.
(adapted from Molenaar 1989)

As briefly discussed in Chapter 3, GIS has two ways to approach conceptual modeling of spatial data— the field approach and the object approach (Fig.6.9), which have their own ways of handling thematic and location descriptions. Another description that many authors (*e.g.,* Burrough 1986, Langran 1989, Keller 1991) have tackled is time. This is in response to the need to develop dynamic maps, because of the criticism of presenting a mere “snapshot” of a situation at a certain moment in time. However, this is not taken up categorically in this research because my emphasis is on designing a GIS using a participatory approach. The temporal aspect can be dealt with in succeeding research.

I chose the object approach in conceptual modeling, because it resembles the way that the Ifugaos currently describe the territory they manage— a catchment area. In it are other spatial entities, such as terrace fields, the *muyong,* the ritual plots, the irrigation canals, and the swidden farms as enumerated in Table 6.1. They see spatial “objects” around them which they have to manage. This differs, for example, from the way that the Bushmen of Namibia see “core points” of food and game around them like “a refuge or oasis in the midst of the larger landscape” from where they can “radiate out” on their way to another place to hunt (Powell 1997:71). They move on as the availability of resources on these “core points” changes with the season. That conforms to the field approach. The Bushmen are wandering hunters and food gatherers, while the Ifugaos are settled in a place. Also, the Namibian landscape is generally a flat expanse, while Ifugao is mountainous. This could explain the way the Bushmen see “core points” to manage, while the Ifugaos see “catchment areas.”

Choosing the object approach corresponds to using the “vector data model.” This model represents the identified objects in terms of point, line, and area objects called “geometric primitives”[7]. Although the available software, ILWIS, accepts vector data, it performs raster-based[8] calculations after “rasterizing” the vector data (for more details, see ILWIS 1997). Data conversion (vector-to-raster or raster-to-vector) is possible, and that accommodates both models in one software.

The object-oriented approach in data modeling is built upon four basic concepts of object abstraction in describing the “universe of discourse.” These are: classification, generalization, association and aggregation. They describe the types of relationships the terrain objects have at a given state (as relationships and states may change after some time). I used these concepts in organizing the data for the database (see Molenaar 1993, and Molenaar 1998b for more details):

1) **Object classification** groups several objects to a common class. Objects belonging to the same class have “properties or characteristics which distinguish them from objects that do not belong to this class.” Banaue River, Alimit River and Cambulo River belong to a common class “River.” This class has attributes River-ID, Name, and Mean Annual Discharge. Each object has its own value for these attributes.

2) **Object generalization** groups several classes of objects which have some properties in common to a more general “superclass.” They define vertical relationships between object classes. In the upward direction, they are called “is_a” relationship (*e.g.*, Ibulao is_a River). In the downward direction, they represent specialization steps. It is important to note that an object’s superclasses and subclasses are abstractions for the same object. They do not describe two different objects. For example, object M1 is a “*Muyong*” belonging to class “Forestland” which is a “Vegetation” type of Land Cover. “*Muyong*,” “Forestland,” and “Vegetation” are all descriptions for the same object M1.

3) **Object aggregation** defines the hierarchies of “composite objects” or the objects which are built from elementary objects. In the upward direction, the relationship is called “part_of” and downward, it is called “consists_of.” When considering the aggregate (the composite object), details about the constituent objects are suppressed. This is because their attribute values are also aggregated to describe the composite object and the resulting geometry (*e.g.*, size, shape) is also changed.

[7] Sometimes called “elementary objects” as building blocks in defining more complex composite objects that represent real world terrain features (Molenaar 1998:74).
[8] As ILWIS is the available software for this research, its vector data input in is a welcome feature. See Burrough (1986), Aronoff (1989), Peuquet (1992) for more details about raster and vector data models.

4) **Object association** is a loose grouping of objects which is not exclusive. This means one object can be associated with several groupings. This relationship is called "member_of." For example, set of fields with area < 1ha.; and set of fields along a river. A particular field can be a member of both sets if it has an area < 1ha., and if it is also along a river.

Figure 6.10 presents the conceptual model which I developed following the four object abstraction guides. It shows the relationships among spatial and non-spatial objects or entities relevant in watershed monitoring. This is very similar to the E-R diagram that I have drawn in figuring out their traditional NRM (discussed in Chapter 5). This conceptual model is specifically about the present-day monitoring of the *barangay* terraces and forests. This is why I introduced the entity "Problem" which pertains to the condition of the entity "Terrace." I also introduced the entity "Household" because, from my observations, not all "Persons" living together under one roof is a "Family."

Table 6.2a provides supporting explanations about each spatial entity of the conceptual model and how it will be represented in the database in terms of geometric primitives. Table 6.2b is the list of the non-spatial entities. While the geometric attributes are realized by digitizing maps and field measurements with the GPS, the thematic attributes are collected by interacting with the local inhabitants through various methods like interviews (for name, age, sex, etc.), observations (for problem, length). A unique identifier (IDNo.) is assigned to every entity (automatically by the software or manually if the user so desires). It is the key in tracing relationships between entities, and ensures proper database search operations or querying (see Howe 1989 for more details).

Table 6.2a Identified spatial entities for watershed monitoring

SPATIAL ENTITY	DEFINITION	GEOMETRIC FEATURE	POSSIBLE THEMATIC ATTRIBUTES
Barangay	The smallest political-administrative unit in the country	Polygon	ID No, Name, Area, etc.
Sitio	Clustering of houses	Point	ID No, Name, etc.
Open forest	Not privately-owned forest[9]	Polygon	ID No, Area, etc.
Open grassland	Un-owned area with grass	Polygon	ID No, Area, etc.
Waterway	Rivers and water channels	Segment	ID No, length, etc.
Swidden farm	Slash-and-burn fields	Polygon	ID No, area, owner, etc.
Muyong	Privately owned forest	Polygon	ID No, area, owner, etc.
Terrace field	Privately owned terraced farm	Polygon	ID No, area, problem, etc
Payoh-cha	Cluster of terrace fields	Polygon	ID No, area, problem, etc

Table 6.2b Identified non-spatial entities for watershed monitoring

NON-SPATIAL ENTITY	DEFINITION	THEMATIC ATTRIBUTES
Person	An inhabitant of a *barangay*	ID No, Name, sex, age, origin, etc
Family	Parents and their children	ID No, Name, etc.
Household	Several persons living together	ID No, etc.
Workgroup	Several persons that work together	ID No, etc.
Expertise	Special ability of a person	ID No, expertise type, etc.
Problem	Terrace problem	ID No, Problem type, etc.

[9] Distinction between privately owned and open (or not privately owned) still prevails despite the fact that the government virtually owns the whole province by virtue of the 18% slope-law (P.D. 705).

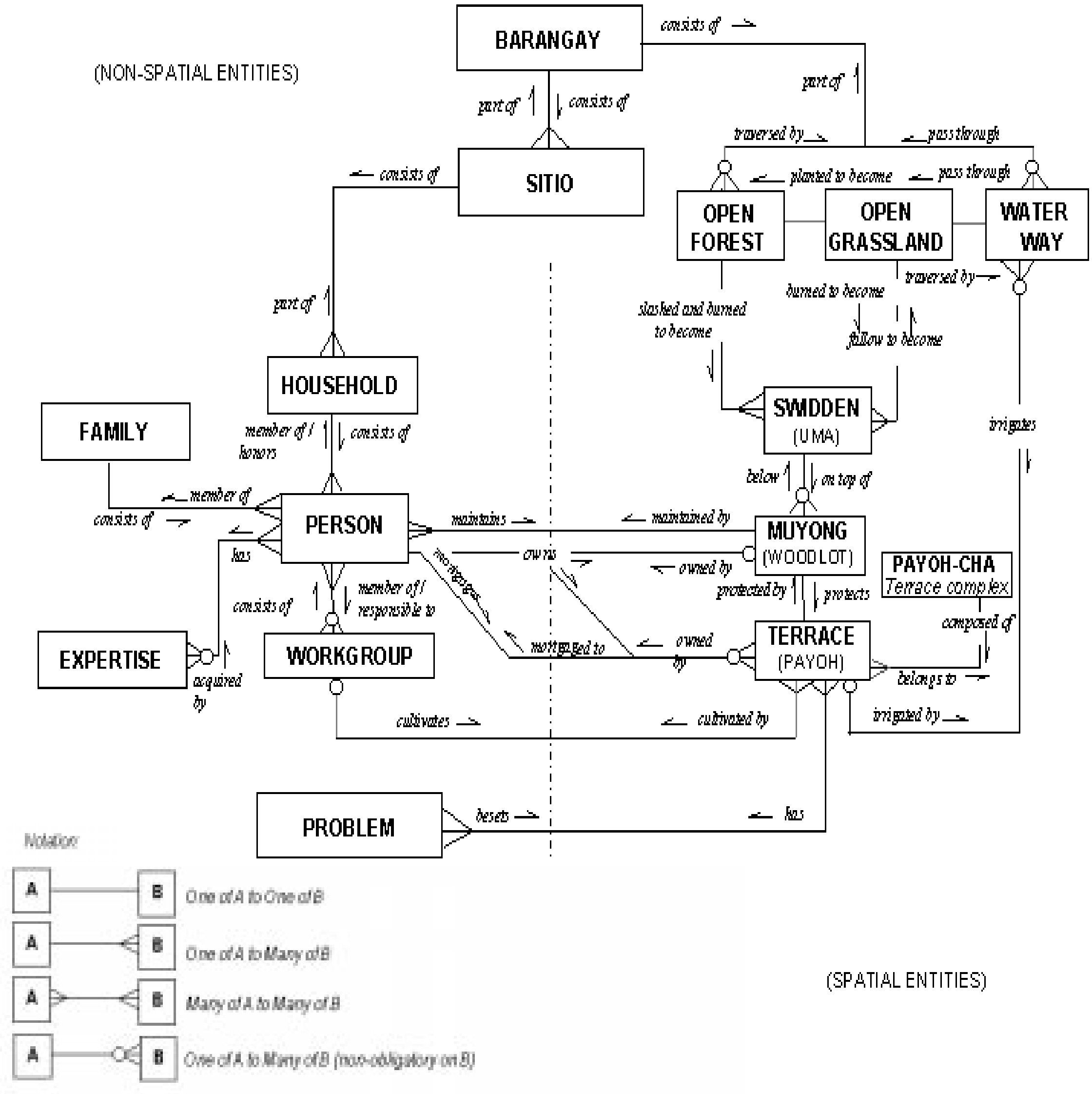
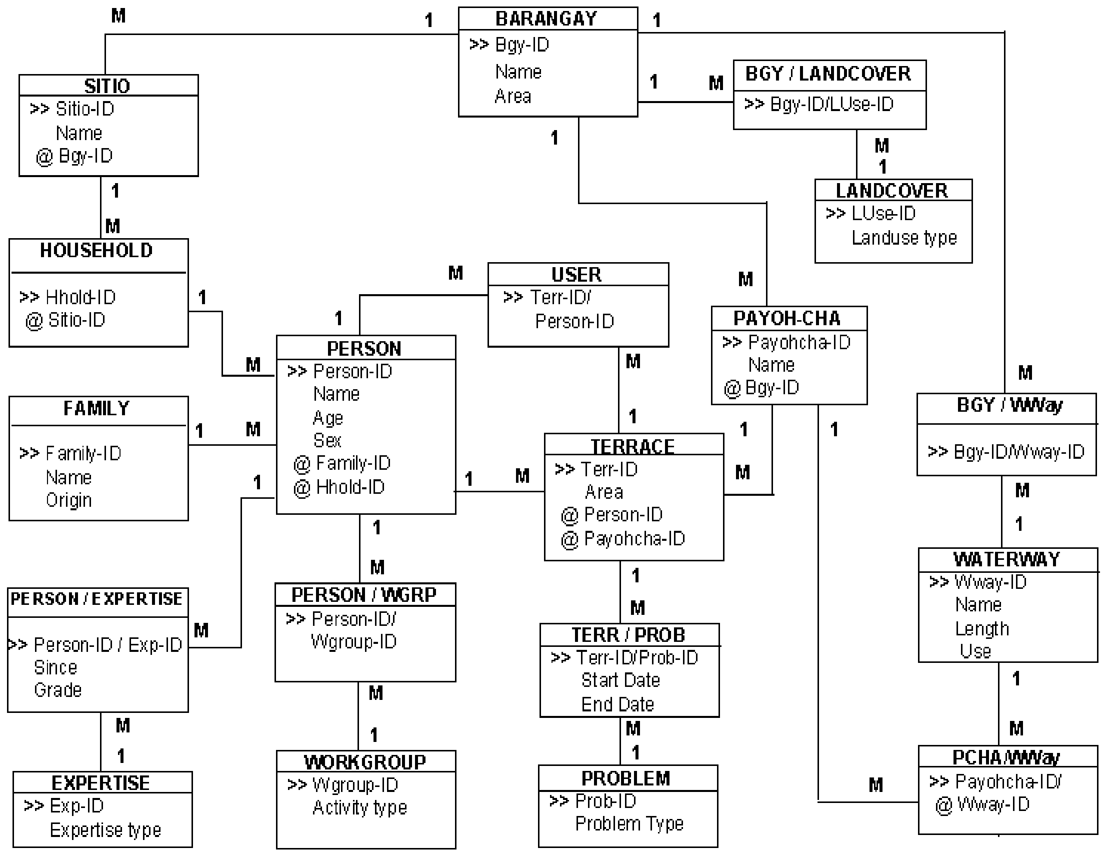


Fig.6.10 Conceptual data model for understanding a *barangay*-based watershed monitoring

- ***Logical modeling***

  - constitutes the core of database design. It includes definite decisions about the descriptors of the identified objects. The scale or level of analysis (in this case, the barangay level) sets this decision (*i.e.*, how detailed the description will be). During this stage, the conceptual design is faithfully translated into a chosen database structure, and the specific software to be used must accommodate that (see Howe 1989, Date 1990 for more details). The database structure is the organization of the collected data. It provides for the expression of the relationships among the stored data. A system for storing and retrieving the collected data for analysis, and presenting the results of the analysis, is called a database management system (DBMS). It is composed of programs that provide the functioning for usage, and the maintenance of the database. This functioning and maintenance follow the database structure. In fact, database management systems are conveniently categorized according to the structuring they present to the users.



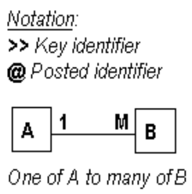


Fig. 6.11 Logical data model for *barangay* watershed monitoring

Following are the different database structures that are currently available, and on which logical data models are based (for more details, see Date 1990, Howe 1989):

1. hierarchical - follows a tree structure, sometimes called "single parent-child" link (such as an organizational chart)
2. network - follows a record and link structure regarded as an extended hierarchic structure that allows more flexibility with the possibility of "many-parents-for-a-child" link (such as a supplier-and-parts chart)
3. relational - follows a tabular structure, wherein a row represents an entity and a column represents an attribute (such as a school registration system)
4. object-oriented - follows a nested tabular structure which allows function and data encapsulation within an object; objects and their components communicate via messages; objects can be subjected to operations that more closely resemble their real world counterparts (such as icons, hypertexts).

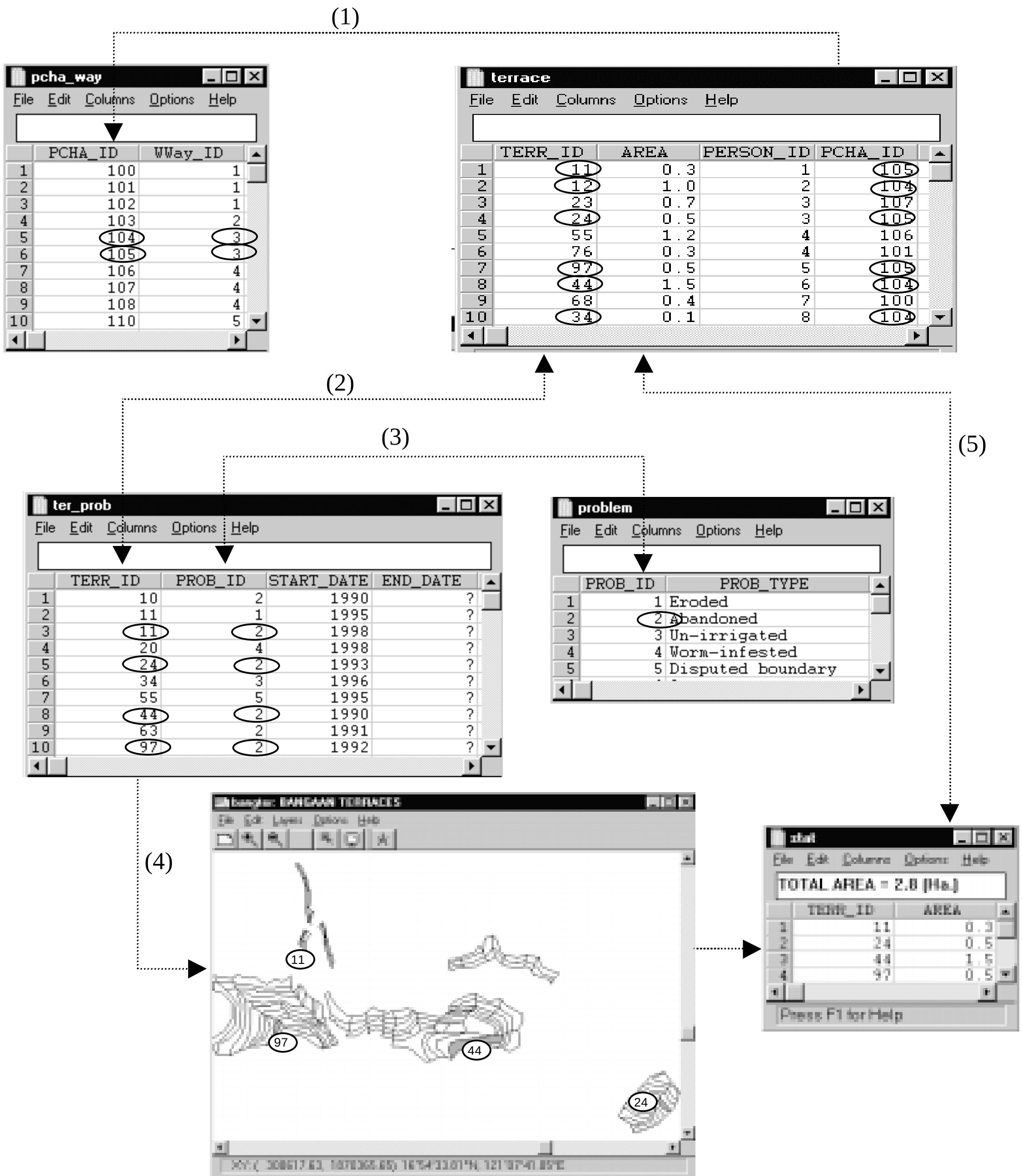


Fig.6.12 Physical data model and links to support database query.

It is important to know the basics of databases because a database is at the core of a GIS. This is why I sometimes use “database design” and “GIS design” interchangeably. The ability to store geographic data, perform spatial analysis on the data, and present the result in map form (aside from table and text forms), is what distinguishes a geographic database from other databases. This also distinguishes a GIS from simple mapping softwares, because a GIS automatically stores the topology[10] of the geometric data in its database (see Howe 1989, White 1994).

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[10] Topology is the mathematical method of defining spatial relations such as contiguity, containment, adjacency, and connectivity of geometric data. In GIS, these relationships must be preserved during map transformation operations such as translation, rotation, and scaling. This ensures that the data organization remains faithful to the conceptual model (see Aronoff 1989:174 for more details).

As I patterned the database structure after the relational model, the data are stored and organized in tables. Each row in a table represents a single record, and each column represents an attribute of the entity it describes. Each entity has a "key identifier" (>> in Fig.6.11) which is a unique number. Attaching these numbers as an attribute to one or the other's table (called "posted identifier"; @ in Fig.6.11) establishes the relationship between two entities.

Figure 6.11 presents the organization of the tables of the database: the 'logical data model'. To reduce the complexity, entities Forest, Swidden Farm, Grassland, and Muyong in the conceptual model are represented by entity "Landcover", which is their superclass (see object-abstraction discussion above). Each rectangle represents a table showing the key identifier, the posted identifier, and the attributes. I normalized[11] the tables by representing many-to-many relationships as entities themselves (*e.g.,* Terr/Prob, Person/Expertise) in order to establish an unambiguous link between two entities. Then querying about the relationships among them can be carried out straightforwardly by tracing such links. As a sample query, suppose we want to find out where and what area of terraces are abandoned despite having access to irrigation, *e.g.,* Irrigation No.3. The program carries out this query through the following steps (see Fig.6.12 for the sample tables):

1. Determine from Table Pcha_Way the PCHA_ID related to Wway_ID = 3 [104, 105]
   and using these PCHA_ID, determine all TERR_ID from Table Terrace [11,12, 24, 97, 44, 34]
2. Select the same TERRR_ID from Table Ter_Prob and determine their PROB_ID [1,2,3]
3. Match their PROB_ID with that of Table Problem for PROB_TYPE = "Abandoned" [2]
   and use this PROB_ID to reselect affected TERR_ID in Table Ter_Prob (in #2) [11, 24, 44, 97]
4. Display the terrace map showing the reselected terraces with the matching PROB_ID
5. Calculate the total area using the software's statistics function [2.8 Ha.]

- ***Physical modeling***
- is a particular software's way of organizing data inside the computer. It is helpful to have some idea about the physical model, because in databases, special care should be taken so as not to confuse the key identifiers or disturb the stored topological data; this will ruin the whole database. Fig.6.12 shows a part of the physical model seen by users; the computer stores them in organized 1's and 0's, *e.g.,* run-length encoding, spaghetti model (see Aronoff 1989 for details). It also shows how the software carries out a particular search in querying the database.

Next is my experience with Ifugao farmers in the preparation of the data to fill the database. It describes how we interpreted the photographs and satellite images for the thematic and geometric attributes of the spatial entities, and how we learned together.

6.4.3 Images of home

Figure 6.13 illustrates the necessary pre-processing of the base maps that I have in order to derive the needed maps in the design of a GIS-assisted CB-NRM and watershed monitoring system. The boundary map has been done (see Section 6.2), but the SPOT[12] image needed to be interpreted to delineate the landcover/landuse map

[11] Tables follow five degrees of "normal forms." These are database design rules to ensure that the key identifier uniquely refers to the attributes; prevent null values in tables; and avoid potential inconsistencies in redundant data (see Howe 1989 for more details).
[12] Systemè Probatoire d'Observation de la Terre— a French satellite launched in 1986.

that will serve to monitor forest growth and swiddening activities. These delineations are necessary to define the "objects" (in this case, Ifugao's resource base) that have to be described and monitored periodically using GIS. As discussed above, describing spatial objects pertains to descriptions about what it is (thematic attributes) and delineation of its boundaries (geometric attributes).

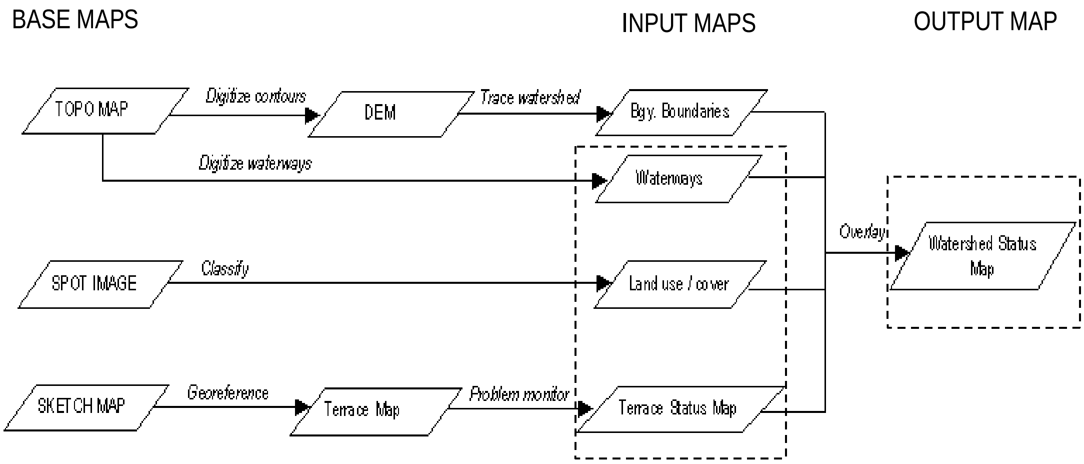


Fig.6.13 Flow chart in pre-processing the base maps to yield the needed data for a community-based watershed monitoring system.

To describe the objects in Ifugao NRM, I called a workshop for the purpose of what I now call, "participatory image interpretation." This means from aerial photographs and satellite images of the study area, the workshop participants and I identify and delineate objects found in the area. Eight answered my general invitation (see Table 6.3) to help me with "interpreting aerial photographs and a satellite image of Ifugao using a computer" (as written in my letter to them). Two PRRM staff were interested in using computers at work and in seeing for the first time a satellite image. They also came to help me with the workshop organization by preparing the snacks and by supervising "ice breaker" games. These games are standard practice in every PRRM workshop, because aside from their entertainment value, they enhance group analysis (pers.com.Umhao 1998).

Table 6.3 Composition of participants in aerial-photo and image interpretation

AGE	SEX	OCCUPATION	EDUCATIONAL ATTAINMENT
19	M	Student	2nd year college
17	M	Student	1st year college
36	F	Farmer, CBCO	3rd year high school
46	F	Farmer	1st year high school
47	F	Farmer, CBCO	College graduate
50	F	Farmer, CBCO	2nd year high school
64	M	Farmer	No formal education
32	M	Farmer	2nd year high school
26	F	PRRM staff	College graduate
28	F	PRRM staff	College graduate

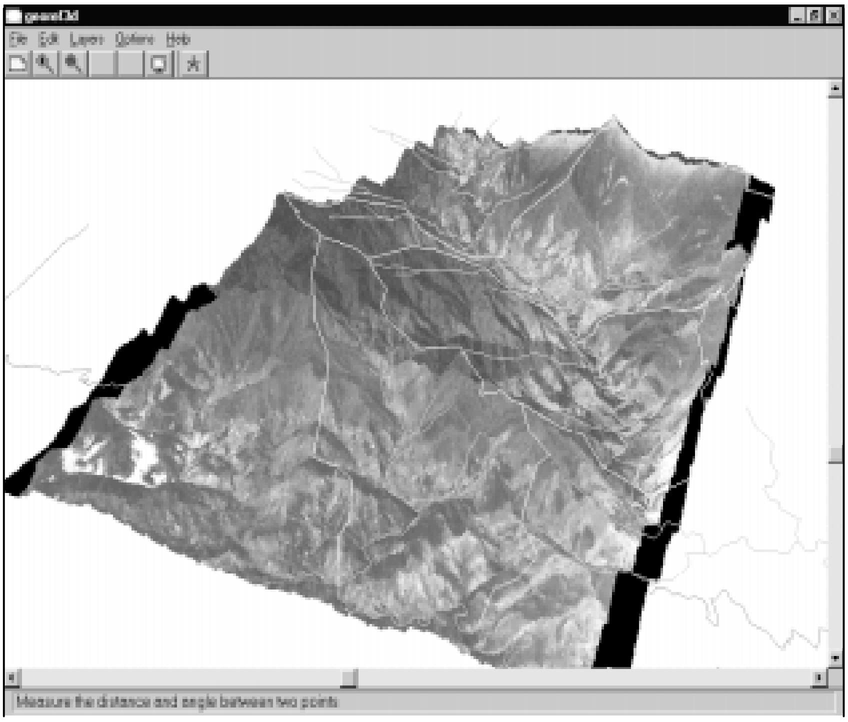


Fig. 6.14 3-D view of the study area on aerial photographs taken in March 1951.

Fig. 6.15 Delineated land use/land cover types after zooming-in on an aerial photograph of the study area taken in March 1980.

When interpreting aerial photographs, we are concerned with identifying features on the earth's surface and judging their significance (Paine and Luba 1980). Judgment is dependent on the purpose and skill of the interpreter, and so, different interpreters come up with different interpretations. This aerial photo-interpretation exercise with the Ifugaos was concerned with joint identification (and my delineation) of different land use/land cover types which are significant in the development of a GIS-supported watershed monitoring system.

Land cover is the observed cover on the earth's surface, "whether natural or manmade, such as: vegetation, buildings, water, ice, bare rock, sand, and similar surfaces" (de Bie, *et.al.* 1995:12). On the other hand, land use refers to the management activities conducted by man related to the land (*Ibid.)*. Despite the distinction, land use and land cover are related because land use takes place within, and has impact on, a land cover type. Therefore, land use can be mapped through the land cover type as additional information (*e.g.,* through interviews, observation) helps categorize the specific landuse. For example, the land cover "forest" can be identified and described directly by field observation or indirectly by remote sensing. Its uses (*e.g., muyong*, rubber-tapping, etc.) are determined after interviewing the land users.

I started with the aerial photographs of 1951 and 1980. The workshop participants immediately recognized the forests because the tree crowns are visible on the photographs. They distinguished between the thick forest *makapal,* and the thin forest *manipis*. I asked how they how they knew that, and one of them answered: "The darker and more coarse areas mean there are more trees." The others agreed. Some principles of aerial-photo interpretation were used unconsciously by the participants. In that case, pattern, texture and tone of the photograph features served as their guide. They also recognized the meandering rivers, but could not name them at first. They were able to name them all when I showed the merging point of three rivers in Barangay Ducligan. These rivers later on served as the reference for them to relate the photos to nearby *barangays*.

I also presented the mirror stereoscope in order to view overlapping pairs of aerial photos in 3D. This facilitated seeing the observed features more clearly, such as mountain trails and swidden patches. However, one participant exclaimed that she did not think their mountains are so steep, as seen through the stereoscope. I had to explain that the stereo model is exaggerated in the vertical direction due to camera lens distortion. I did not think my explanation was very well understood but could not think then of any other way to clarify it. This highlights how complex the translation of photo-interpretation concepts and practices is, and that it can emerge at any moment in the process.

The participants' knowledge of their area helped me identify (on the photographs) and verify (later in the field) the different recognizable "objects" pertaining to land covers or land uses (see Fig.6.14 and Fig.6.15):

1. high-density forest - land cover (original thick growth forest)
2. secondary forest - land cover (second-growth / replanted forest)
3. open grassland - land cover (area covered by grass)
4. waterway - land cover (area covered by waterbody)
5. swidden farm - land use (area used for shifting cultivation)
6. "terraced rice field and others" - land use/land cover (terraced cultivation, etc.)

I decided to employ object generalization concepts to the last category (6): "terraced rice field and others," because a separate category for terraced fields resulted in very unrealistic landuse/landcover change. For example, analysis of change from 1951 – 1980 yielded 42 ha of "terraced farms" to have emerged from what was formerly classified as "secondary forest" (see Fig.6.20a and Fig.6.20b) This wasted my time in re-digitizing, and made me realize that this aerial-photo interpretation exercise had been guided by the participants' intimate knowledge of their place. They were capable of seeing many details from what are officially classified as semi-detailed scale photographs (1:45,000 and 1:60,000). This illustrates the differences in what people "see" in the same world which need to be negotiated to construct a common view.

6.4.4 Knowing and seeing

The next activity involved interpreting the satellite image with the workshop participants. Unlike aerial photographs that obtain analogue images as replica of the original scene which are "directly applicable to visual processing" (Buiten 1993:69), satellite images record spatial variation of detected radiation into "pixels" (picture elements) which "need to be processed by means of a computer in order to extract quantitative information or emphasize features of interest"— digital image processing (Rees 1999:96). This includes a host of pre-processing activities for radiometric corrections (*e.g.,* atmospheric interference), geometric correction (choosing a projection such as latitude and longitude), filtering and contrast enhancement before it can be classified. I had performed all these pre-processing procedures on the SPOT image (see ILWIS® User's Guide 1997:191-260 for the details) long before the workshop in order to be ready for interpretation together with the Ifugao farmers.

The result of interpreting an image is a classified image. This is why the process is sometimes called "image classification." In image classification, "each pixel of the image is assigned to one of the finite number of classes (*e.g.,* land cover types) on the basis of suitable decision rules" (Reese 1999:97). Computer power is used to accomplish this voluminous task. Wood (1992:54) describes these manipulations attending image processing, and points out that in the end, what we see as a "realistic view" of the world is actually "fogged" by instrumental, methodological, and political constraints:

> "The light reflected from the earth is broken up (into different bands), it is transformed into an electric signal, it is recorded, it is played back, it is transmitted, it is received, it is recorded again, it is calibrated, annotated and recorded yet a third time, or it is calibrated, annotated, and used to drive an electron beam recorder to produce a picture. Each of these steps reflects a code that says, *this* means *that*."

Molenaar (1998a:1) refers to this "fogged" issue by rephrasing Hamlet in *To see or not to see?* He explains that, "We do not see things plainly; we see only those things to which we are receptive." Being receptive is caused by observational factors such as the kinds of instruments used ("aided eye"), the training or discipline of the observer ("directed eye"), and available methods in linking new perceptions to existing descriptions ("educated eye"). This highlights the need to involve different disciplines in developing *new ways* "to see," thereby extend our knowledge about the "real world," and enlighten our action towards a better future. Following is my experience with the Ifugaos in seeing through pixels to better understand their space.

None of the workshop participants knew anything about satellites, and so, I had to initially discuss the aerial photographs we used earlier. We talked about the camera on board a plane that was able to take such pictures. Then, I made an introduction about satellites as something like unmanned airplanes that continuously circle around the earth to take pictures. I drew a rough sketch on the blackboard to describe how the satellite records light reflection from objects on the earth, and relays it to receiving stations. Interpreting back the identity of these objects from their recorded reflectance values (expressed in numbers and assigned colors) is the purpose of image classification. This explanation, and the use of the DEM with the SPOT image draped over it, plus the ILWIS® software's capability for zooming in to selected features, proved to be sufficient for the workshop participants to be able to help me in classifying the image.

I zoomed-in on a very familiar landmark to every Ifugao— the Banaue Hotel, which is the only big building in the area. The Ifugaos are familiar with the top view of this hotel because the road network is located much higher than the hotel compound and so, they see the long rectangular roof of the hotel as they pass by. The zigzagging road around the mountains was also evident. These landmarks made the connection between the image and features on the ground. The participants took turns in enumerating what other features can be found along the road, at the town center, the school, the smaller hotels, the stores and the houses of people they know. When I asked how they could see all those little details, one participant replied, *"Nakikita namin, kasi alam namin!"* ("We see, because we know!") The others agreed. Indeed the Ifugaos know their handcrafted habitat very well. Workshop participants even appreciated the presence of clouds on the SPOT image. Being a high-elevated province, Ifugaos often say to tourists, "In the city, you look up to see clouds, but here you look down to see clouds." Cloud cover on a satellite image is a nuisance to image processing technicians because clouds induce mixels[13], and hide information about the earth's surface. But for the local people who know what is behind those clouds, that is not a problem. They said that they see because they know. They may not be fully aware that they know because they see, they feel, they do— they experience their place. Clark (1997:221) calls it an "embodied, embedded cognition" and emphasizes the interconnection of our brain, body, and world acting as a whole; he rejects the traditional divisions among perception, cognition, and action. This interconnection is also evident in the following account about workshop participants' ability in seeing patterns.

I realized that it was easy for the workshop participants to understand and carry out image interpretation, because the women are weavers (and recently, are engaged in cross-stitching), while the men are woodcarvers. They are keen in recognizing patterns. Rapanut, *et.al.* (1996:48) researched on the mathematical concepts employed in the weaving patterns of the neighboring tribes of the Kankana-eys and found out that "algebraic structures[14] exist in their weaving patterns, in their music ensembles, and in their kinship systems." They concluded that mathematics is embedded in the

[13] Mixed pixels or "mixels" are ground resolution cells with more that one class, so that the obtained spectral signature becomes ambiguous. The common way to get around this problem is by replacing the mixel with a pure neighboring class (see Buiten and Clevers 1993 for more details).

[14] Rapanut, *et.al.*(*op.cit.*) referred to "freize pattern" in weaving, "Klein-4 group" in gong music, "semi-group" in kinship system" as organizations of form and symmetry wherein application of mathematical set operations were identified.

Cordillera culture. They pointed out these people's ability to synthesize and "put parts together to form a new whole that was not previously present" (*Ibid.*:51). This explains their intuitive capacity (*i.e.,* partly or unconsciously aware) to see patterns. The only complaint of the workshop participants about the SPOT image was: "We do not like our trees to be colored red!" I then changed the computer representation to green and they appreciated the image better.

In a "false color composite" image, red = vegetation, blue = built-up areas, white = clouds, and blue-black = water and shadows. This coding system was originally developed from "false color photography" during World War II. It was used "to distinguish live vegetation (which appears red on false color film[15]) from dead vegetation (or paint) used as camouflage (which appears blue or purple)" (Wood 1992:55). While photographs rely on the emulsion to record the scene, a satellite image does not. Therefore, any arbitrary computer-generated color derived from digitally mixing red, green, and blue can be used. However, the image-processing discipline is more accustomed to the original false color coding system. In this exercise, the Ifugao farmers chose a color (green for vegetation) that makes more sense to them.

The knowledge of workshop participants about their environment was utilized in selecting "training pixels" for classifying the whole image. "Training pixels" are sample pixels whose spectral values are known to have come from the corresponding classes of interest (in this case, land use/land cover classes). Thus, they provide the basis on which the image classification software decides whether each pixel of the image to be classified is "similar enough"[16] to a training pixel class. This is called "supervised classification," and is used whenever there is prior knowledge of the study area. This means we (the workshop participants and I) selected sample pixels (from the image) for each land cover or land use type that we have identified (see Table 6.1). For example, for the class waterbody, we selected the pixels along the river courses to represent this class; for the high-density forest, we chose pixels from those areas where the farmers say (and I verified) high-density forest are found; and so on for the other classes. Then, the image-processing software classified the whole image using this set of sample pixels (see Fig.6.16b).

In case there is no prior knowledge of the study area, "unsupervised classification" or "clustering," is resorted to. In clustering, the software automatically groups the image data into spectral clusters based on statistical properties of all pixel values. After that, it is up to the user to find out which land cover type corresponds to each cluster. (see ILWIS® Reference Guide 1997:341 for more details). I tried the unsupervised classification, but it yielded an unsatisfactory result because some forests, rivers, and terrace fields were classified as cloud or shadow. Some forests were also classified as swidden farms. (see Fig.6.16a and Fig.6.16b).

[15] The emulsion (photo-sensitive material for coating photographic films) used in a false color film is sensitive to red, green, and infrared wavelengths of light instead of the usual red, green, and blue.

[16] I will not go deeper on the decision rules of the algorithm "Maximum Likelihood Classifier" that assessed the similarity (see Buiten and Clevers 1993 for more details). I chose this algorithm from among the possibilities in ILWIS because it gave the best result in separating classes (*i.e.*, overlapping of signatures was minimized using this algorithm as compared with, *e.g.*, "Box Classifier").

Hussin (1995:7) explains this difference: "in unsupervised classification, the resulting classes may be referred to as spectral classes." They are solely based on spectral properties of the data stored in each pixel, precisely because there is no prior knowledge of the study area. On the other hand, supervised classification follows what can be called "information classes which represent the ground cover types of interest to the analyst" (*Ibid.*). The person doing the classification has given some meanings to the data (by identifying training pixels) before classifying. He continues, "Information classes and spectral classes may not exactly correspond to one another. Two information classes may look alike spectrally (*e.g.,* corn and soybeans).

On the other hand, an information class may be composed of two or more spectral classes (*e.g.*, rice of different growth stages)." The resulting image had to be refined because some spectral values of classes overlap (*e.g.,* waterway, terrace fields and grassland). I displayed the feature space[17] to see how spectral classes overlap (Fig.6.17). The waterbody was the most dispersed class, but the availability of the waterway map as auxiliary data makes it easier to separate. I carried out this class separation in two steps: first, I converted the waterway segment map to raster (using the ILWIS® command RASTERIZE); then, I reclassified (as waterbody) all the pixels on the SPOT image that overlap with the rasterized waterway map. The ILWIS® command to reclassify the overlapping waterways map goes this way:

SPOT2 = IFNOTUNDEF(WWAYS, "Waterbody", SPOT1)4

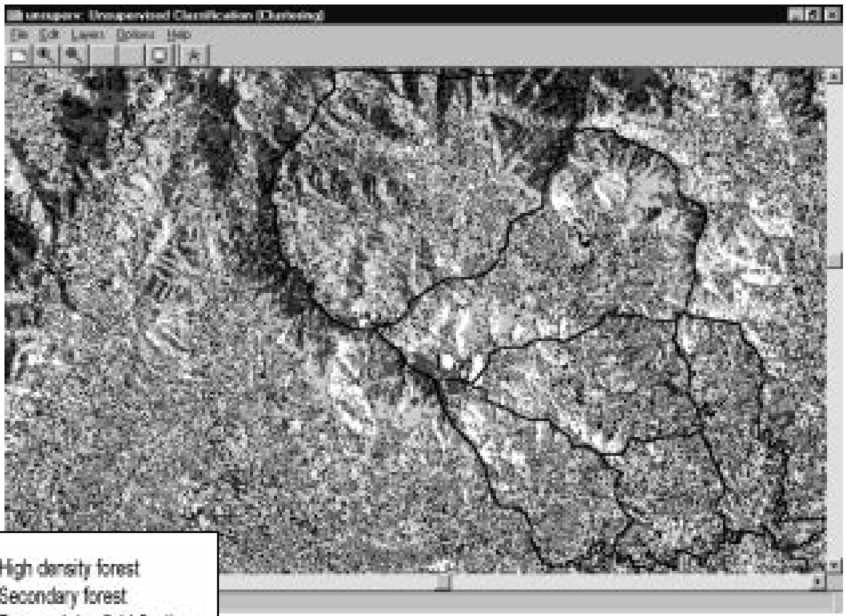
For separating rice and grass classes, I asked the farmers where the highest terraces are found. I requested one of them to accompany me there (the next day) to measure its elevation— 1,300m. This means all those pixels in the image with elevation higher than 1,300m and mis-classified as "terraced rice field and others," had to be reclassified. I used the DEM as the auxiliary height data during this reclassification. The ILWIS® command goes:

SPOT3 = IFF(((DEM > 1300) and (SPOT2= "Terrace")), "Grassland", SPOT2)

As for the lower areas (those with elevation < 1,300m), which were mis-classified as terraces, they were determined by ocular inspection and by local familiarity of the location of terraced areas. I did this step for every *barangay*. We agreed to reclassify them as "grassland" which have overlapping spectral signatures with rice. This step had to be done manually on-screen by selecting pixel areas using the pixel editor function. After classification, I filtered the classified image using the "majority filter"[18] to remove "noise." This means isolated pixels are reclassified (using the "majority filter" algorithm) to result in more homogenous areas. Having more homogeneous areas reduces the number of polygons (therefore smaller tables for the database; and that means less time in doing search operations), and so the map is not too complicated to handle (see ILWIS 1997:313 for details). It represents the state of Ifugao's NRM "objects" (*i.e.,* landcover/land use) in 1997. The classified image

[17] A feature space gives a visual overview of the separation of classes of training pixels (ILWIS 1997). The spectral values from one band are put along a horizontal axis and the spectral values from another band along the vertical. At the position of a sampled pixel, the color of the assigned class appears.

[18] Filtering is the process of replacing each pixel in a raster map with a new value. The new value is obtained by applying a certain function to each pixel and its direct neighbors. Majority filter is a 3x3 filter (*i.e.,* 3 rows and 3 columns of pixels). This filter assigns the predominant value (hence, the term majority) among the nine pixels, to the central pixel (ILWIS 1997). I chose this filter because it suits the purpose of creating homogeneous areas by reclassifying scattered pixels of different classes.



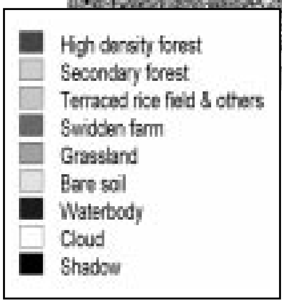


Fig. 6.16a Unsupervised classification of the SPOT image.

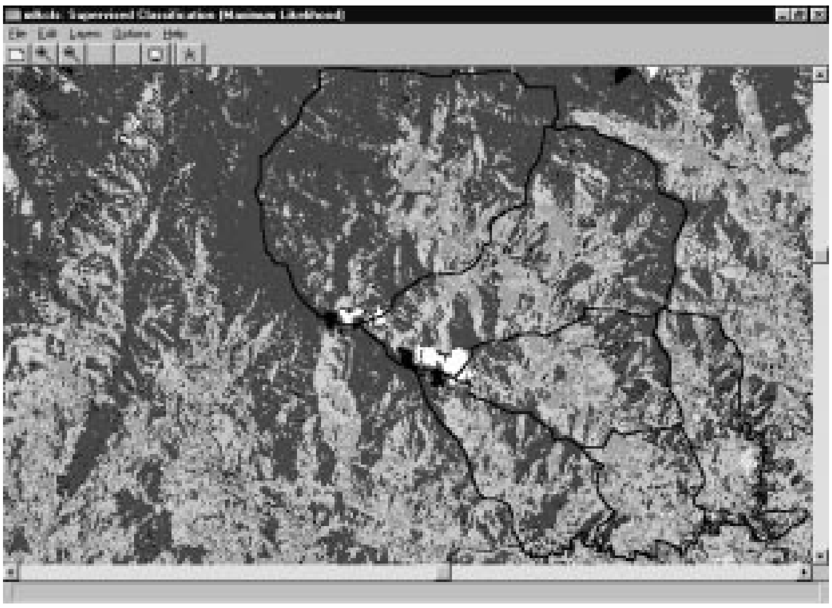
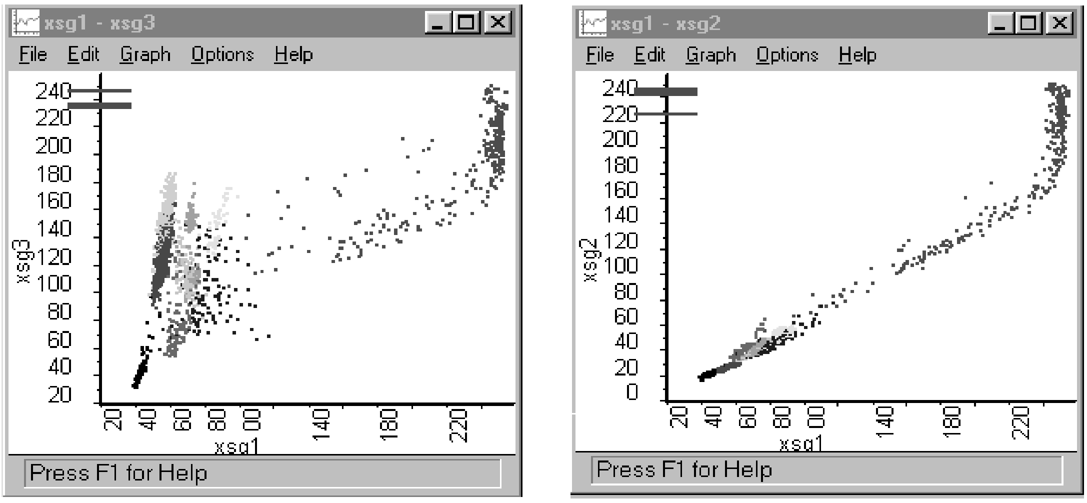
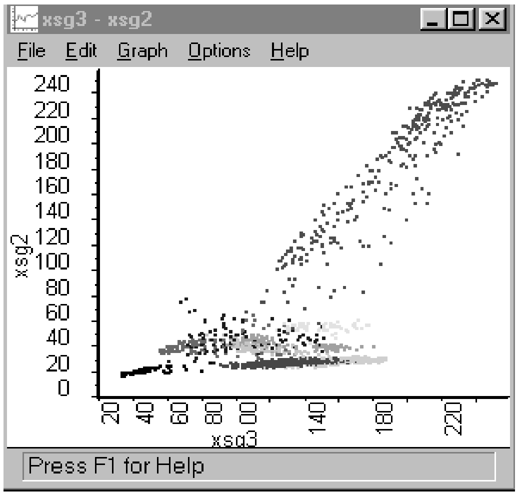


Fig. 6.16b Supervised classification of the SPOT image.

(Fig.6.20c) is then ready to be used for analyses needing landcover/landuse information from 1997.





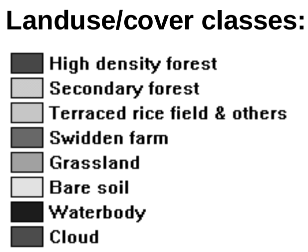


Fig. 6.17 Feature space for information classes

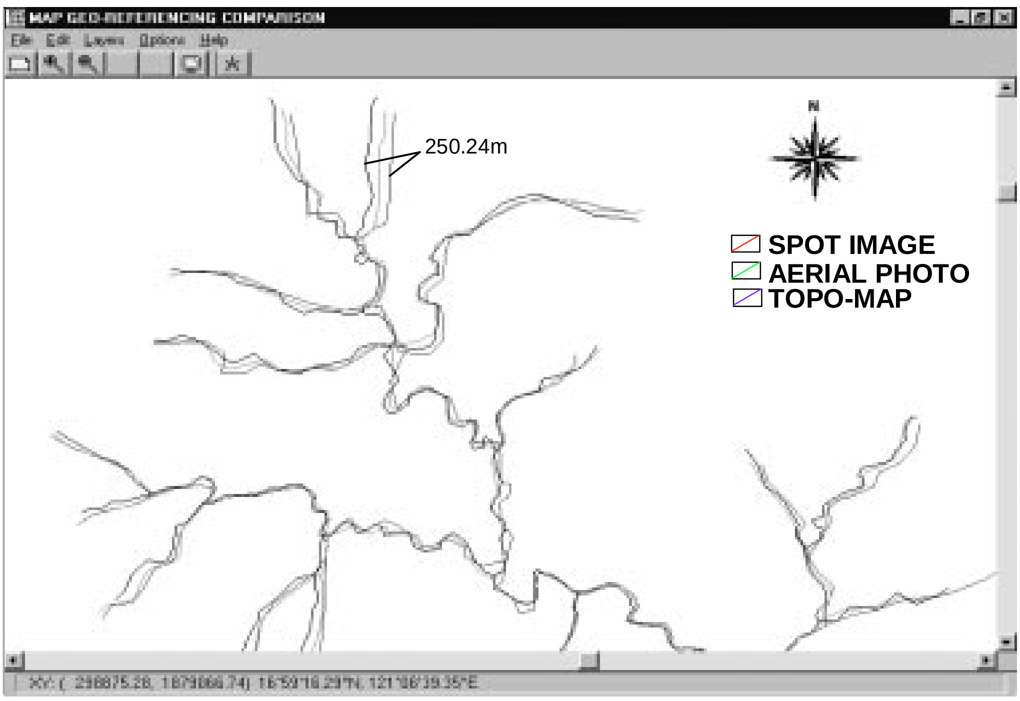
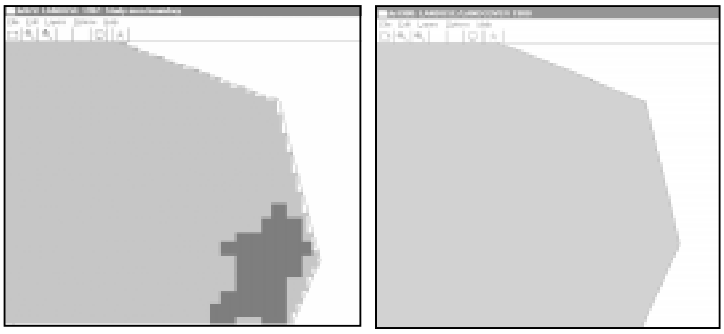


Fig.6.18 Relative accuracy in geo-referencing three map sources.

6.5 Discussion

- On accuracy



(a) (b)

Fig. 6.19 Pixel-by-pixel (a) and manual (b) delineation of boundaries between classes.

The resulting land use/land cover change map in Fig.6.20a, 6.20b, and 6.20c and Table 6.4 have to be analyzed with several considerations. First of all, the difference in data sources (aerial-photos and SPOT image) made the difference: the landuse /landcover map for 1997 was obtained by image processing (pixel-by-pixel computation), and this accounts for the very fine differentiation and segmentation of classes; on the other hand, aerial photo interpretation involves manual delineation of the different land use/landcover classes, and therefore results in more consolidated boundaries (Fig.6.19). This accounts for the difference in the total area when summed up: 7,717Ha. for aerial-photographs and 7,713Ha. for the satellite image.

But the bigger source of error is my attempt in the foregoing exercise to portray the environment as distinct spatial objects in order to be accommodated in a computer. Boundary lines denoting the forest and other land cover classes have to lie somewhere and I had to make my best guess in drawing those lines. This results in inaccurate descriptions, both geometric and thematic, of the object being delineated (with respect to the "real world"). Following are the problems I encountered in object delineation, and the uncertainties produced in delineating them (Molenaar 1998b):

- attempting to delineate terrace boundaries from aerial photographs of insufficient scale— *Existential uncertainty* – insufficient evidence that the object exists (*i.e.*, the different objects are clearly seen by ocular observation on the field, but such objects are difficult to ascertain on the photographs or images);
- attempting to accurately delineate forest, grassland, and swidden boundaries— *Extensional uncertainty* – continuous boundaries associated with fuzzy objects (*i.e.*, the object is clearly seen on photographs or images, but its boundaries are difficult to delineate);
- discrepancy in digitized waterways from different sources (SPOT image, aerial-photographs, topo-map)— *Geometric uncertainty* – limitations in defining geometric attributes (*i.e.*, boundary measurements depend on the sensitivity of instruments used);

- On fuzzy boundaries

The foregoing clearly shows the gap in representing continuous geographic space into discreet computer space. Formalisms in mapping this correspondence have to deal with uncertainties in their descriptions (*e.g.,* syntax, semantics) and involve the use of "fuzzy logic" and spatial statistics (*Ibid.*).

According to Zadeh (1988:84), "In fuzzy logic, everything, including truth is a matter of degree." It is an approximate mode of reasoning where a proposition can be true, false, or partly true. He introduced the concept of "fuzzy set" to model vague concepts or categories by using approximate reasoning. In classical set theory, an object either belongs to a set or not. However, in "fuzzy set" theory, an object can belong to a set based on a "grade of membership"—a number that ranges from 0 to 1 (where 1 represents full membership, 0 represents non-membership, and numbers between them such as 0.25, 0.5, 0.75 etc. represent partial membership). The "degree of membership" or "grade of membership" is a kind of "ordering that is not based on probability but on *admitted possibility*" (Burrough, *et.al.,* 1992:5; italics mine*),* and thus, depends on the requirements of a context.

In using fuzzy set theory in delineating, for example, forests and grasslands for a GIS, the uncertainty in object description and delineation is best handled by defining "transition zones rather than crisp boundaries," and which is more desirable than computing for "positional accuracy of boundary points" (Cheng 1999:19, Wang and Hall 1996:574). A unit area of a forest cover can therefore be classified to be 1-absolutely forest, 0.75-generally forest, 0.5-more or less forest, 0.25-slightly forested, and so on. This is a topic for further research as it has great implications for the image and photo-interpretation that we did. However, this is beyond the scope of the present study, which focuses on bridging participatory methods in developing a GIS. I limited my initial local interaction using discreet sets. Suffice it to say that the resulting landuse/land cover change maps from 1951-1980-1997 generated awareness on the declining amount of forest. Workshop participants saw how the forest areas have decreased and said, "*Nakakalbo na,*" ("It is getting bald"). This expression actually refers to a fuzzy phenomena, because how bald is "bald?" Indeed, definition of membership function is in order, and must be dealt with in succeeding research.

- The error matrix

In assessing the accuracy and reliability of our classified SPOT image, I turned to the confusion matrix (Table 6.5). ILWIS® has a built in function to create the confusion matrix by crossing the map of the classified image with the ground truth[19] map (see ILWIS® Reference Guide 1997). To save space for the matrix, I had abbreviated the land use/land cover classes to: **HD-F** for high density forest, **SC-F** for secondary forest, **GRS** for grassland, **SWD** for swidden farm, **TR&O** for terraced rice field and others, **WTR** for waterway, **Bsoil** for bare soil, **Shad** for shadow, and **Unclas** for unclassified. The confusion matrix was created (automatically using the software) by comparing the classification results (in columns) to the ground truth pixels (in rows). The strength of a confusion matrix is that it identifies the nature of the classification errors, as well as their quantities (ILWIS® 1997)— the proportion of correct classifications are indicated (along the diagonal), as well as the amount of incorrectly classified pixels (in the off-diagonal). Accuracy is the fraction of correctly classified ground truth pixels over the total number of ground truth pixels of a certain

[19] A ground truth map is a set of pixels of known features on the ground created in the same way as the "training pixels" described in section 6.6, but are especially reserved to evaluate the accuracy of the resulting image classification process.

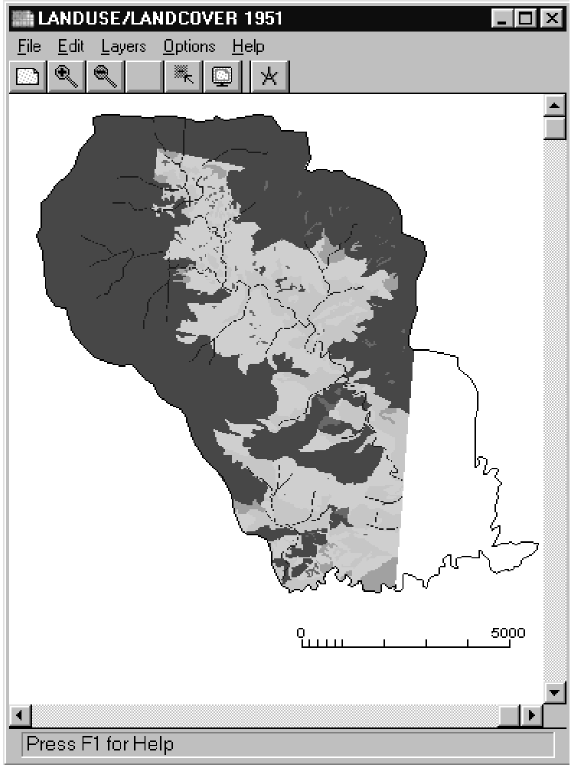


Fig. 6.20a Land use/Land cover 1951 (Arial-Photos)

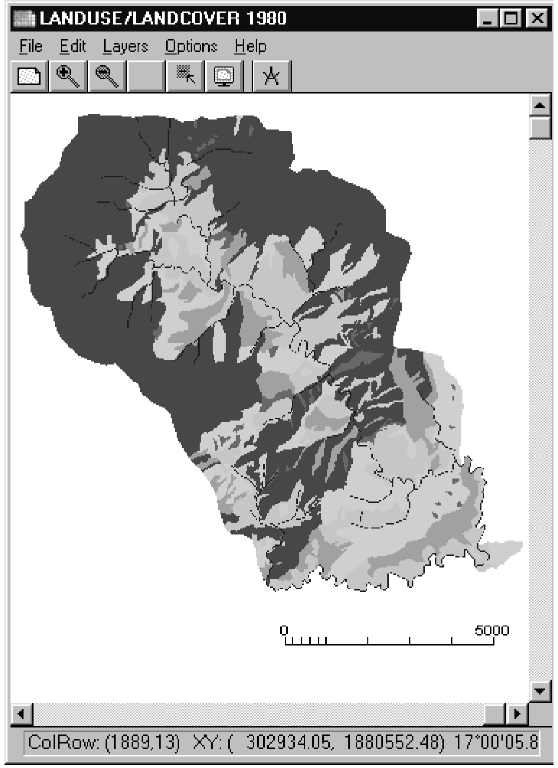


Fig. 6.20b Land use/Land cover 1980 (Arial-Photos)

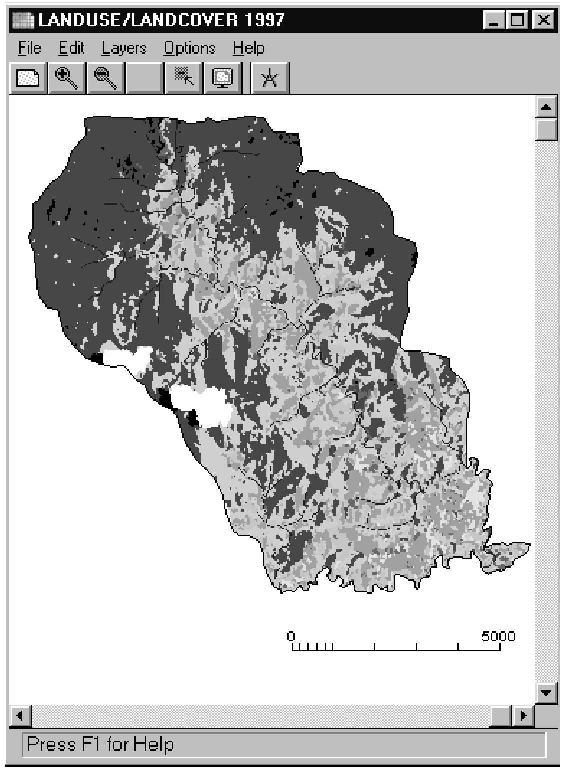


Fig. 6.20c Land use/Land cover 1997 (SPOT)

<u>Note</u>: *The aerial photographs of 1951 did not cover the whole study area. Landuse/landcover for the uncovered portion remained unclassified.*

Table 6.4 Land use/Land cover change from 1951 – 1980 – 1997

LEGEND	LANDUSE/LANDCOVER TYPE	1951 (Ha.)	1980 (Ha.)	1997 (Ha.)
	High Density Forest	3949	3884	3389
	Secondary Forest	1500	1402	1665
	Grassland	145	748	1072
	Swidden Farm	71	134	151
	Terraced Rice Field & Others	917	1375	901
	Waterway	132	174	174
	Bare Soil	0	0	139
	Cloud	0	0	146
	Shadow/Unclassified	(unclassified) 1003	0	(shadow) 76
	TOTAL	**7717**	**7717**	**7713**

land use/land cover class. For example, the accuracy (ACC) in classifying the secondary forest is computed by dividing the number of pixels that were correctly classified by the total number of ground truth pixels for secondary forest (219/236 = 0.93 or 93%). Reliability (REL) of the classes in a classified image is computed by dividing the number of correctly classified secondary forest to the total number of pixels that were classified as secondary forest (219/240 = 0.91 or 91%).

Table 6.5 Confusion matrix between ground truth test pixels and classified image.

	HD-F	SC-F	GRS	SWD	TR&O	WTR	BSoil	Cloud	Shad	UNClas	ACC
HD-F	376	17	0	0	0	2	0	0	0	0	0.95
SC-F	17	219	0	0	0	0	0	0	0	0	0.93
GRS	3	4	193	0	33	6	0	0	0	0	0.81
SWD	0	0	4	72	8	5	1	0	0	0	0.80
TR&O	0	0	74	7	83	23	0	0	0	0	0.44
WTR	0	0	7	7	8	67	0	0	0	0	0.75
Bsoil	0	0	32	0	3	2	13	0	0	0	0.26
Cloud	0	0	0	0	0	1	2	201	0	0	0.99
Shad	0	0	0	0	0	0	0	0	80	0	1.00
REL	0.95	0.91	0.62	0.84	0.61	0.63	0.81	1.00	1.00		

Ave. Accuracy = 76.99%
Ave. Reliability = 82.01%
Overall Accuracy = 83.06%

From the confusion matrix, the foregoing classification was fairly accurate for high-density forest (95%), secondary forest (93%), grassland (81%), and swidden (80%), but not so for bare soils (26%) along with terrace fields & others (44%), whose sample pixels were more associated with grassland. One way to rectify this is by field measurements and re-classification, but the difficult terrain and the fact that we were classifying a one-year-old image made me settle with this uncertainty in mind. That is, I consider this uncertainty whenever I utilize this map (see Chapter 7).

Figure 6.18 shows how the waterway features from these three maps coincide or diverge when overlaid together. Considering the scale (1:50,000), a 1 mm. difference translates to 50m. in the field. ILWIS provides onscreen measurement, and I got as much as 250.24m discrepancy. This translates to errors produced after overlaying of information from these sources (*e.g.*, when computing landuse change between, a change from/to a waterway will be indicated around these areas. Explaining the divergence will require a deeper research focus about map accuracy. These inaccuracies extend all the way to mapping and affect the estimation of the total resource base of the area, which may have serious consequences in planning.

Nevertheless, for the purpose of obtaining the general trend in the decline of forest in a rural, mountainous area, my primary aim is to engage in a spatial dialogue with its farmers. A different degree of acceptability is required for urban area purposes, where a half-meter difference in setting boundary can be a big controversy. Other attendant computer processing must also be considered in assessing accuracy—digitizing, algorithms in rasterizing, filtering, and the object generalization that I had I had to make due to data limitations. The results of this exercise were acceptable for communicating the trend in forest destruction, but not that of the terrace fields. I proposed a different method to monitor the terrace (see Chapter 7). Indeed, maps, GIS and remote sensing are not perfect, but they provide us with educated guesses and insights about actual conditions and relationships that can help in decision making.

Table 6.6 Summary of GIS-design learning experience with the Ifugaos

Activity	**Participation / Interaction**		**Learning points**	
	Researcher	*Farmers*	*Researcher*	*Farmers*
1. Setting boundary	Facilitation, interpretation, Comparison of different concepts of boundary	Sketch map, explanation of local boundary markers	Boundaries as societal constructs modeled in GIS, Existence of physical and social boundaries; Ifugao's shift to physical boundary	Shapes and relative sizes of the *barangays* provided a source of "identity" as they compare with others
2. Creating DEM	All preparations	None	Catchment area ("water district") management unit, Interconnectedness of *barangay* clusters	Engaging in spatial dialogue, relating map and the physical features (relative heights)
3. Database Design:				
3.1 Information needs assessment	Observation of local NRM processes; Drawing DFD and E-R model; Identification and procurement of required data; Proposed GIS-assisted set-up	Do usual CDP process Check DFD, check E-R model confirming needed data	Information gap between NRM actors; Proposed communication channel among NRM actors as a learning system	GIS-generated maps for better communication with other NRM actors
3.2 Database modeling:				
- database structure	Analysis of processes and relations; Data organization	Granting interviews when necessary	Interactive data gathering— data as a result of this interaction	Data they provide for database can come back as information GIS can provide them about the situation of the greater area
3.3 Data pre-processing:				
- photo-interpretation	Delineation / digitizing of landuse and land cover classes	Identification, description and location of landuse and land cover classes	Difference between what the farmers "see" and what the photos indicate;	Landuse change 1951-1980-1997 generated an awareness of the declining forests
- image classification	Introduction to satellite image; Image processing	Selection of training pixels, Image interpretation	Cycle of knowing and seeing, Seeing objects through codes	Seeing patterns through pixels; Regional perspective of their town; Interconnectedness of *barangays*
- image refinement	Separation of classes, Filtering, error matrix	Ground truthing, verification	Human limitations in field verification (accessibility of area); I had to trust the people but verify from others, too	Machine classification errors can be corrected by local knowledge of the area
3.4 Data input	Filling out(computerized) tables for the database	None	Generalizing farmers' detailed descriptions to conform to model's scale for data integration	None

- On learning points

My interactions with the Ifugaos as described in this chapter yielded more than the fulfillment of GIS-design procedures in facilitating their environmental scanning and mapping activities. A joint learning ensued between and among us (Table 6.6). My very first encounter in delineating the study area's boundary revealed much about societal constructs about space. Local inhabitants are totally oblivious of what the land surveyors have dutifully established as benchmarks for official demarcation of perhaps electoral or statistical or taxation boundaries. This is far removed from local concepts of boundary, which are constructed around the inhabitants' survival as a group—the water catchment as an emblem of their identity, along with the responsibility to protect and maintain it. GIS helped to show this discrepancy.

In interpreting the aerial photographs and satellite image, a spontaneous process of learning collectively about the local environment emerged, *e.g.,* the inter-connections of features and the changes that have occurred between 1951-1980-1997 such as relating the decline of forest to the increase in swidden area. Workshop participants also teased each other about whose *barangay* has the least amount of forest left. This generated laughter, but at the same time, pride in the ability to manage forest better than others. They recognized the help that interpreting a satellite image can give in monitoring their forest. This exercise also showed the importance of local knowledge in refining image classification. Workshop participants became aware of computer errors and the need for them to provide the corrective information. I noticed how farmers would scrutinize details on the topographic map and point out errors like labeling of *barangay* names and the locations of the schoolhouse or a church. They also pointed at the area on the satellite image where they said a protested road project is located. They recalled a drowning accident when the victim's body was recovered far down at the Magat Dam. They traced (on the image) the possible route that the body had taken. They have learned to connect features on the image with those on the physical environment. Seeing their place in a regional perspective enhanced self-awareness as they learned to approximate their position with the rest of the region.

These incidents, while outside the scope of the main GIS-design procedures, provided insights as to the effectiveness of using GIS in learning together about one's environment even with people having no computer training. I was able to impart some of its capabilities, and when the occasion warranted (*e.g.,* giving directions about going to someone's house), they jokingly asked me to map it out with my laptop computer (which I always carried in my backpack). Upon learning that my GPS can also measure elevation, one farmer who helped me do measurements borrowed it several days later, because he wanted to determine the height of their waterfalls. He said the GPS could simplify measurements for a micro-hydro generator project, In another instance, a CB-CO suggested mapping out the location of reliable mountain springs using the GPS so that they could be given proper care by the municipal government during road construction work. These are purely anecdotal, un-quantifiable impacts, but they are very much observable and indicate an active interplay of knowledge processes. They learned about new things, and they wanted to try them with the hope of improving their local procedures.

The next chapter is about trying out the database for the proposed GIS-assisted watershed monitoring system that mobilizes the *barangay*s' NRM councils.

Chapter 7

To regenerate a watershed: Work teams and mapping

Let the river flow.

7.1 Introduction

This chapter is about my attempts to test the utility of the GIS design in supporting specific *barangay* NRM activities. The first case is Barangay Bangaan's terrace monitoring system, as a prelude to aggregating gathered information for the whole watershed. The concept is based on the traditional monitoring system incorporated in the *baddang*— having a *mun-unod,* who monitors irrigation channel and terrace status to alert the whole community into acting together at the slightest damage. Today, local initiative to act together in terrace maintenance is driven more by monetary considerations from externally formulated projects than by communal concern. It is clearly necessary to engage external agencies in getting a picture of the overall situation and direct project resources to where they are needed most. The second case is about the effort of Barangay Ducligan's CB-NRM council to reforest their *barangay* watershed area. I noted how their efforts developed from piece meal to an organized approach— engaging local work teams and neighboring *sitios.*

In both instances, despite data limitations, I analyzed the role that a GIS-assisted learning process played for Ifugao NRM actors to jointly understand the environment they are managing.

7.2 Monitoring Bangaan’s watershed

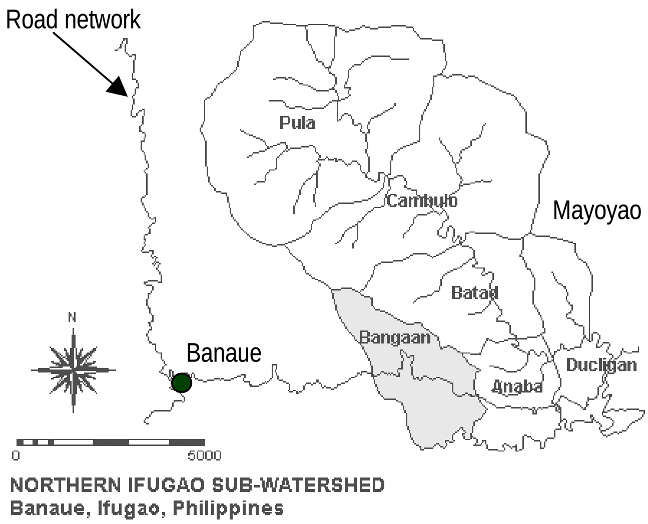


Fig. 7.1 Location of Barangay Bangaan

Bangaan lies about 13km east of Banaue town proper and is traversed by the road leading to Mayoyao (see Fig. 7.1). It covers approximately 800ha. of mostly forested area. Bangaan’s terraced valley floor is one of the most visited places in Ifugao, not only because of the daily travelers along this Banaue-Mayoyao road, but also because tourists who could not make the grueling two-hour hike to the more majestic Batad terraces, come to Bangaan to enjoy the scenery.

Being a major tourist destination of the province, Bangaan’s terraces are among the ITC’s “priority terrace clusters” (ITC 1994). Some of its terrace owners have benefited from two major terrace wall repair projects of the commission since 1996. The CECAP had also cemented major footpaths and a 1km-long irrigation canal. PRRM sponsored the extension of that canal for another 1.2km in 1992. An irrigation project of the NIA (National Irrigation Administration) was ongoing at the time of this research, which provided an opportunity to discuss with the NIA project supervisor. He made it clear that the role of their office is purely to build the structure. Maintenance work is the local community’s responsibility. He showed the memorandum of agreement, which was undertaken between the *barangay*’s association and their office, which stipulates such terms. He showed me an earlier NIA irrigation project in 1986 that presently needs maintenance work. That is not their job anymore. The local community has to devise ways to maintain those structures, whether through *barangay* or municipal projects or other project donors.

Bangaan is composed of 15 sitios and according to the survey conducted in the course of this research, has 114 households with a total population of 479. This is much lower than the official count of 678 in 1995 (PPDO 1996), and may suggest migration[1]. Also, in filling out the survey form, seven households had actually counted in their family members who are working abroad whose names had been stricken out during my tallying. Bangaan’s population classification into age group and sex is tabulated below (Table 7.1) in order to have an idea of its current labor force. Note that only 73 male farmers are available to maintain Bangaan’s walls and canals on about 81ha. of terrace farms. Terrace construction and repair require highly skilled workers and some of the men are not that adept. This explains why the ITC had to import some workers from other *barangay*s for its repair projects— something

[1] Errors in the census of 1995 may have occurred as well if it was carried out by simply distributing and collecting standard questionnaires without the benefit of interacting with respondents who are accustomed to consider family members that have emigrated or even those that have died. Barton (1919/1969) observed that Ifugao family includes the unborn (family exists for the generations of it) and the dead (ancestor worship).

that was not clear to Bangaan's inhabitants and had become a source of ill-feelings (perceived favoritism in awarding repair contracts) as indicated in my interviews. Conklin (1980:27) noted that routine minor repair works on irrigation channeling required "20 man-days per hectare of terrace service area." In a more serious landslide, he counted 289 man-days spent in clearing away debris, saving as much topsoil as could be saved and rebuilding a terrace surface area of only 175sqm. This gives an idea of how much labor is needed for terrace maintenance. Bangaan's population record reflects labor availability far less than the requirement.

Table 7.1 Bangaan *sitios* and population profile as of May 1998

SITIO	**No. of HOUSEHOLDS**	**POPULATION (15 yrs old-up)***				**(0-14 yrs old)**	
		M		**F**		**M**	**F**
		Farmer	**Others**	**Farmer**	**Others**		
Al-lar	8	8	2	5	6	2	4
Ayangan	3	4	11	6	6	7	4
Bangaan Proper	21	7	13	7	15	14	11
Bay-o	1	1	0	1	0	0	0
Batwag	3	4	0	3	0	0	0
Boble	6	3	1	3	2	12	7
Bokong	7	6	3	4	3	14	16
Bocos	14	9	7	8	14	15	13
Bul-od	11	9	4	11	7	8	10
Chotar	3	3	3	2	1	2	1
Dalican	12	3	5	9	7	12	8
Lawigan	10	7	4	5	4	11	11
Pidlan	10	3	6	7	1	8	10
Pin-nog	4	5	0	5	0	3	1
Tam-moc	1	1	0	1	0	0	0
TOTAL = 479	114	**73**	**59**	**77**	**66**	**108**	**96**

*The country's minimum age limit for inclusion in the labor force (M=male; F=female)

Irrigation canal maintenance and terrace maintenance go hand in hand. In fact, when informants talk of terrace repair projects being done here and there, they comment that these projects are no good unless there is water: "*What good is the terrace without the water? Water is the key to life, and it is also the key to terrace life.*" While a clear understanding of the role of water management in terrace upkeep is implied, that remark negates my observation of local attitudes towards maintenance work. I observed that local people heavily depend on externally initiated maintenance projects. For example, the CECAP-initiated irrigation project has not been repaired since 1990, after an earthquake had induced landslides. A succession of landslides since then has worsened the situation and it continues to deteriorate as of this writing. Bangaan's residents are "waiting for another round of maintenance projects" to hire them (pers.com. Manang Virgie H.).

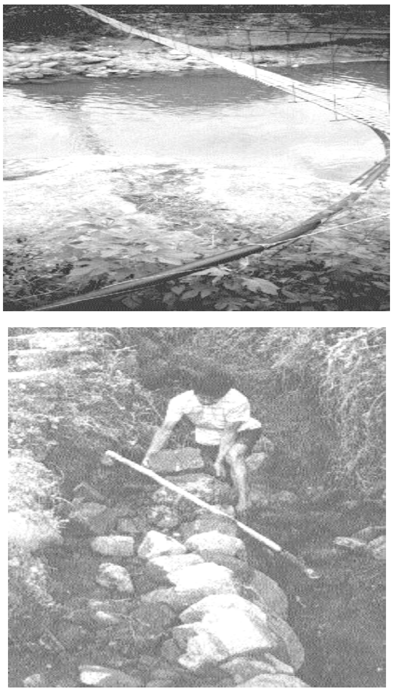


Fig.7.2 Individual efforts to channel water (plastic hose, gravity and earthworks).

I observed three types of individual efforts to do canal work: those who can afford it use kilometer-long plastic hoses; others with nearby sources channel water by gravity and earthworks; sometimes, bamboo pipes are also used. In general, collective and voluntary management of irrigation and terrace walls has given way to paid labor and *kanya-kanya,* the Filipino term for individual effort.

7.2.1 The 'baddang' of old

In the old days, menfolk used to join a special kind of workgroup, called *baddang* specifically for the construction and maintenance of irrigation canals. But in these days of contract labor and unorganized communities, irrigation and terrace maintenance work are undermined. During a group discussion that I arranged with Bangaan's five CB-COs, 65 year-old Buok Hangdaan narrated how the *baddang* had worked. He sometimes paused to recall the right word or term to use and other members of the group and curious on-lookers pitched in. (Later on, informants from other *barangays* confirmed this system of water management, although they sometimes called it differently *e.g., fadchang, dang-a*):

"The men would gather one late afternoon and discuss the need to channel water from an identified source. The elevation of the water source and the canal route to be constructed determined which terraces would benefit. The owners of these benefiting terraces would pledge to convene at a signal early in the morning. Such signal was usually a shout from the *pechang* (the *baddang* leader), followed by shouts from the others, and the chant would continue as they walked their way towards the meeting point. Each one would bring some *ukat*, which is (cooked) rice and viand for the day's work. Only on the first day, three chickens, donated by the richer terrace owners or those who have more terraces to be benefiting, are butchered. And while at work, these chickens would be simmering in a big pot. The work would continue every day until the whole canal network is finished. The number of days of participation depended on the size of terrace(s) that one owns. Those with more or bigger fields to benefit would render more working days, but he could also bring along another person, like a son or any other relative, to compensate for it. Those who did not participate, but whose terraces would benefit, will have to pay a fine— something like an equivalent payment for work, and that could mean 3 chickens. Otherwise, they would be ostracized and would lose face to the whole village. Such a shame would extend to their future generations. Non-beneficiaries of the canal may also join in the construction, and this would earn them respect from the whole village.

The owner of the last terraces to be irrigated acted as the monitor (called the *mun-unod*) for maintenance work. Aside from keeping the canals clean of debris from falling leaves, weeds, and stones, he reported destroyed portions, and those affected (owners of terraces comprising the *payoh-cha* or terrace complex) will again convene one morning to make repair work. The *mun-unod* did the report everyday, and must inform others to do it for him on days that he could not. Otherwise, he would get the ire of the group and that would mean losing face.

There was also a scheduling of canal watchers, called *mun-adog*, in times when water supply is low. The canal beneficiaries took turns in filling their terraces and in watching the flow at night in order to guard against those who might steal water. Indicators for canal tampering include a decrease in the rate of flow and muddy water. Those who are caught stealing water (diverting the flow) would be given a talking to and a warning not to do it again. If caught for the second time, all the water would be drained from his/her field and a fine (maybe 2 chickens) would be collected. This would also be a big shame for his/her whole clan" (pers.com. B.Hangdaan 1998).

This recollection describes how the Ifugaos' traditional NRM includes a spatial information system which is woven into their daily decision making process, in their way of life. Many spatial analysis concepts are present in this narration— site selection (water source), network analysis (canal route), neighborhood analysis (damage extent), height/area comparison— which are routine GIS procedures. Aside from these, the supremacy of community welfare over selfish interest in the old Ifugao society is indicated. Water is a vital resource, and strict compliance with water rights was enforced. Corresponding punishments awaited would-be offenders. The narration also implies that family prestige served to control the behavior of its members, as wrongdoing of one is a shame to the rest of the clan. When I asked why this effective water management system of the *baddang* is not adhered to anymore, two answers were elicited from the group:

1. The men are busy with off-farm work and other things to attend to in town.
2. The lack of materials— stones (most have been carried away by erosion or used elsewhere[2] in the construction of pathways), cement, and sand which are necessary, otherwise, their "effort will be wasted" on simple earthworks that are easily washed away with the water.

The first answer indicates the present necessity to transact business in town (for personal purposes, coordination with the municipal government or the church) and the opportunities for off-farm work. The present minimum wage law stipulates 190 pesos per day (8 hours of work) and is more attractive than toiling on one's terraces or irrigation canals with no immediate compensation. The second answer is not just about simple lack of materials around them, but also of money to buy those materials. Stones and cement are now being bought and brought in by truckloads. It also suggests a third reason— their present reliance on purchased materials, and new technology to do things which are much desirable than the usual manual methods. And indeed, simple earthworks demand continuous maintenance, which is difficult in the present set-up with fewer farm hands. A review of Table 7.1 shows this deficit: only 73 males are farming. The other 59 are students who are attending schools in different towns and cities, or are jeepney drivers, carpenters or laborers whose work routines are done elsewhere.

Incidentally, a teacher from Barangay Ducligan provided another explanation for the collapse of their collective system: the lack of a "moving force" such as the belief in the rice god, which had compelled the early Ifugaos to do things at once, including the accompanying rituals. Their spirituality was an effective motivation in the past, but people cannot revert back to discarded beliefs. Aside form that, most Ifugaos[3] have already adopted different religious beliefs and are now Catholics, Protestants, 7th-Day Adventists, or followers of various Christian sects (PPDO 1996), that have no connection with terrace agriculture, unlike the rice god. It is now very difficult for Ifugaos to rally behind one shared "moving force."

Fig.7.3 Paid workers carved a road around mountainsides.

[2] Informants say they can appropriate eroded stone walls from damaged terraces, which have been abandoned, or from those whose owners are not doing anything to repair their terrace walls.

[3] Some informants remain un-affiliated with any religious group.

Other mechanisms to encourage collective work are now being resorted to, such as incentives (whether financial, social services, etc.) which are more commensurate to difficult terrace work. Based on PRRM's project experience, enough labor can be easily obtained when payment for it is assured. In some cases, a "food-for-work" scheme does it. I observed the same practice in a municipal government project in Barangay Batad (done during the last month of my stay in the area). A foot-trail was converted into a road that is wide enough for a jeepney to pass through. It was carved around mountain slopes within 3 weeks by 75 paid workers[4] using simple hand tools (Fig.7.3). Such an amazing feat shows that the collective, voluntary spirit of the old Ifugao society, which sustained their terraced landscape for more than 2,000 years, have been replaced by incentives like wages. This is characteristic of the change from communalism (collective labor and barter) to a market economy in less than 100 years (as the society needs cash to exchange commodities, including labor). There is no doubt about the hardworking Ifugaos, but they need cash.

7.2.2 Continuous monitoring

The old institutions of the *tomoná*, the *ubbu* workgroups or the *pechang* and *baddang* workgroups are not functioning as they used to, but it should not be assumed that the local inhabitants of the present-day *barangay*s are not aware of the status of their canals and terrace walls anymore. Their daily routine remains the same—walking through the same paths, working on the same fields, seeing the view in the process, and a lot of talking among themselves (theirs is a society with an oral tradition). And in such a community without telephones, it is always certain that people meeting each other along the pathways pause and talk for some time before proceeding. Through the present-day informal information network, everybody knows what is happening around— the landslides, the rat attack on which fields, the available springs despite the El Niño, needed harvesting help, the meeting organized by the local health officer, weddings, births and deaths. In fact, this research had relied heavily on information from casual group discussions in going about daily chores like washing clothes by the river, cooking meals for the meetings, joining in harvest time *ubbu*, and during the long jeepney rides. However, no individual has the responsibility to collect and systematize such information for collective use or action as the *tomoná*, *mun-unod* and *pechang* had done before.

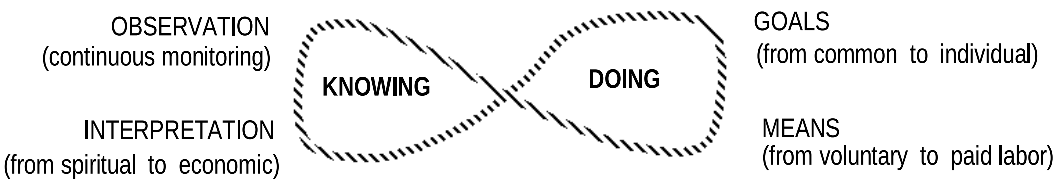


Fig.7.4 Changed knowledge-action path for present-day Ifugao

From the foregoing, it can be said that the local people's network for monitoring or "gathering information" remains an integral part of their lives. The Random House Dictionary of the English Language defines monitoring as "the

[4] Sometimes, the whole family helps although only one member is actually paid on a per volume basis.

process of observing, detecting or recording an operation or condition with instruments, to check and keep track for purposes of control or surveillance." Monitoring is crucial for the whole knowledge-action path, and the old Ifugaos had demonstrated an efficient monitoring system through their *baddang*.

Today, monitoring of events goes on, only the course of action has changed (see also Table 7.2). At some point in their life, the Ifugaos changed their goals (from common good to that of the individual), and so have their methods (from voluntary workgroup to paid contract labor). That is, as monetary considerations became primary, the course of action for doing canal repair has changed from voluntary group work to paid individual effort. And because of this new goal and action, the interpretation of an event (repair project) changed as well. An example is the perceived favoritism in awarding contracts. Informants say nepotism and political party affiliations determine who gets the job. There may be truth to this allegation (despite real scarcity of skilled labor in the area), because there is a change in the interpretation of their actions from the spiritual (an offering to their god) to the economic (a job opportunity). For why the bickering, when repair work is being done anyway? Moreover, processing information for collective use or action (which used to be done by traditional workgroups and its leadership) is not done anymore. During landslides, the municipal government is informed,[5] and the people wait for its bulldozers to do the job of removing the fallen debris. In the same way, irrigation canals remain un-repaired and individual efforts at channeling water is noticeable (*e.g.,* using plastic hoses) as they wait for government repair projects.

Table 7.2 Changes in the Ifugao *baddang*'s knowledge-action continuum

KNOWLEDGE-ACTION PATH	THEN	NOW
Observation (of eroded canal) Observed by	Ocular observation Oral transmission Individual (*mun-unod)* to collective	Ocular observation Oral transmission Individual to individual
Interpretation (of eroded canal) Interpretation (of repair work)	Threat to the whole community Spiritual fulfillment	Threat to the individual Economic gratification
Goals	For common good	For individual interest
Means	Voluntary workgroup Communal irrigation canal	Paid contract labor Individual plastic hose Cemented canal Bulldozers

7.2.3 New monitoring path

With the weakening of traditional workgroups, only the strong family bond and the clan continue to function today. However, migration and a changed individual lifestyle are slowly undermining these, too. The development of the *barangay*s now rests heavily on external agencies exercising their official mandates. Externally generated projects are dominating the local development landscape. For example, using its own set of criteria, the ITC (1995) has drawn its own "priority areas." These are the towns of Banaue, Hungduan, Kiangan and Mayoyao. And in each of these towns, it identified *barangay*s with "priority terrace clusters." The ITC's criteria in selecting priorities for terrace restoration and preservation (*ibid.)* are:

[5] By oral transmission, usually involving jeepney drivers who ply the route.

- Shows significant scenic and cultural value
- Supports a large number of farmers and/or a tourism asset
- Exhibits various degrees of deterioration and abandonment
- Located within a microwatershed with a good source of water that is in need of urgent repair
- Representative of any of or a combination of protection/buffer/multiple-use zone
- Located strategically to be able to show-case success stories for wider replication

Strictly speaking, these criteria could apply to all of Ifugao's terrace clusters. But the point of view is clearly from an external agency looking in for commercial tourist destinations (*e.g.,* "tourism asset," "show-case,"). In Banaue, eight terrace clusters were identified by ITC. Bangaan was "lucky" to be included in the list, but other *barangay*s in the study area were not. Being *suerte* (lucky) or *malas* (unlucky) are Filipino terms (of Spanish origin) used by informants to express their joy or disappointment and helplessness, as the case may be, in accepting externally generated development projects. Manang Rosa of Sitio Ayangan harped about the "unclear basis for awarding contracts" and what seems to her as "outright favoritism" from government officials in awarding repair contracts to individuals. Individual project contracts have replaced collective work.

The present situation is characterized by the growing interest of the government (up to the national level) to preserve the terraces for tourism purposes. I noticed that the government provides wages and project materials, but is not utilizing the monitoring capability of the local inhabitants to determine priority areas. Such local involvement could help to set priority project areas in a more transparent manner. A new monitoring process through joint efforts for a common goal (*e.g.*, productivity and preservation of the terraces) could emerge out of it.

Fig.7.5 Erosion damage on a terrace complex in Bangaan.

I discussed this idea with PRRM's area team leader. I pointed out that the groundwork for a new monitoring system has been set by PRRM's approach to development. It recognizes the potential of the local people's information network with its "environmental scanning and mapping" process (as described in Chapter 6). Although she knows how the traditional *baddang* had worked, she was not conscious of the fact that what they are currently doing can be seen as a parallel undertaking for monitoring the whole terrace structure of each *barangay*. They need to make a more comprehensive description of the watershed condition using a formal recording of their volunteered information. Monitoring maps can facilitate this. Aside from their potential in negotiating with other NRM agencies, Bangaan's CB-NRM council may also use the same maps in their CDP planning and terrace maintenance (see Chapter 6). She was certain that the CB-COs could be tasked to head the monitoring teams and coordinate with *sitio* inhabitants in updating the monitoring maps. We agreed to develop this set-up. Time and data constraint did not allow its full implementation, but I shall describe the steps we did to develop the method. This exercise was done for PRRM's Bangaan area team as a prototype terrace monitoring system.

7.2.4 Mapping the terraces

My proposed terrace-monitoring scheme requires a terrace map. I inspected the sketch map which was drawn during the boundary delineation exercise (Chapter 6), but it was a very rough sketch, out of scale, and out of proportion. However, it contains landmarks. These are prominent features in the area which are meaningful for the inhabitants because of their use and for being conspicuous (*e.g.,* schoolhouse, footbridge, ritual plot, road junction). They are the key in making a georeferenced sketch map, because most likely, they are also recognizable on the base maps. They also serve as reference points for orienting one's position on the generated sketch map. (Upon knowing the importance of these points, one CBCO asked me for the spelling of "landmarks." She said she must remember this word to keep in mind that it refers to the important points in their area).

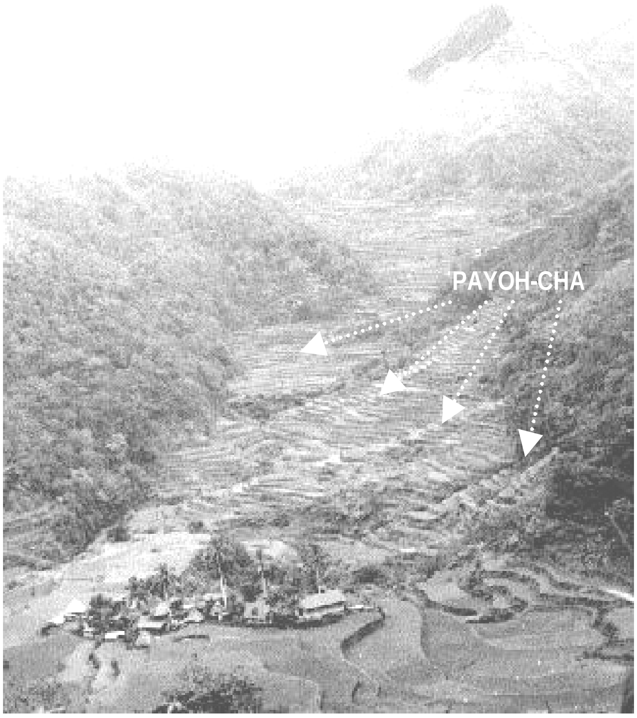


Fig. 7.6 Terrace complex of a *payoh-cha.*

Two CB-COs helped me measure the locations of these points using the GPS. They took measurements on points that were too difficult for me to climb. It was not a problem for them as it was straightforward reading the screen display. They only had to wait for about three minutes for the GPS to establish a "fix" with at least four satellites to automatically compute for the position. Aside from the landmarks, we also noted the locations and elevations of turning points and intersections. However, because of the difficulty of measuring points for every terrace step, I decided to use the *payoh-cha* (terrace complex) boundaries for demarcating the terraced field areas.

A *payoh-cha* is a grouping of terraced fields that benefit from the same irrigation canals, and is demarcated by two such canals that run along its sides from the topmost terrace to the lowest. As such, it covers a big portion of a mountainside, and can be discerned through natural contours and canal breaks (Fig.7.6). Demarcating all of the *payoh-cha* was very difficult because of the terrain. During the fieldwork, we selected only those points that were more accessible. We concentrated on sitio Bangaan Proper. Aside from 13 landmarks, we were able to measure 30 other points in their vicinity. In the future, large-scale aerial photography can simplify this procedure. Conklin's (1980) aerial photos, for example, clearly showed such demarcation lines. Having photographs of such a scale (1:15,000) can facilitate tracing even every terrace's boundaries by on-screen digitizing. Aside from that, recent developments in remote sensing technology can now provide 1-meter resolution with the IKONOS satellite images (ISPRS 1999).

- Steps undertaken to make the terrace map:

1. Plotting the landmarks *(with the CBCO)*
   I chose the SPOT image as the background for plotting the landmarks, because it provided a clearer view of the terrain (distinct landcover on 3D view). I also overlaid our established *barangay* boundary lines (Chapter 6), the waterways map, and the roadmap (I digitized from the topo-map) for a clearer orientation. Together with one CBCO who helped in GPS measurements, we identified the corresponding landmarks (from the sketchmap) on the SPOT image. These are the road junctions, the ritual plots, the Bangaan Family Inn, the school, the chapel, the merging streams, the mountain tops, which are identifiable on the image.

2. Plotting the GPS measurements *(with the CBCO)*
   Next, I plotted the GPS measured points on-screen. The coordinates are displayed as the mouse moves across the screen, and so, I click to mark the point when the measured coordinates are indicated.

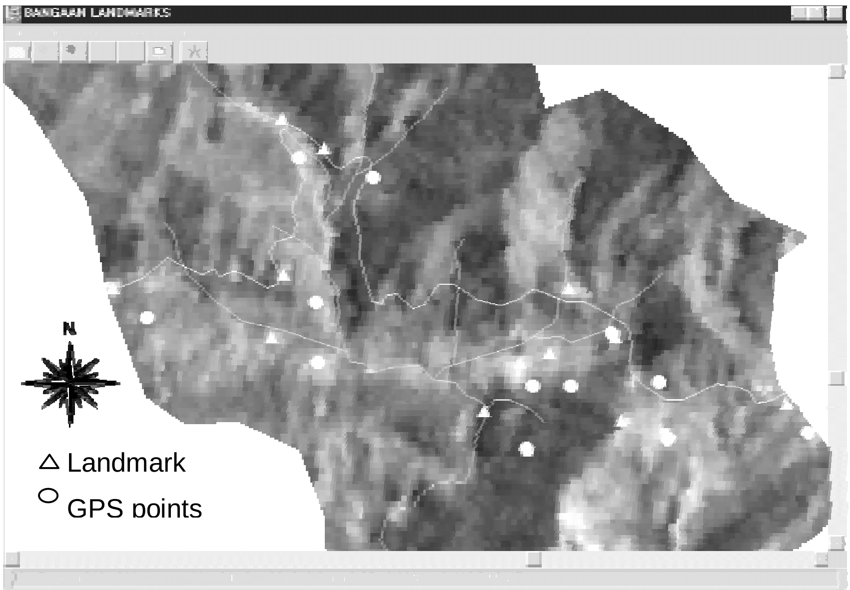


Fig.7.7 Positional errors between SPOT image landmarks and GPS field measurements.

We had problems with the GPS-points which were too far off when plotted (some of them by 200 meters). The GPS we used (Garmin 12XL) has 15-meter position accuracy, but all GPSs are subject to the US Department of Defense imposed "selective availability program." This program degrades the accuracy of GPS

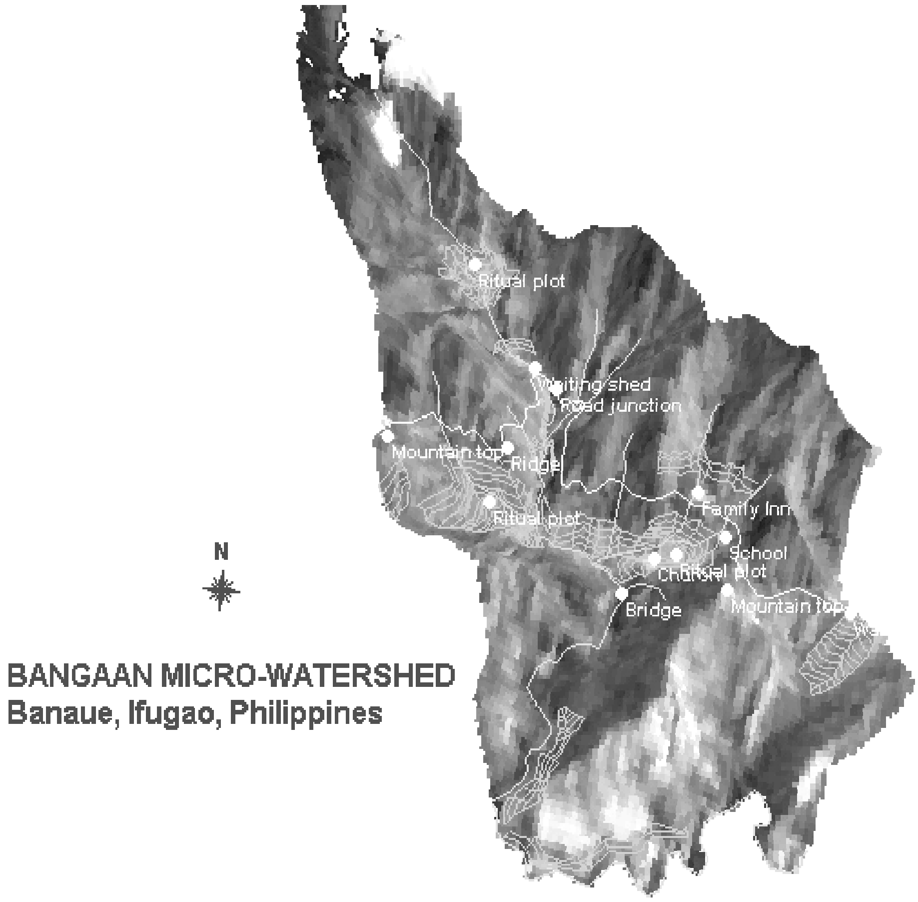


Fig. 7.8 Plotted terrace map on 3D view

measurements to deny "hostile forces" position accuracy "by as much as 100m" (Berry 1995:138). This problem can be minimized using a "differential GPS" (that applies measurement corrections), but such a kind of GPS is very expensive (for more details, see Hurn 1989, Garmin 1997). GPS measurements also deteriorate under thick vegetation and in deep valleys (Berry *op.cit.*). Also, my error in geo-referencing (*i.e.*, the 0.5 residual error) translates to 10m on the ground.

I explained this problem to the CBCO, and we recalled the ground points where the measurements were taken. I repeated the measurement if it was accessible (otherwise, I deleted the point). However, the second measurements were still way off the marks. I then decided to retain the landmarks as plotted through the SPOT image in (1), and adjusted the GPS points according to our knowledge of their relative locations (discussed in step 3).

3. <u>Adjusting the "wayward points</u>" *(with the CBCO)*
   I adjusted the GPS "wayward" points (*i.e.*, too far from the reference point) using the pencil icon and the pincers-icon of ILWIS. The latter allowed "picking-up" and relocating the "wayward" points according to our field knowledge of relative positions of the landmarks and turning points. We debated on the location, and I re-plotted erroneous points on-screen using recognizable features on the SPOT image as guide. I sometimes let the CBCO to plot the point by clicking the mouse on the spot where we agreed the ground feature is located.

4. Digitizing the terrace boundaries *(Alone)*
   I connected corresponding points along the terrace edges by digitizing the lines between them. Using the topo-map as background, I digitized the terrace steps. The contour lines served as guides in ensuring that digitized lines defining the terrace steps are along the same elevation. I also used the contour lines as guides in digitizing simulated terrace boundaries for the other *sitios*. I used the SPOT image on 3D view as background (Fig.7.8) to help visually determine the relative fit of the *payoh-cha* on the mountainsides (*e.g.*, terraces should be located on mountain sides, not mountain tops).

5. Printing the terrace map *(Alone)*
   Lastly, I printed and photo-copied the final map (Fig.7.9) and delivered it to the area team leader for discussion with the work teams.

The result is similar to sketchmapping, only this time, the product is a "geo-referenced sketchmap." The CBCO and I discussed and debated on the actual location of the plotted points. In all cases, we agreed on our knowledge of the actual location of the points. This "computerized sketchmap" serves to demonstrate to the PRRM staff the procedure for the proposed terrace monitoring system. A more accurate terrace map can be plotted in the future using large-scale aerial-photos or 1-meter resolution satellite images. The cost can be reduced in cooperation with the national mapping agency, and this highlights the coordination shown in Chapter 6 (Fig. 6.8).

7.2.5 Monitoring teams

Figure 7.9 shows the printed terrace map with the *barangay* boundary lines and landmarks for Bangaan. The landmarks helped me, PRRM's area team leader and the five CB-COs to talk about and orient ourselves with respect to the ground locations of the terraces. This means we used the landmarks to figure out which terrace clusters are represented on the map. The area team leader appreciated the new "mapping tool." She identified four monitoring teams headed by the CB-COs. The four teams correspond to the three original catchment areas (described in Chapter 5) and the additional disputed area[6]. They were like the *mun-unod* of the proposed monitoring system. In this case, the monitoring teams indicated on their respective monitoring sheets (Fig.7.10) whether a particular terrace terrace is irrigated, non-irrigated, abandoned, or eroded. I stored these data in the database. As there was no more time to gather all the personal data for this design, I made a few simple querying with the "eroded areas" and overlaid the terrace map with the classified SPOT image to demonstrate the facility in watershed monitoring (Fig.7.12).

The team leader suggested that the names of the owners and/or users of the terraces be included, as it is necessary to indicate the primary person(s) who is responsible for its upkeep. In this way, determining the area and location of abandoned terraces and responsible persons is facilitated. I used simulated data (*i.e.*, ownership data, and users or mortgage, and un-verified location of problems for hard-to-reach terraces) to give bulk to the database, and I did the rest of the querying off field after my fieldwork period elapsed.

[6] Barangay Bangaan has a boundary dispute with neighboring Barangay Anaba.

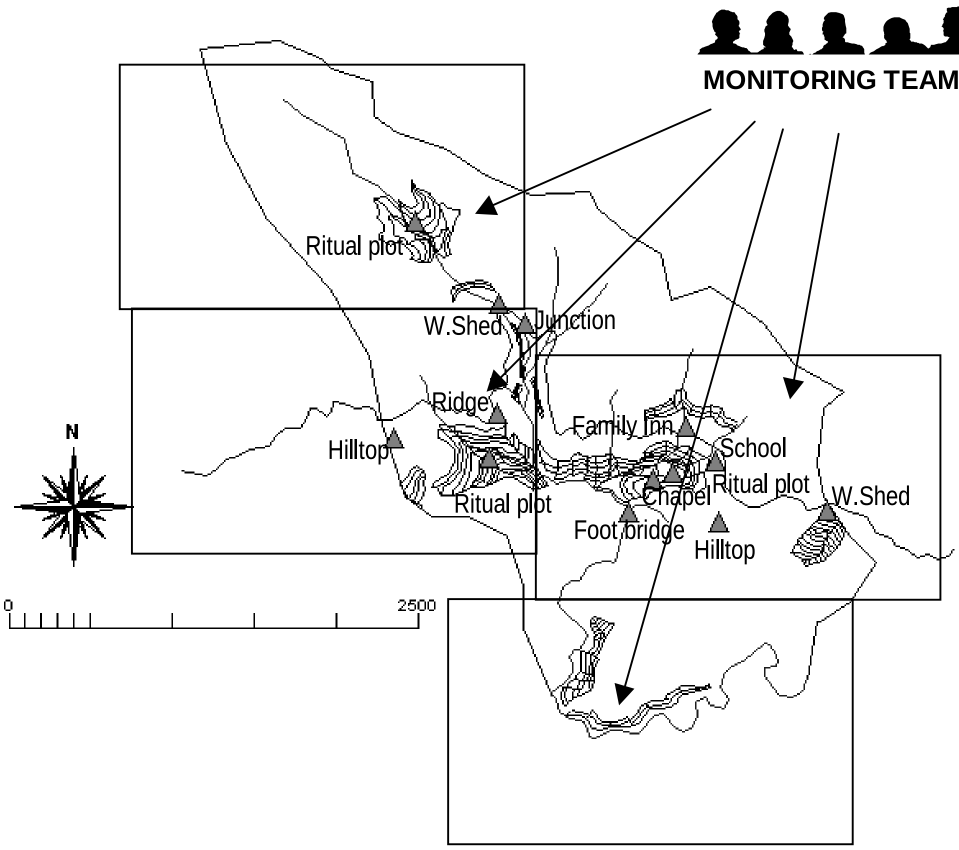


Fig. 7.9 Division of work into four monitoring teams for Bangaan.

BARANGAY BANGAAN Terrace Monitoring Sheet No.1

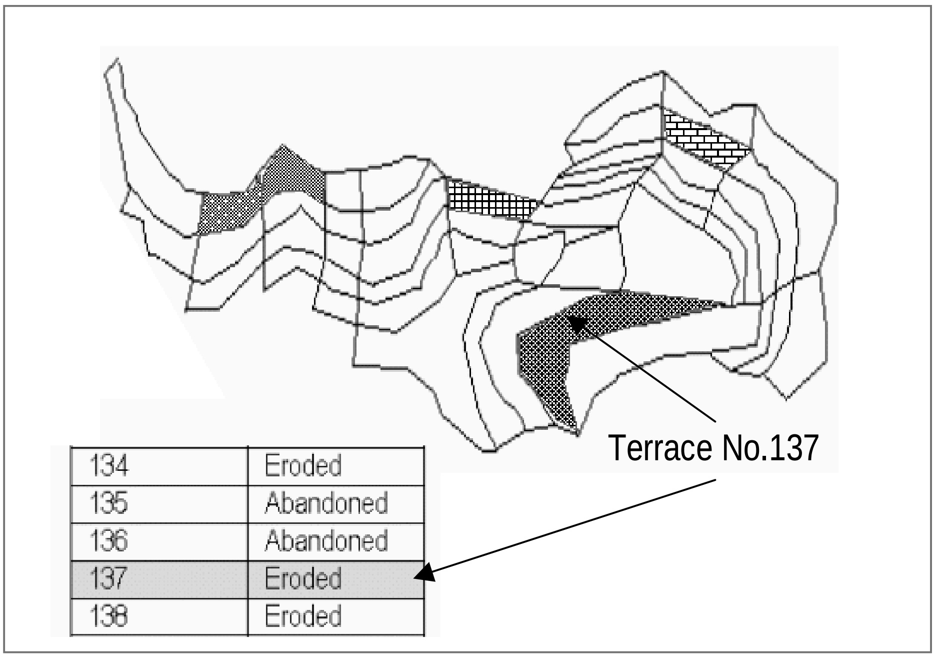


Fig.7.10 Sample terrace monitoring sheet

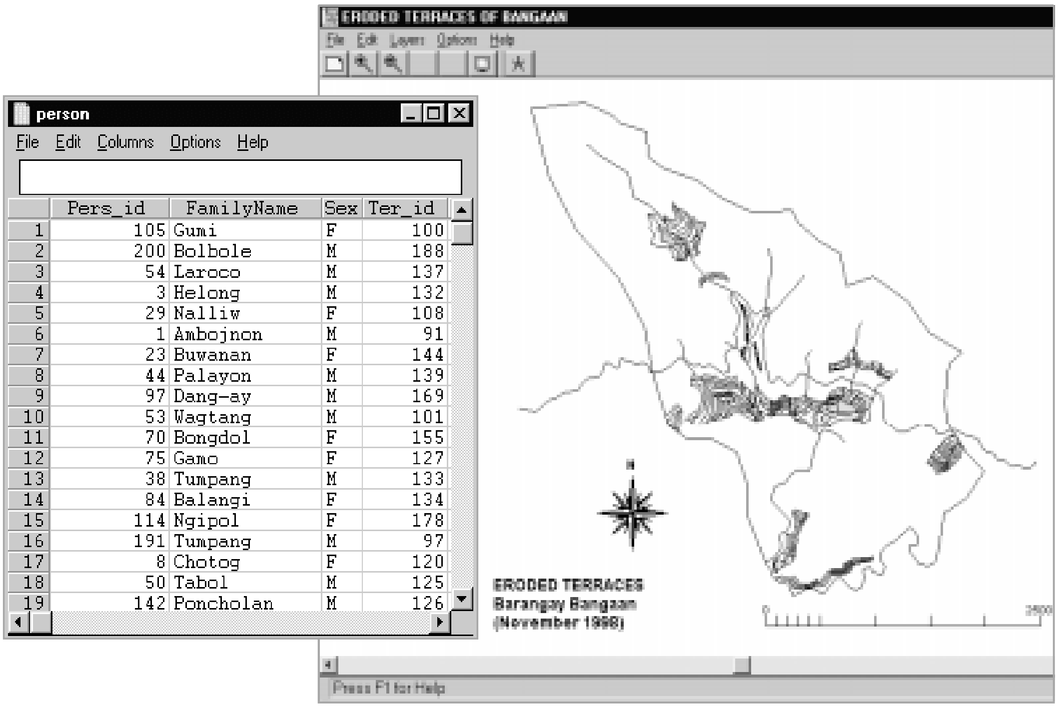


Fig.7.11 Sample database querying result shows eroded terrace map and concerned owners.

For a sample query: what area of terraces is eroded, where are they located, and who are its owners? And who are the owners of the neighboring terraces? Knowing the owners of eroded terraces as well as those of neighboring terraces (even if the terrace has no problem) is important in tracing them and/or their relatives, who can be contacted in order to start negotiations on steps to be taken to rehabilitate the whole terrace complex (*payoh-cha*). As the team leader had suggested, their availability in its repair may help avoid alleged 'favoritisms' in awarding job contracts. Concerned persons can have the chance to express their interest to work. The ILWIS program provides information from the database for each terrace polygon (*e.g.*, area, IDNo.) by simply clicking the mouse on it. For a complete listing, the querying steps are as follows (see Fig. 7.11 for the output map and table):

1. Look-up from Table Problem the Prob-ID for Eroded (1)
2. Determine from Table Ter_Prob the Terr- IDs with Prob-ID = 1
3. Display Terrace map showing the terraces with Terr-IDs obtained in (2)
4. Determine the total area with erosion problem (using statistics function)
5. Using the Terr-IDs obtained in (2), determine Pcha-IDs from Table Terrace
6. Using the Pcha-IDs obtained in (4), determine from Table Terrace all the other Terr-IDs posted with such Pcha-IDs
7. Using Terr-IDs obtained in (6), determine from Table Terrace all posted Person-IDs
8. Using Person-IDs obtained in (7), determine from Table Person the corresponding names.
9. Display Table Person with the selected names obtained in (8).

I overlaid the output map from this query with the landuse map of Bangaan which was obtained by interpreting the satellite image (see Chapter 6), and the result is a map showing the condition of the whole *barangay's* micro-watershed (Fig.7.12).

7.2.6 Discussion

The steps described above only illustrate the terrace-monitoring scheme due to lack of a more accurate terrace map. This can be done using large-scale aerial photographs or 1-m resolution satellite images. I plotted the location of field-measured GPS readings against the plotted points using recognizable landmarks from the SPOT image on screen (Fig.7.10), but the differences vary from 50 to 200meters. Investigating these errors calls for a different research focus.

However, these shortcomings gave way to experimenting what I may call, "on-screen sketch mapping" *i.e.,* using on-screen plotting of recognizable landmarks on images using local knowledge of the terrain as an alternative to hand-sketch mapping. The advantage is that, the plotted on-screen map is already geo-referenced thus, facilitates visual comparison and understanding of spatial relationships. For example, when draped over the DEM, an eroded terrace may be given more priority if it can provoke more damage (*e.g.,* located above the terrace complex). The team leader saw the facility to inform the municipal government about the location of more important terraces for rehabilitation, which are not being considered in the ongoing projects. Unfortunately, there was no available map of ITC's terrace rehabilitation project which can be overlaid to show the differences in priority areas.

This exercise also demonstrated the possibility of utilizing local monitoring teams whose collected data was aggregated to give a picture of the terrace situation for the whole *barangay*. Together with the landuse/land cover map that was generated using the satellite image, the result is practically a monitoring system for the condition of Barangay Bangaan's micro-watershed (Fig.7.12). This procedure can be followed in the other *barangays*, and later, aggregated for the whole town or province. The provincial board members realized this GIS facility and have taken steps in going ahead with it (see Chapter 5). The satellite image provides a sweeping monitor of forest cover, while terrace monitors account for what the satellite cannot provide (terrace-level data). One data source complements the other.

With the provincial government's consideration of this scheme for their own NRM monitoring purposes, I expect one possible problem— the bulk of the created files. My computer registers 550MB (megabytes) of data for all six *barangays* of the study area, and now has memory-size-related problems (*e.g.,* hanging, slower speed). For Barangay Bangaan alone, the accumulated files are almmost 100MB. Considering that simulated data was mostly used, a much bigger bulk of data is expected (it may reach 150MB) when this system is actually implemented. This is not a severe problem for one *barangay* as computer harddisk capacity nowadays is in the order of gigabytes; it has great implications for upscaling. Ifugao has 11 towns that account for 175 *barangays*. This means aggregated data for the province can reach 25GB.

Harddisk capacity problems in computerizing for the province can be skirted by using *payoh-cha*-data aggregation at this level, and keeping terrace-data aggregation only up to the municipal level. For example, the 329 polygons representing Bangaan's terraces can be aggregated to form 55 *payoh-cha* polygons that they are part of. This means the provincial government can opt to store a more generalized view (*payoh-cha* level) of the problem area, while the municipal and *barangay* governments can maintain a more detailed terrace-level view.

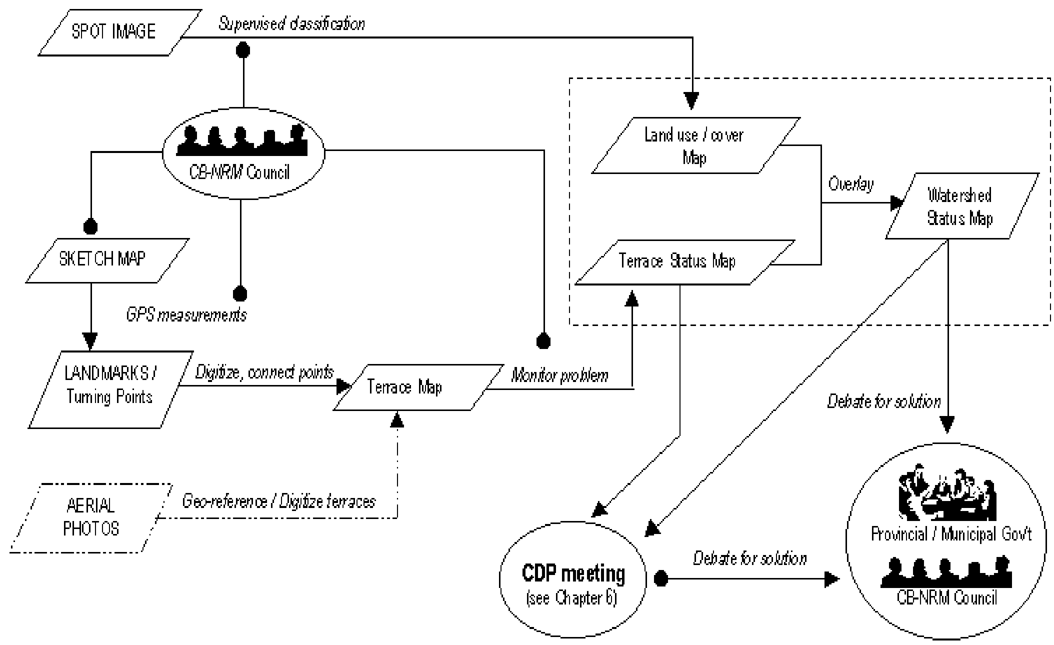


Fig.7.12 Flow chart for a *baddang*-inspired GIS-assisted watershed monitoring

Based on this exercise, Figure 7.12 shows the overall design of a GIS-assisted watershed monitoring that utilizes *barangay*-based terrace monitoring teams. The CB-NRM council will have to assign these teams. For the purposes of this research, PRRM's area team leader and CB-COs temporarily chose those that helped me during my fieldwork. Node points (—●) in the diagram indicate the activities wherein these teams can effectively participate (*e.g.,* local knowledge is needed, training with instrument use, local responsibilities). This figure takes off from the discussions in Chapter 6 about the CDP meetings, in which sketchmaps and action plans are being generated locally. It connects with the GIS-assisted CB-NRM planning cycle which I proposed (illustrated in Fig.6.7 and Fig.6.8).

Prospective use of large-scale aerial-photographs (or 1-meter resolution satellite image) for a more accurate terrace map is also indicated (dotted arrow in in Fig.7.13). Once this terrace map has been completed, the future activities in effecting monitoring (dotted box in Fig.7.12) will revolve around updating terrace status and combining the information with those that regularly come from supervised classification of satellite images (see Chapter 6). As shown above, this yields the watershed status map. Local and provincial NRM actors can debate about more clearly defined areas (*i.e.,* more definite location, landcover/landuse at such location, and magnitude) and work for a common view on how to use or take care of it.

Ifugao's traditional terrace monitoring system of the *baddang* and *mun-unod* offers valuable lessons in timely collecting and disseminating iinformation. Modern GIS technology can play a role in setting up and strengthening a *baddang*-inspired monitoring system for present-day purposes. Although initially seen by local participants as a "mapping" or "drawing" tool, the capability of GIS in spatial analysis can be appreciated later, after more interactions, and after the proposed design is fully implemented. This research has laid the groundwork for this appreciation.

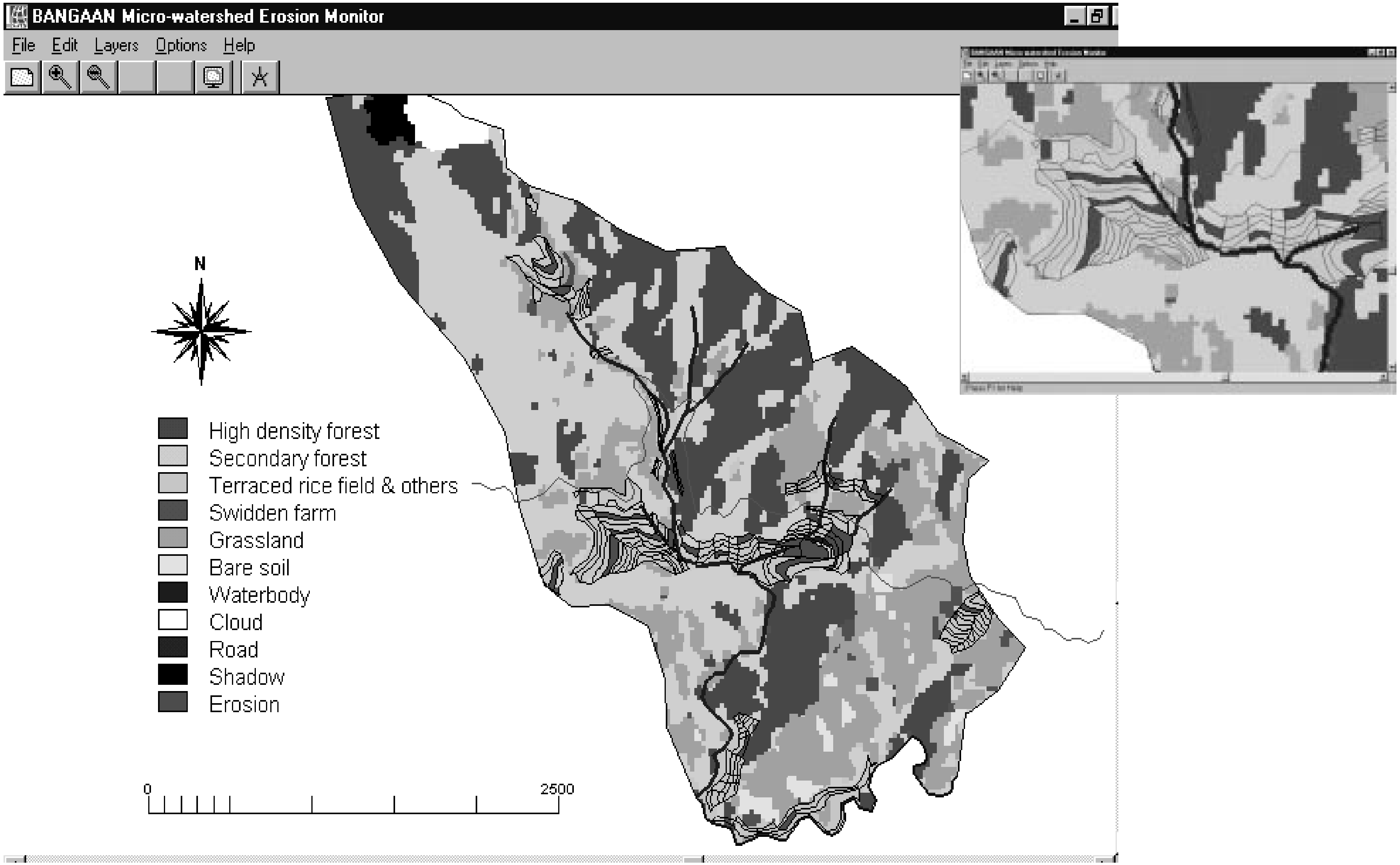


Fig.7.13 Combining *barangay*-based terrace monitoring and remote sensing for total watershed monitoring (inset: enlarged view of middle portion).

7.3 Reforesting Barangay Ducligan

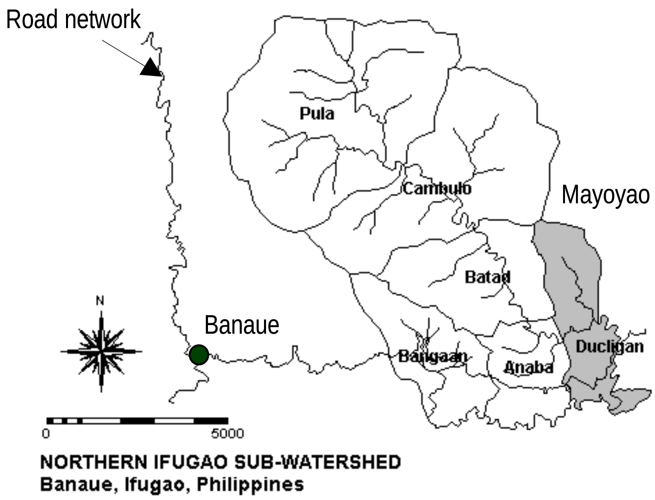


Fig. 7.14 Location of Barangay Ducligan

Ducligan is located around 20 kms. East of Banaue town proper and is along the provincial road that connects the municipality to Mayoyao. It has the lowest elevation (from 1,400m to 413m) among the *barangay*s of this study area (Fig. 7.14) and has about 734 hectares of mostly grasslands. It is often compared with its poor neighbor, Barangay Anaba, but it has the advantage of being located at the foot of the sub-watershed where meandering rivers converge and thus, provide a steady supply of nutrient-carrying irrigation water to its wide riverside terraces (only the lower terraces). Farmers of these lower terraces could grow two rice crops (higher-elevated terraces rely on rainwater), which in 1994 produced enough to for its population of 896 (PRRM 1994). In 1996, the population grew to 1,002. Informants say they are buying commercial rice from town.

Fig.7.15 Meandering rivers and deforested hills of Ducligan.

Ducligan operates one elementary school and one secondary school— the Banaue National High School, which also serves students coming from the other *barangay*s of Banaue and the neighboring town of Mayoyao. Thus, the place is bustling with school-related activities and sporting tournaments that add to its socio-economic growth. It is not a priority area for the ITC's tourism-oriented projects, but the local people feel that the village hot springs can be a tourist attraction.

7.3.1 An organized lot

PRRM began its Ducligan area development work in 1990 and found a degraded environment (eroded and deforested) and poor people struggling to survive (PRRM 1993). With the sorry state of their forests, lack of irrigation water for higher terraces, rat infestations, while not being a priority area for government-sponsored projects, Ducligan had to practically fend for itself. Thus, it has developed a local organization. In furthering their development, PRRM capitalized on local traditional cooperative and mutual support systems such as the following:

fadchang	-	rendering voluntary services among themselves
ubfo	-	labor exchange in farm and irrigation work
changa	-	voluntary services in house construction
hachang	-	cash or kind support for sickness or death
fohan[7]	-	cash or kind support for court litigation or bail bond

PRRM aims to strengthen and consolidate these cooperative practices and mechanisms through the sustainable rural district development program (SRDDP). It was able to help organize the Ducligan Community Development Association (DCDA). It has a membership of 127 men and 50 women from 177 households comprising almost 80% of the total number of households in the *barangay* (PRRM 1997). Several PRRM-assisted self-sustaining livelihood projects of this association are in operation (*e.g.*, integrated crop-fish-duck production[8], village pharmacy, alternative trading and marketing cooperative).

PRRM strongly cooperates with the Ducligan Barangay Council, which formulated a comprehensive community development plan and organized the community associations and project committees in spearheading substantial community mobilization for development activities. One of their plans is to regenerate Ducligan's watershed area. With alternative livelihood and health projects initiated, the present challenge is to reforest its barren mountains to conserve the soil, and restore the watershed and its wildlife.

Fig.7.16 Integrated rice, fish (and duck) culture.

7.3.2 A burning issue

During my discussion with the *barangay* elderly, we talked about Ducligan's deforested hills. The first reason for deforestation, which they pointed out almost in unison, was that fire from traditional *uma* or *kaingin* (slash-and-burn farming) had caused its destruction as can be seen from the black, ashen slopes. Yet, when reminded that the practice has been going on for thousands of years by their ancestors who managed well in the olden days, individuals narrated several other causes.

[7] With the *fohan* and *hachang,* a person-in-charge collects the cash-or-kind support from everyone, (varying from a few to a hundred pesos to several chickens or rice) in order to tide over the crisis.
[8] In this set-up, the middle portion of the adopter's terrace is fenced-off to keep the fish and the ducks in; a small shed at one end provides shelter for the ducks. Sometimes, no ducks are raised and the whole terrace perimeter is fenced to keep the fish in (in which case, the whole terrace can grow rice).

Teresa Bongao, 48, noted that most of the time these days, "fire-lines *(lugid)* are not done anymore." She was referring to the old practice of clearing the perimeter of the *uma* before burning in order to contain the fire within and prevent it from spreading into adjacent areas. Especially when the wind blows, fire quickly spread all over without this precaution. "I do not know why it is not done anymore." Nobody could offer a reason, except that "Some people now are just too lazy to do it"— the general comment ascribed to the new generation of Ifugaos. It can also be attributed to the general lack of farm hands to do the clearing these days, as more young Ifugaos prefer off-farm work.

Bennagen (1983) has made a comprehensive two-volume study of swidden cultivation in the Philippines and the government's efforts in stopping the practice. It was traced to as early as 1874 with the Spaniards fining swidden farmers and formulating the decree called "Definitive Forest Laws and Regulations." Later, the Americans' 1901 "Kaingin Law," meted much stiffer fines including imprisonment. Despite all these measures, *kaingin* remains. In 1964, the National Conference on the Kaingin Problem admitted that (*Ibid.*):

1. forest destruction is caused not only by swiddening but also by irresponsible logging;
2. swiddening is not an isolated problem but one related to the other aspects of poverty and socio-economic problems of the country;
3. the government's approach has been purely punitive and remedial;
4. what is needed is a sustained and coordinated socio-economic approach.

A change in government policy towards *kaingin* has taken place. Distinctions are now being made between *kaingin*s made by inexperienced, migrant poor and those made by indigenous, forest-dwelling tribal Filipinos whose *kaingin*s have prospered for generations among luxuriant mountains (BFD 1982).

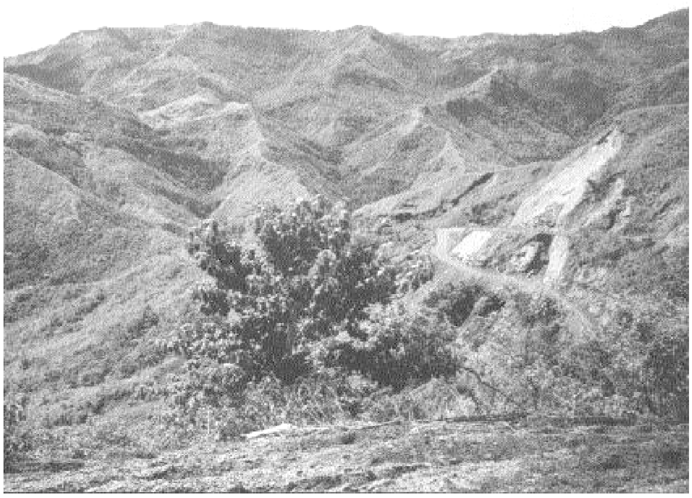
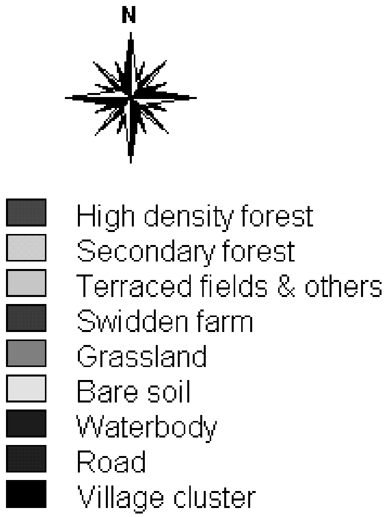


Fig.7.17 Road construction-induced landslides.

I clipped Ducligan's area from the classified SPOT image to focus on the serious status of its resource base (see Fig.7.18a). Landslides are rampant in the area due to a careless road construction method (Fig.7.17).Unsupported exposed earth eventually give way after mountain slopes are scraped off for leveling and bulldozed over the ravines below. This leads to more landslides further on. Also, Burning of trees and shrubs during swiddening exposes the earth for some time before planting starts. This helps explain the big occurrence of bare soil (77has.) in Ducligan's landcover/landuse map. However, it also has to be considered along with its confusion matrix-derived accuracy of only 26% (see Chapter 6).



LANDCOVER / LANDUSE	AREA (Ha.)	% Total Area
High-density forest	84.1	11.5
Secondary forest	182.9	24.9
Terraced rice field and others	96.4	13.1
Swidden farm	35.1	4.8
Grassland	297.5	40.6
Bare soil	20.7	2.8
Waterbody	16.9	2.3
TOTAL	**733.6**	**100**

(a) Landcover / Landuse Map **(b) Map POTNL** **(c) Map DUCREFO**

Fig. 7.18 (a) Ducligan's Landcover / Landuse map for 1997 derived from classifying the SPOT image
(b) Potential areas for reforestation (grasslands and bare soil areas).
(c) Priority areas for reforestation conforming to some CDP-criteria (tree-less, moderate slope, distance within 500m).

Table 7.7 Ducligan's preferred tree species for reforestation and some of their specific growth requirements (LUR)[a]

SPECIES	CLIMATE				SOIL				
	Altitude	Mean Ann. Rainfall	Mean Ann.Temp	Dry season	Texture	pH	Drainage	Depth	Fertility
Gmelina *(Gmelina arborea)*	0-800m	1000-2500mm	21-28°C	2-4mo.	Light Medium Heavy	Neutral to acid	Free draining moist	Moderate (50-150cm)	Moderate
Mahogany *(Swietenia macrophylla)*	50-1400m	1600-4000mm	23-28°C	0-4mo.	Medium Heavy	Alkaline to neutral	Free draining	Moderate to deep >150	Low
Alnus *(Alnus nepalensis)*	1000-3000m	>500mm	19-32°C	---.	Light Medium Heavy	adaptable	Free draining moist	Moderate (50-150cm)	Moderate
Kalantas *(Toona ciliata)*	0-1200m	850-1800mm	22-28°C	2-6mo.	Light Medium	Neutral to acid	Free draining	Moderate (50-150cm)	Moderate

Box 7.1 Some characteristics of bamboo[b]

1. Scientific names:
   Bambusa blumeana; Bambusa vulgaris;

2. Morphological characteristics:
   - possesses a primary shoot without secondary growth; tree-like habit;
   - woody; complex rhizome system; branches at culm nodes;
   - petiolate leaf blades;

3. Physical and mechanical properties:
   - for *Bambusa blumeana:* when used as a beam, can support 0.5 ton; when used as a column, can support 4.0 tons

4. Durability:
   - low (because of susceptibility to insects and pest attacks but can be treated to improve durability);
   - untreated can last for 3 yrs outdoors; can last for 7 yrs indoors;
   - can last 10-15 years when exposed to fumes or burning fuels

5. Soils:
   - well drained sandy-loam to clay-loam;
   - at least 30 cm depth;

6. Elevation:
   - sea level to 1,500masl
   - clump-forming species in low and medium alt. climbing species in higher areas

Box 7.2. Some characteristics of vetiver grass[c]

1. *Scientific name:*
   Vetiveria zizanioides

2. Morphological characteristics:
   - erect grass with stiff stem; can stand up on deep water flow
   - massive fine root system without rhizome; difficult to dislodge

3. Physiological characteristics:
   - tolerant to extreme climatic variation (drought, flood, temperature)
   - able to regrow quickly after adverse conditions
   - tall (80cm) grass stem provide shade for pasture animals

4. Soils:
   - from highly fertile black earth to poorly structured and infertile soils
   - olerates wide range of soil pH (3.0 to 9.5)
   - olerates wide range of toxicity (Aluminum, Manganese, saline, heavy metal; acid sulfate)

5. Strength:
   - strong fine roots penetrate and provide binding agent to soil
   - can grow vertically on 80% slope

[a]Webb, et.al. (1980), A guide to species selection for tropical and sub-tropical plantations. FAO - ECOCROP Database of Crop-Environmental Requirements.
[b]TRC (1994), Bamboo and bamboo products. Makati: Technology Resource Center.
[c]Truong, P. (1999). http://www.vetiver.org/truongoverres.htm

accuracy of only 26% (see Chapter 6). Ocular observation as well as the feature space (Fig.6.18) also show that bare soil class overlaps with grassland and terrace classes. To get around these overlapping problems, I re-classified bare soil areas which are more than 200m from the road as grasslands after considering road-widening patterns.

Ducligan's forest badly needs replanting. Ben Tugguin, the former *barangay* captain (now provincial board member), was not surprised by the small amount of forest area when I showed him Ducligan's landcover/landuse map (Fig.7.18a). He had been trying different ways, through Barangay Ordinances[9], to replenish the forest. As attested by other informants, Ducligan's forest condition before was much worse than the present (pers.com Mr. and Mrs. Cuyup 1998). We discussed and agreed that the indicated swidden area on the map may not only be 31has. on the ground, because the swidden cycle also includes the development of grasslands and shrubs (33% of the total area) during the fallow period.

As I observed, I believe that intensified wood carving activities can be an important factor for the continuing decrease of Ifugao's forest area. This is because firewood supply is often derived from smaller branches of trees (not the main trunk), fallen twigs, and wood carving residues. People are also using liquefied petroleum gas (LPG) and kerosene for fuel. However, in going from one study area to another, I usually observe two or three men in the forest working on tree trunks that are cut into one- or half-a-meter lengths with a chain-saw. These are carried away on their shoulders to be carved later into figurines targeted at tourists and the export market. Indeed, with the promotion of Ifugao as a tourism area, woodcarving and furniture making have flourished despite its dwindling sources of wood (ITC 1994). Although woodcarving is a good source of income, the problem is that replenishing the fallen trees is being neglected. Nobody can explain to me why *pucho* (selective cutting and replanting of trees) (INDISCO 1993), is not being done anymore. I believe the people are now going after quick income-generating activities, as they need more cash. Table 7.3 is the list of registered cottage industries in Ifugao, and shows that most of them rely on the forest. If one considers that many other activities are not officially registered, one gets an idea of the scale at which the forest is being exploited.

Table 7.3 List of (registered) cottage industries in Ifugao

TYPE OF INDUSTRY	No. of ESTABLISHMENTS	LOCATION (town)
Woodcarving	32	Banaue, Hingyon, Hungduan, Lagawe
Handloom & woodcarving	17	Banaue
Weaving & woodcarving	1	Banaue
Antique & woodcarving	2	Banaue
Cogon & woodcarving	1	Banaue
Basketry & woodcarving	1	Banaue
Furniture	5	Banaue, Lagawe, Kiangan, Lamut
Mat weaving	1	Hingyon
Bronze product	1	Banaue
T-shirt making	1	Lagawe

Source: Department of Trade and Industry (PPDO 1996)

9 For example, not to disturb (cut) the trees along waterways and spring points; obligating irrigation beneficiaries to plant 100 tree seedlings per year; obligating couples to plant 6 tree seedlings each before a marriage permit is granted.

7.3.3 Greening Ducligan

Ducligan's community-based NRM council (CB-NRM council) and the Barangay council have joined their efforts in reforestation. Among others, they spearheaded the following activities:

- identification of approximately 10 hectares of forest for protection;
- identification of approximately 15-hectare reforestation area;
- establishment of a community nursery in cooperation with the DENR

Results form these reforestation attempts (see Table 7.5) were unsatisfactory with a 20% survival rate and stunted growth of trees (PRRM 1997). They are now finding ways to improve the results of their efforts.

I joined the CB-NRM council's community development planning (CDP) brainstorming meeting, in which 11 representatives coming from 9 sitios (out of 16) participated. It was chaired by the local CBCO (community-based community organizer). Three PRRM staff were also present. They analyzed their previous reforestation project (see Table 7.4) that failed their expectations. They criticized the failure of the monitoring teams in overseeing the growth of newly transplanted seedlings (*e.g.,* maintaining soil cover around the seedlings to keep upright) and they resolved to make it better. They discussed about the lack of water and searing heat of the El Niño. Their discussion circled on the general lack of water, which is attributed to the general lack of trees, and the lack of water that limits the growth of trees they had planted. They did not mention the suitability of the species to the type of soil.

Table 7.4 CDP-participants' analysis of Ducligan's 1996 failed reforestation

PROBLEMS	CAUSES	ACTION
20% Survival rate	Lack of water (+El Niño) Not monitored Eaten by insects Dried by the sun's heat Burned by fire from *kaingin* Infertile soil[10]	- Frequent monitoring - Put shade[11] for protection - Transfer to another area
Stunted growth	Infertile soil Shallow soil	Transfer to another area Transfer to another area

While the effect of the 1997-98 El Niño was really devastating for the whole country (PDI 1999), I also volunteered information about the difficulties in their chosen tree species, gmelina *(Gmelina arborea)*: it is a broad-leafed tree species, and so it needs much water in order to survive; the amount of water it consumes can also deprive other crops. It is a favorite in reforestation projects (even with the DENR[12]), because it is a fast-growing tree. Another reason for its popularity is its resilience—even when burned, the stump would continue to grow after some time. However, the quality of the wood it produces is poor and is commonly used to make paper (it is also called "paper tree").

[10] Soil fertility is actually established based on the performance of the planted tree seedlings.
[11] Banana tree sheaths and leaves on top of the transplanted tree seedlings.
[12] The DENR actually introduced the Gmelina in its reforestation projects in Ifugao (pers.com. Manong Albert 1998).

The CDP participants discussed about other alternative species to use. They agreed that these are the common tree species found in most of Ifugao, and are considered adaptable to this environment. Their seeds are also easily available from commercial nurseries:

- mahogany *(Swietenia macrophylla),*
- pine *(Pinus kiseya),*
- alnus *(Alnus japonica/nepalensis),*
- rain tree *(Samanea saman).*

They also mentioned other indigenous tree species, but they require additional efforts in seed and seedling collection, because they are not commercially available:

- *kalantas (Toona kalantas),*
- *hawili (Caediaeum variegatum),*
- *dalipawen (Alstonia scholaris).*

For reforestation projects, PRRM solicits funds and procures the seeds or seedlings from commercial nurseries. Then, they are distributed to the *barangays.*

I suggested using bamboo *(Bambusa blumeana* or *Bambusa vulgaris)* for the reforestation project. This is because bamboo is said to belong to the grass family *(Graminae)* and therefore grows on any type of soil as long as there are at least 30 cm. of it (pers.com.Alfonso 1998). A contact person was willing to train (for free) anybody who wants to learn how to propagate bamboo seedlings. In contrast, timber and fruit-bearing trees require some specific soil types and need to be taken care of. The only disadvantage of bamboo is that other plants will not be able to grow around it because of its extensive shade and its towering height (10-25 meters). However, "if the purpose is to reforest the vast Philippine uplands, which are mostly eroded, barren or cogonal areas, then bamboo is the best species to use" (pers.com. Alfonso 1998). Bamboo trees can be observed thriving in some areas around Ducligan and have served many purposes (channeling water, fence, bench, etc.), but it has been taken for granted in reforestation projects. Nobody could say since when those bamboo trees have become part of the Ducligan landscape. I thought it would be worth considering propagating its growth as it poses no problem with soil types.

I asked a PRRM staff member, and she said that the CB-NRM councils do not usually consider soil types in their reforestation projects. They simply agree upon the tree species and identify accessible tree-less areas for reforestation. This time, Ducligan's CB-NRM council is more carefully selecting areas conducive to their growth (*e.g.,* deeper soil, *mataba* or "heavy" soil). During the meeting, they also considered moderate steepness to compensate for the effects of erosion during the rains on the growing seedlings. Aside from these plant requirements, they considered proximity to the residences or fields of the monitoring teams (I estimated around 500m based on their pointing) in order to increase monitoring frequency. I listed down these CDP-participants' criteria which clearly involve spatial analysis:

- tree-less area
- deeper soil
- heavy soil
- moderately steep
- proximity to residences and fields

7.3.4 Location of reforestation

I took stock of the data I have that can help in selecting possible sites for Ducligan's reforestation project. I also translated the CDP criteria into attributes of the unit area used in official mapping of natural resources (Table 7.5). As there was no available information in the field about the soil characteristics required by the particular tree species they will use (such as pH, texture, and drainage), I did not use them yet in the site selection (I considered them later off-field, when I got hold of more data). I already made the slope map (derived from the DEM) and the 1997 landuse/landcover map from the classified SPOT image. I also made a 500m-distance map of the *sitio* and terrace field (see ILWIS® 1997:282 for the procedure).

Table 7.5 CDP-participants' reforestation site selection criteria

CDP CRITERIA	SOURCE MAPS	EQUIVALENT MAP AREA ATTRIBUTES
Treeless	Landuse/cover map	Landcover = grassland, bare soil
Deeper soil	Soil map	Soil depth ≥ 50 cm
Heavy soil	Soil map	Soil texture = loam/ clay-loam/ sandy-loam
Moderately steep[13]	Slope map	Slope < 50%
Proximity to *sitios* (within 500m)	*Barangay* map	Distance ≤ 500m

The available soilmap (BSWM 1987) was of a too generalized scale (1:250,000). I had to make do with only two classification units, called land management unit (LMU) that describe the soils of the whole study area (Table 7.6):

Table 7.6 Characteristics of the land in Ducligan *(adapted from BSWM 1987)*

	LMU 114	LMU 142
Parent material	Meta-volcanic rock	Meta-volcanic rock
Texture	Clay-loam surface	Clay-loam surface
Fertility level	High: OM (%) 1.32 – 5.85 P (ppm) 2.45 – 72.10 K (ppm) 1.76 – 136.5 Ca 4.75 – 35.75 Mg 2.5 – 6.0 BSP 14.5 – 85.0 CEC 6.0 – 53.10	High: OM (%) 2.4 – 12.5 P (ppm) 2.85 – 44.94 K (ppm) 0.8 – 10.55 Ca 3.41 – 50.9 Mg 0.07 – 0.08 BSP -no data- CEC -no data-
pH	4.9 - 6.9 (High)	5.0 – 6.3 (High)
Depth	Shallow to moderately deep (<50m to 50 – 100m)	Shallow to moderately deep (<50m to 50 – 100m)
Drainage	External: moderate Internal: moderately well drained	External: moderate Internal: moderately well drained
Slope	30-50%	30-50% or more
Erosion	Slight to severe	Slight to severe
Flooding	None	None
Elevation	200-500 masl	> 500 masl

[13] The FAO Guidelines for Soil Profile Description (1977) defines "moderately steep" as 13-25% slope. However, most of the study area have slope greater than 25%; the term is relative to the local inhabitants'standard of steepness. I therefore interpret that it corresponds to FAO's <50% standard.

Using these available data and the CDP-criteria, Fig.7.19 illustrates my procedure in querying the database (as described in Chapter 6) for helping identify Ducligan's priority reforestation sites

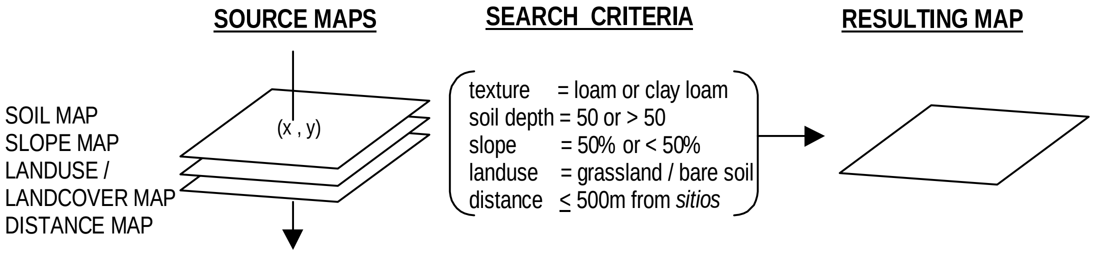


Fig.7.19 Schematic diagram of the site selection procedure

Fig.7.20 Ducligan's SALT project and reforestation sites.

In this procedure (Fig.7.19), I first generated the map of all the bare soils and grassland areas from Ducligan's 1997-landcover/landuse map (see Fig.7.18a), because the reforestation project is directed at these areas. These tree-less areas represent the potential reforestation sites (Map POTNL), with a total of 317.7 has. (see Fig.7.18b). I showed to the PRRM staff and the CBCO the subsequent searches on Map POTNL using the CDP criteria (see Table 7.5). This search yielded the areas (Map DUCREFO) that satisfy these criteria (see Fig.7.18c). The staff and CBCO were not as receptive as I had expected, and so I had to explain what the computer has done. I repeated the procedure and explained each step until they realized that the resulting map (DUCREFO) represents "priority reforestation areas" that meet their criteria. The area team leader became more enthusiastic with the procedure and results. We oriented ourselves using landmarks, such as road and river bends, with the map and pointed at the corresponding areas on the field. I also reminded her that other areas farther away (not visible from where we were standing, but indicated on the map) also satisfy the criteria. One of the staff asked me if it is possible that their project partners (*e.g.,* funding agencies, DENR) have access to satellite images. When I said it is possible, she said, "Then they can monitor the progress of our reforestation projects from abroad!" (pers.com. Umhao 1998). This indicates that she has learned monitoring capability of a GIS-assisted set up.

I explained that the soil texture of the LMUs (clay-loam) satisfy the species requirement, and the mapped soil depth are too generalized, and so, I did not use them in database search or querying anymore. I was left with only the slope and the *sitio* and field distance criteria to consider in querying. The search yielded 84.8

has. of priority sites or 27% of the potential area (see Fig.7.18c). Although the utilized search criteria were all observable (tree-less, moderate slope, within 500m), the procedure facilitates obtaining a general view of the possible sites, even those which are beyond our view. In other words, the database guided them where to look for contiguous possible areas that meet their present and other future considerations (*e.g.*, contiguous areas, minimum size,). Most of all, the database procedure can keep track of their project results that can guide future undertakings (*i.e.*, project failures and reasons for such failures such as soil depth or soil fertility, based on project experience, can also be kept in the database).

During the next CDP meeting, the CBCO reported on the consultation results regarding the use of bamboo for reforestation. Three individuals expressed their readiness to be trained in bamboo propagation. (Later, during Ducligan's *barangay fiesta*, the vice-governor was the guest speaker and was commending the use of bamboo for reforestation). However, the CB-NRM council body reiterated that the other seedlings, specifically, mahogany and alnus be used as well in order to meet the needs of those who like to continue with the woodcarving business. These chosen species take a long time to mature, but I observed that immature trees, even with around 20cm in diameter are being felled for woodcarving. I noted that this desire to grow preferred tree species for woodcarving must be considered seriously by PRRM because, it is in conflict with their reforestation objectives. Clearly, NRM is a complex tangle of conflicting interests that must be negotiated among actors.

Tackling these choices and conflicts also involves careful evaluation and enhancement of the present capability of the land to grow those preferred species. With PRRM's help, seedlings are being solicited from concerned individuals and agencies in the country and abroad. This GIS-assisted reforestation site selection procedure helps improve the present approach in order to save money and effort.

7.3.5 Evaluation of options

As shown above, the current procedure of Ducligan's CB-NRM council in selecting reforestation sites is hampered by the lack of knowledge in considering the soil's capability to sustain the growth of a particular tree species. A systematic tool in conducting soil-crop matching is offered by the FAO Framework for Land Evaluation. It helps find the degrees of suitability of each match in order to offer alternatives to the decision-maker. What is evaluated is not the land but the suitability of the combination of a piece of land and a particular use (Beek 1978; FAO 1983). This approach has recently been improved and elaborated to give more attention to active participation of land users right from the start (Kutter 1997). However, in the case of Ducligan, the problem is not about enlisting user participation, but in adding new knowledge about the present characteristics of the soil and the requirements of the tree species. Although these species had once grown in the area, the current state of the land (denuded and eroded) has obviously deteriorated and may not possess the same qualities. Thus, the land evaluation framework offers an analytical tool to facilitate in Ducligan's trial-and-error search for tree species that could thrive in the present state of its environment. I tried to improve on my proposed GIS-assisted procedure for reforestation site selection off-field, as I gathered more data about the species requirements.

I composed Table 7.8 from several sources (see Table 7.7, Box 7.1 and Box 7.2) in order to determine the minimum requirements of the pre-chosen reforestation species, the LUTs— alnus, gmelina, mahogany, *kalantas*, and bamboo. I also considered vetiver grass because of its known usefulness in soil conservation efforts in other parts of the Philippines, as well as other countries in the region (Truong 1999). All the climatic requirements of these species match the Ifugao environment— *i.e.*, the required altitude range, annual rainfall, temperature range, and length of dry season are all characteristically Ifugao (see Chapter 1 about climatic condition of the province). However, information and consensus to grow vetiver must be done, because Ifugao farmers may not like planting grass as it provides habitat for pests.

Table 7.8 The LUTs and the limiting land characteristics for their requirements

SPECIES	LAND CHARACTERISTICS			
	pH range	Fertility	Min.Soil-Depth (cm)	Slope (%)
LUT1: Alnus	5 – 8	Moderate	50	<50%
LUT2: Gmelina	4 – 7.5	Moderate	50	<50%
LUT3: Kalantas	4.5 – 7.5	Moderate	50	<50%
LUT4: Mahogany	6 – 8.5	Moderate	50	<50%
LUT5: Bamboo	4.5 – 6.5	Adaptable	30	any
LUT6: Vetiver	3-9.5	Adaptable	30	any

My problem was getting the necessary data about the soils of Ducligan. I had the very generalized LMUs and a soil sampling results of one auger boring in Ducligan. In this case, the objective is to find a suitable match of the requirements of the chosen tree-species to reforest Ducligan's barren hills. The landuse types (LUTs), *i.e.*, the tree species, have specific requirements that are desirable for its success, called landuse requirements (LUR). This can be called the "demand side" of the species to be grown. It includes the specific crop requirements regarding soil, climate, and management. At the "supply side" are the land qualities (LQ), which consist of measurable properties of the land, called land characteristics (LC) that describe the status of the environment (soil and climate), and their manageability and/or constraints (*e.g.*, accessibility, slope, erosion). To test this procedure (off field), I considered the limiting soil characteristics (*i.e.*, minimum requirements such as pH, and depth) required by the particular tree species they use (see Table 7.7).

The soil requirements for each LUT are summarized in Table 7.8. Fertility is associated with several land characteristics such as: "nutrient availability (Na, Ca, P, K, exchangeable bases), presence of trace elements (Cu, Z, Fe, Mn) soil pH, organic matter, organic carbon, cation exchange capacity, and soil texture" (FAO 1983:217). I examined the soil test results (Table 7.9) for the presence of these elements, and it is apparent that the soil on the hill where the sample was taken has lower traces of these elements than those of the BSWM LMUs.

Table 7.9 Soil sampling results on a Ducligan hilltop

	Auger Boring No.4 (Ducligan)	
Parent material	Andesite and basalt	
Texture	Sandy loam	
Fertility level		
	OM (%)	0.72 – 1.56
	P (ppm)	5.1 – 6.3
	K (ppm)	0.1 – 0.3
	Ca	18.8 – 21.1
	Mg	3.9 – 4.2
	BSP	72 - 80
	CEC	26.2 – 30.1
pH	6.0 – 6.6 (High)	
Depth	60 cm	
Drainage	Moderately well drained	
Slope	30-50%	
Erosion	Severe	
Flooding	None	
Elevation	600masl	

From soil test taken on 15 July 1998.

Due to lack of an appropriate soilmap to base the actual fertility and depth of the soils of the database-derived reforestation sites, visual indicators through filed observation of the mapped areas (*e.g.*, informants say soil color and grass cover are indicators of soil fertility) can supplement the site selection procedure described above. This is only to show the procedure and does not, in any way assert absoluteness of the query results.

However, the lack of a desirable soilmap must not discourage using this GIS-assisted approach. In fact, it can help in obtaining very detailed information about Ducligan's soils based on experiences and findings at each project site. The big advantage of this computerized site selection process is the systematic recording of the history of the trial-and-error procedure that includes the description of the soils. This can guide future projects and save money and effort that can be directed where it is needed most. Presently, results rely on field reports and memory. In PRRM's ten years of operation in Ifugao, there is no available way to analyze the spatial character of the overall results of their reforestation and SALT projects. The proposed GIS-assisted set-up supports plotting of results as attributes of the project sites. Then, displaying the map of these results can give an overview and a general trend about tree-species performance across the area may be inferred.

7.3.6 Discussion

As was the case of Ducligan when PRRM started its operation in the area, its inhabitants are practically fending for themselves. The proposed procedure answers their need to systematize their trial-and-error site-selection procedure (see section 7.2.3), and at the same time, has the potential to place their plight and good example to the attention of the whole province. The vice-governor has noted their effort, and the possibility for replication is in place after full implementation of this set-up. The whole process of GIS-assisted site selection for particular reforestation species is summarized in Fig.7.21.

The actual testing and recording of the performance of planted species on the soils of Ducligan is value-added for this procedure. The present database can be updated with past findings from such trial-and-error projects, and a historical data will be created. For example, the areas where Gmelina did not develop substantially in the previous projects may be marked in the database so that future efforts (and therefore, database queries) can be guided accordingly. This proposed procedure actually addresses the paucity of data about the soils of the study area, which does not belong to officially categorized priority areas. Ducligan is not ITC's priority area for tourism purposes. Also, the Bureau of Soils and Water Management (BSWM 1987:6) has its own criteria in prioritizing soil survey areas:

- semi-detailed survey - for land features that are significant to man or more useful areas responsive to the needs of a growing population
- reconnaissance survey - for rugged terrain or inaccessible areas covered by thick forest

Ducligan, or the whole study area for that matter, belongs to the latter category. The proposed GIS-assisted procedure can demonstrate the viability and replicability of a *barangay*-based land capability assessment for Ifugao's area development projects.

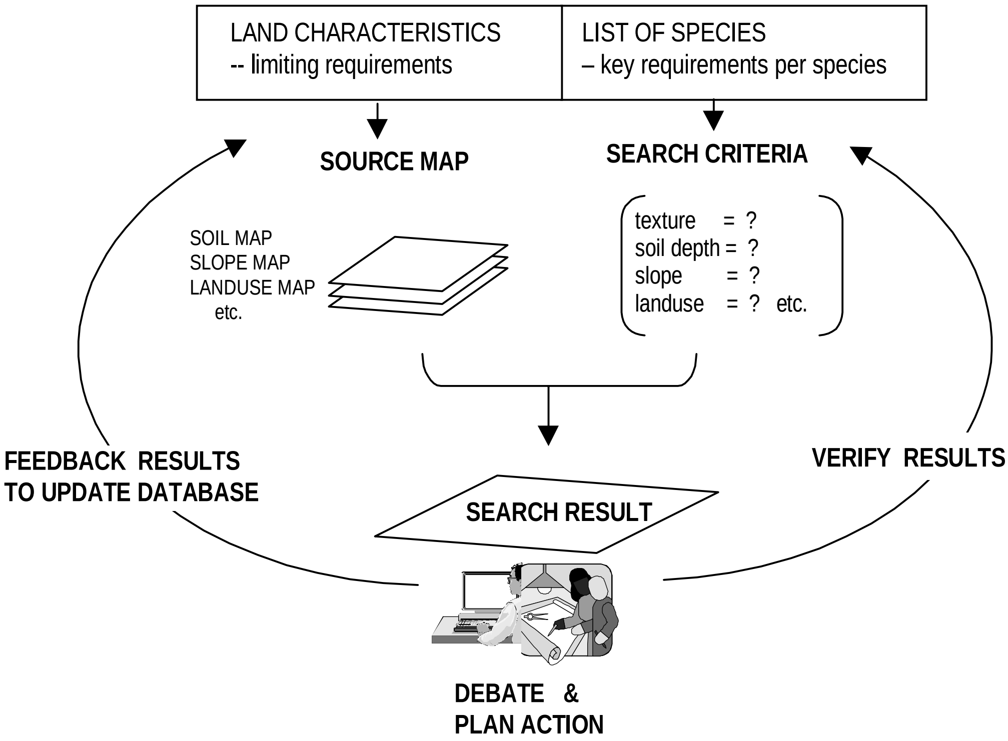


Fig.7.21 GIS-assisted site selection procedure for Ducligan's reforestation

However, as I pointed out in section 7.2.4, timber needs for woodcarving should be carefully balanced with the necessity to maintain forest cover of the hills. Soil erosion of barren hills is presently the biggest problem in Ducligan as can be seen in the big amount of bare soils and grasslands (Fig.7.18a). This compounds the general lack of water in the area. Only the lower terraces are presently irrigated. A possible water source that can fill the highest terraces was found to be about 7 kms. away (pers.com. Mr. Cuyup 1998). I believe that Ducligan's reforestation projects have to be focused on more permanently maintained forests. In viewing the classified satellite image, inhabitants of the other *barangays* jokingly accused Ducligan's and Anaba's inhabitants of "stealing from our forests." They were teasing and laughing, but they clearly understood that something must be done about it.

7.4 Summing up

These experiences demonstrated the viability of engaging local resource managers in GIS-assisted learning about their environment and jointly deciding how to improve their situation. The two cases showed the utility of GIS in supporting "double hermeneutic" in NRM. In both instances, data limitation (large scale aerial-photos for terrace map and more detailed soilmap) affected the accuracy of results, but they nevertheless became effective fora to debate the future of their environment. By understanding local activities and priorities, I have engaged the researched in designing and creating tools to reinforce them, and articulate their views with provincial NRM actors who have now taken the responsibility to see it through.

Chapter 8

Conclusion:
New channels

Young and old hands.

8.1 Introduction

This exploratory journey is not yet over. It shall go on, but I stop to view the tracks from this vantage point. Lessons need to be drawn from stumbling in the rugged terrain of such a complex real world setting as Ifugao. I was daunted at the start, but hopeful that the spatial analysis and visualization capabilities of GIS could help the researcher and researched in jointly understanding their problematic situation. In this chapter, I revisit the research objectives in order to see how far I have gone towards meeting them. That this is an exploratory research means there are no hypotheses to prove, but they can be drawn or can emerge from this study as “landmarks” that shall become topics for future research. These landmarks can shed light on the appropriateness of exploring and probing as a research approach. Lastly, I discuss key points relevant to PRRM’s area development work in Ifugao, in channeling efforts for debating the future of Ifugao’s terraced ecosystem, and the possible routes ahead.

8.2 Objectives revisited

Since the outset, I have emphasized that GIS technology is not the solution in itself to the problems facing Ifugao today. It simply offers a tool to:

- integrate spatial data from disparate sources, ranging from imagery to all kinds of geographical and alpha-numeric data, using a consistent framework (*e.g.*, providing a common geo-reference, presenting data sets as map layers, aggregating data to a scale required for analysis);
- analyze complex spatial relationships at great speed; (*e.g.*, map overlays, neighborhood analysis, network analysis)
- visualize results of computerized analysis (*e.g.*, screen display, printed maps, graphs, and tables).

As such, GIS has great potential for facilitating joint learning about a common environment. Different conceptions of the same space (or scenarios) which are difficult to verbalize or externalize can be visualized in order for people to engage in a "spatial dialogue." This ability to provide concrete representations for the "See what I mean?" expression is a key element in debating and sharing knowledge about a common space, thereby generate views which are not seen before.

The research was carried out under specific complicating circumstances:

- a very complex multi-actor NRM problem situation;
- an organization engaged in empowering local actors for NRM negotiations;
- a spatial data set of regional scale (topo-map, aerial-photos, satellite image) which may not give enough details in studying local NRM processes;
- a very promising tool (GIS) for NRM but labeled as a "top-down" technology.

Hence, I had to experiment and mix methods. The complexity of the problem situation is a challenge for facilitating the convergence of the different NRM actors to understand and improve their situation. My strategy is a learning approach, because of the need to share knowledge processes among the many actors involved, including myself. GIS, with its integrative, analytic, and visualization capabilities, offers a tool to facilitate this approach. And so, as explained in Chapter 2, the main objective of this research evolved into an exploration about participatory use and development of a GIS for joint learning about the environment:
To explore the use of participatory methods and Ifugao farmers' participation in developing a GIS for facilitating multi-actor learning about their problematic situation in natural resource management at the local level, and articulating the same at the provincial level.

In order to assess how far I have gone towards meeting this main objective, I go through each of the specific objectives as I synthesize the learning experience:

Specific objective 1
To trace the history of Ifugao's NRM in order to learn about the traditional spatial information system they used in maintaining their terrace ecosystem, and how it evolved into its present situation.

- As discussed mainly in Chapters 4 and 5, I was able to learn about Ifugao's traditional NRM practices by reading its written history, observing present practices, and interviewing its people especially the elderly. The Ifugaos are very open about their life story. Although I admit that there are aspects of their life that I cannot know, I was able to confirm and learn more than what has been written through casual conversations, and in some occasions, by joining in their NRM and social activities (*e.g.*, planting, harvesting, weeding, wedding rites),

- However, I observed that much about Ifugao's past remains as memories and reminiscences of the elderly, or else, is relegated to researchers' books which are mostly not available in their own public libraries. Only very recently did the Department of Education, Culture and Sports start including Ifugao history in the local curriculum (see Box 5.1 in Chapter 5) to educate the younger generation about lessons from their successful ancestors.

- The most important inference I got from tracing these traditional NRM practices and institutions is their organization around a definite space— the "water district." Their management success was embodied in the institution of the *tomoná* who coordinated the responsibilities among definitive social aggregations managing corresponding spatial aggregates of this district: the family/clan for the *payoh/muyong/uma* they own, the workgroups for the *payoh-cha* terrace complex they mutually benefit from, and the *tomona* and *lupun* for the whole district that represent their territory. Coordination with other districts was effected when common resources such as open forest and water sources had to be managed. They had developed successful platforms for decision making in NRM that spelled rights, responsibilities and accountability for a definite space to manage.

- Traces of Ifugao's traditional information system are apparent from the institution of the *tomoná* with its corresponding rites, rituals and customary law for NRM and the general conduct of Ifugao life, such as the *baddang*. General attendance in such rites and rituals ensured knowledge dissemination and commitment among inhabitants of the whole community. Apprenticeship by special individuals (*i.e.*, from father/mother to son/daughter) for expertise and responsibility ensured their continuity. American colonizers who took over from initial incursions by the Spaniards caused the breakdown of Ifugao's successful NRM and the information system embedded in its traditional institutions.

Tracing Ifugao's NRM history provided a learning experience for both researcher and researched in appreciating an almost forgotten treasure of successful strategies in coping with a fragile environment. This learning exercise is absent in the present social set-up, especially so that today's is a generation captive to externally imposed education that has wronged the past. Ifugao's traditional knowledge processes in NRM offered valuable evidence about holistic management of the "water districts."

Specific Objective 2
To identify the past and present actors in Ifugao's NRM, to determine their corresponding interests, and/or changes in their inter-actions as a step towards understanding individual and mutual interests in NRM negotiations.

- Chapter 5 details how I used the E-R diagram technique to illustrate the organization of Ifugao's past and present NRM actors. It shows how "interlocking platforms" for decision making worked advantageously in the old Ifugao *tomoná*'s water district, while the present *barangay* council is loosely organized around a bigger area to manage. Juxtaposing the past and present NRM set-ups helped generate awareness of the changes for individuals in both the *barangay* and the provincial management. They relished the success of the past, and pointed out the socio-economic demands of the present (*e.g.*, the need to earn money, off-farm jobs, higher education) in addition to agricultural activities.

- Ifugao is now relying heavily on tourism-related industries (*e.g.*, tour guides, inns, handicrafts) and woodcarving, which conflict with externally-initiated terrace rehabilitation and restoration projects (*e.g.*, ITC, CECAP, PRRM) and the general effort to reforest its watershed. Local inhabitants have become accustomed to project contracts with top-down criteria. There is a clear need for higher-level NRM policy-makers to be informed of local conditions on which to base their project decisions which are sometimes not clear to the local actors.

- Traditional NRM leaders like the *tomoná* and the *lupun* closely coordinated with the workgroups to be mutually informed of the overall situation and the actions to take. Present-day NRM leaders of the *barangay* council have become implementers of top-management decisions. Also, election outcomes greatly determine favored projects to be undertaken.

Comparing past and present sets of NRM actors gives insights into motivations and constraints that they contend with. Whereas in the past, NRM actors were constituents of a closed society and were driven by communal concerns, their present counterparts have been heavily influenced by modern ways and are more driven by economic concerns. This comparison helped the researcher and the researched (*barangay* and provincial levels) to better understand the problematic change from interlocking social and physical system aggregation to the present loose organization of the *barangay*.

Specific Objective 3
To participate in and observe NRM activities of the different actors in order to better understand the processes and interactions involved and identify those with potential applications for GIS.

- Chapter 6 gives an account of my observations on how the PRRM-initiated CB-NRM councils undertake community development planning meetings and notes how they come up with project programs for the year. I identified their activity called “environmental scanning and mapping” as running parallel to the traditional *mun-unod*’s role of monitoring the watershed for problems that need collective action.

- The CB-NRM councils submit sketchmaps and written proposals for alternative livelihood projects to higher level NRM actors and other agencies for support. On the other hand, government projects concentrate on the rehabilitation and restoration of pre-identified terraces based upon their own criteria. There is no clear channel for effective communication between their knowledge processes.

- Using the DFD and E-R diagramming techniques, I traced the *barangays’* current CB-NRM planning process and proposed a GIS-assisted set-up to responsible PRRM staff. The new set-up can facilitate the meeting of different knowledge processes in a new channel for joint-learning by aggregating local level terrace monitoring outputs for higher-level management to overview the situation.

Drawing the flow of the old and new CB-NRM planning set-ups also helped me identify the exchange of information and therefore, the basic maps needed. This drawing exercise helped me to identify current NRM processes ("environmental scanning and mapping") that have the potential to be reinforced by using GIS. Aside from that, I have identified the necessary data for the proposed scheme. Being based on the current scheme, PRRM staff viewed the new GIS-supported scheme as facilitating their process of making maps for communicating their plans with other NRM agencies. Such an initial appreciation can later extend to GIS analysis capabilities when they become more engaged with its use.

Specific Objective 4

To use participatory methods with GIS techniques in developing an NRM information system that integrates qualitative and quantitative spatial information in order to make visible the different knowledge processes and facilitate their interaction in NRM at both local and provincial levels.

- In Chapter 4, I analyzed gathered literature and found out that most previous attempts at using GIS with communities limit local participation to providing information and guiding the area surveyors. In Chapter 6, I looked for stages in GIS design procedures when local participation can be effective (*i.e.,* when local knowledge processes can better be used and local farmers can actively participate). I involved Ifugao farmers in those stages (*e.g.,* delineating boundaries, aerial-photo and satellite image interpretation, image refinement, GPS measurements).

- Local participation in GIS design activities became a spontaneous joint-learning between researcher and researched. GIS concepts that are familiar for me, such as boundaries and pattern recognition, took on new insights about meanings people ascribe to and agree upon regarding the environment. On the other hand, local farmers were able to see their place on a regional plane, and realize how better/worse they fare compared with others. They also learned new techniques (GPS, computer mapping) and thought of local applications for them (Chapter 6).

- Provincial level NRM actors recognized the potential of the proposed set-up in their own management activities— settling boundary disputes, monitoring reforestation projects, overview of terrace conditions. Recent news heralds Ifugao's GIS acquisition and utilization to monitor the terraces, and the provincial moves to learn from the historical successes of local NRM (see Box 5.2).

Meeting this particular research objective fulfilled more than the requirements for designing a GIS. It was also a spontaneous operationalization of joint-learning between researcher and researched, a demonstration of a feasible local model for watershed monitoring, and a persuasive approach to higher-level NRM actors to tap the local knowledge processes.

Specific Objective 5
To assess the present outcomes and the potential of the participatory GIS developed in Ifugao for effective NRM at local level, and for articulation with provincial managers.

- Chapter 7 details the development of a GIS-assisted terrace monitoring system which is based on the traditional monitoring system of the *mun-unod.* It demonstrates how data about terrace problems can be aggregated to show the situation in a *barangay* and further aggregated to show the over all situation for the province. The provincial government appreciated this approach, and has decided to go ahead with this set-up, as recent news reports the acquisition of GIS for Ifugao (see Chapter 5).

- As pointed out in Chapter 2, this proposed monitoring system is a form of joint-learning system, too, in the establishment of channels of communication between local and provincial NRM actors. Local views (*e.g.*, priority problem areas) can be effectively communicated as mapped data for higher-level NRM actors to learn about local situations for consideration in the formulation of projects. GIS facilitates the flow through this channel using the principle of data aggregation and integration by overlay operations.

- The possibility of operationalizing this set-up in a rural setting was demonstrated through local initiatives. One local inhabitant suggested using a current inverter attached to a jeepney battery to overcome the irregularity, or sometimes, total absence of power supply. The set-up illustrated how local people learn to adapt external technology to their own conditions and consider it as their own. They readily recommend its use when they see appropriate situations. In another instance, my GPS was being borrowed for elevation measurement.

The research was able to facilitate knowledge generation in the study area. This specific objective supports replicability of the GIS design set-up in other *barangay*s, and in scaling-up their constituents' outlook from local concerns to that of the neighborhood comprising a sub-watershed (*e.g.*, in seeing the classified SPOT image, workshop participants hypothetically joked about the thinly-forested *barangays* "stealing" trees from those of thickly-forested *barangays*). On the other hand, the very generalized view of provincial NRM actors can be given richer insights with the aggregated information (*e.g.*, the provincial board appreciated the information about the terraces).

8.3 Major landmarks

The foregoing review of the fulfillment of the research objectives does not necessarily mean that our designed GIS-assisted activities were able or will be able to solve the problems that Ifugao is now facing. We (the researcher and the researched) had simply been able to create a tool for facilitating a dialogue of ideas about the space that the Ifugaos are managing with others. With GIS at their disposal, alternative perspectives about their environment can be constructed (*e.g.*, as map layers) and discussed or negotiated (*e.g.*, as screen display, overlays, aggregation) to arrive at common knowledge, and hopefully the wisdom to act accordingly. We were also able to create a bridge between locally available data and provincial management processes in a more coherent way than what they had before. The following are important insights from this exploration:

- For joint-learning approach in NRM

Ifugao's terraced ecosystem shows a classic example of triumph of collective work. It couldn't have been built and maintained without concerted effort. This and the multi-actor character of its present problematic situation are my bases for proposing a joint-learning approach in its management. This is an attempt to enhance collective effort once more, by creating new fora or platforms to debate about improving the situation. Such learning, as shown in this research, must start with tracing Ifugao's NRM history in order for the present actors to appreciate valuable lessons from their past success— their ancestors managed effectively for centuries, and that must offer good leads to address the present situation.

I have shown the importance of learning from history and how a participatory approach in GIS use can facilitate such joint-learning processes in:

1. tracing the traditional boundaries and its significance (Chapter 6), because
   - the sub-watersheds or catchment areas follow the "part_of" and "composed_of" relationship between objects, and therefore offer convenient units for data aggregation;
   - this facilitates scaling up efforts to generate information for total watershed management;
2. tracing the traditional management unit (Chapter 5), because
   - the "water district" gives a logical approach to small area-specific, independent but inter-connected Ifugao NRM;
3. tracing the traditional management organizations (Chapter 5), because
   - the nested platforms, the *tomoná*, *ubbu*, and *baddang* became apparent;
   - Ifugao NRM encompasses management of individual terraces, but extends to terrace complexes (*payoh-cha*), and whole water districts and supra-districts that must be coordinated;
   - NRM is for a collective undertaking and not for selfish goals
   - spatial character is provided to decision making by specifying responsibility and accountability for definite aggregates of geographic space instead of imposing a single solution to an entire area;
4. channeling efforts between local and higher-level NRM actors (Chapter 7), because
   - terrace and forest monitoring system, inspired by the efficiency of the *baddang*, established a link between *barangays* and provincial government for total watershed management;
5. facilitating a joint-learning process (Chapter 6), because
   - researcher, researched, PRRM, and provincial government engaged in joint-learning and showed how GIS helps develop local knowledge processes.

- For the research method used

I was trying out a mix of methods, probing, and exploring in a joint learning approach together with the use of modern geo-information technology:

- The method started with the initial village encounter (fieldwork part 1) for reconnaissance and establishing rapport. This was done by my introduction to the key officers of *barangay* organizations, and joining in community agricultural activities and festivities. They helped me grasp the local situation and understand behavioral patterns and/or NRM decision making;
- The method continued with casual group discussions, individual interviews, focus group interviews, and triangulation methods to elicit the information from the local people regarding their traditional and current practices in NRM (fieldwork part 2);
- I joined and observed community development planning meetings, conducted workshops, and measurement surveys;
- I consulted secondary sources such as publications and reports.

I did this research as a recognized PRRM member and also as a student; the result is that people volunteered more information on how their NRM activities are done, but not on some deeper issues that affect these activities (*e.g.*, water disputes, boundary disputes). And so, I will never come to know the totality of the lives of the researched. Besides, everything is seen from one's "worldview" or "*Weltanschauung*." Doing research therefore, becomes an engagement in a socially-constructed process of knowledge production (which is inter-subjective because of cultural differences—values, meanings) of both the researcher and the researched; as such, the research cannot mirror an "objective reality."

Having followed the action-research cycle embedded in PRRM's community activities, much of this research became a by-product of an on-going development activity. My role as a researcher became that of facilitating tool creation to reinforce specific NRM activities. I did this by involving local farmers in designing a GIS around their activities. According to Kensing and Munk-Madsen (1993:79), this is "bridge-building, because something new is created from two separate things— the users' present work, and the technological options." In my effort to link participation and GIS (a research problem), I was able to build a bridge between the Ifugao's activities and technological options within the *barangay*, and between the *barangay* and the provincial government (a practical problem). However, I recognize my limitations in providing the expertise, and this highlights the need for inputs from experts of the different disciplines involved. From this experience, following are the advantages and disadvantages of using the action-research approach:

Advantages:

1. Mutual learning is enhanced, and this leads to better understanding of the situation. (see Chapter 6 on learning points).
2. Research output is relevant in supporting existing activities, and this leads to better appreciation. (see Chapter 6 on team leader reaction; also Chapter 5 on provincial board meeting).
3. Researcher and researched are engaged in the development of a product (a prototype GIS) and the process itself, and this means better grasp of the new method (see Chapter 7 on team leader suggestions for database querying; although the ability to handle the computer has yet to be reinforced by training).
4. The foundation is built for mainstreaming the product and the process, and this means better chances of getting them implemented (see Chapter 5 on provincial board meeting).

Disadvantages:

1. Researcher adjusts to the work schedule of the researched (local people have their own work schedule, schedule of meetings, etc.); the research depends on the local tempo, therefore, it costs more time.
2. Researcher assumes that the researched understood the general purpose and principles, but not necessarily the details of the processes (see Chapter 6 when team leader views GIS as a mapping tool; understanding of GIS as analysis of relationships among mapped objects will have to take time).
3. Researcher gets too involved with ongoing development work which does not directly concern the research (*i.e.*, helping in day-to-day problems and organizational problems is hard to resist).
4. Researcher is obliged to takes on roles of different disciplines which are absent in unfolding tasks (*e.g.*, forestry, soil science, etc. see Chapter 7); this highlights the need for joint-learning with different disciplines.

- For PRRM's area development work

The NRM activities of the PRRM-initiated CB-NRM councils in Ifugao are suitable for GIS applications. However, they might be more effective if they would also try to go deeper into the rich history of Ifugao's NRM to find more parallel undertakings. I believe this could better enhance local self-confidence and capacity to work collectively. From my observation, the new generation of Ifugaos are becoming alienated from their rich heritage. GIS use in a *barangay* setting proved to be possible and feasible in tracing back this heritage, and enhancing local knowledge processes.

The cost of software and data can be taken care of when a formal link with responsible agencies is established (*e.g.*, national mapping agency) to provide satellite images or carry out large-scale aerial photography to obtain data of desirable scale. Staff development to acquire the necessary skills in using GIS is definitely necessary for replicability and continuity. The local PRRM staff's initial perception of GIS as a "mapping tool" can be raised further after more exposure to its use. PRRM's Ifugao branch was undertaking a general computer training when I left. We have put in place a new tool that improves the present practice of drawing sketchmaps which are inefficient in analyzing the situation and in keeping track of valuable historical data. These paper maps pile up to house spiders and bugs in an office corner. With a GIS developed for their specific use, not only is data effectively preserved, but also more especially, it offers a dynamic approach in doing their "environmental scanning and mapping" activities.

- For poor farmer participation in developing a GIS

Poor farmers do not yet double-click a mouse, but computer literacy is not my intention. I allowed them to touch the computer to familiarize themselves with its features, but this research showed a successful attempt at combining participatory methods with GIS techniques among people having no computer skills through:

- data acquisition (sketches, interviews, E-R diagram, GPS measurements)
- data processing and analysis (photo- and image-interpretation)
- data display (communication/sharing perspectives)

Ifugao farmers became engaged in a free discussion to exchange views (making perspectives explicit) to learn more from each other's knowledge about their environment. Their participation is needed to gradually build up the needed knowledge for developing and using a GIS, and these three stages (surveying, data processing, display) remain the entry points in opening a blackbox. This is will be very useful in the near future as recent acquisition of GIS for Ifugao province reports on its use to monitor the status of the terraces and the watershed (see Box 5.2).

These recent developments can benefit from our research experience. As a researcher, I have correctly identified the entry points and space for local participation in developing a GIS (see Fig.3.3); and together with the researched, we have laid down procedures (see Fig.7.13 and 7.21) for local participation in GIS-assisted resource inventory, monitoring, debating, and prioritizing that can make a difference to their present effort. Ifugao farmers understood and trust the created tool because they were able to participate in its creation. We have demonstrated that limitations in technology know-how need not be a deterrent to engage in shaping the future of one's environment. We have paved the road just in time. The entry of such "high-tech" machines surely carries the danger of reinforcing externally planned or "top-down" development that, for a century now, has proven to be disastrous to Ifugao's more than 2,000 year-old beautiful ecosystem. However, we have demonstrated that Ifugao's poor farmers in their remote mountain environment need not be sidelined by the technology experts in town. We have demonstrated that those poor resource managers hold the key to make a GIS truly work for them and their environment.

I was inspired by the success of the early Ifugaos in operationalizing interlocking platforms for decision making about their fragile environment— a joint-learning. I was able to establish that they had their own "folk GIS" which is embedded in their traditional NRM institutions such as the *tomoná* (see Chapter 5) and *baddang* (see Chapter 7). They succeeded, showing great artistry, in using what modern people might call, "crude" technology to sustain their life for generations. But the big difference is that they were then a free people of a collectively organized society. Their social organization provided the solid foundation for the terraces. The early Ifugaos' success demonstrated to the world that the real power of a technology for sustainable NRM resides in the kind of society it operates. They demonstrated the web that enmeshes people and technology. They demonstrated a successful example of what we now call "participatory design" of technology.

- For making GIS a local artifact for thinking about the environment

GIS is a tool that literally draws in different perspectives and makes them interact through overlays. Thus, especially that we opted for a participatory approach, mutual learning by researcher and researched, and among the researched, was facilitated. New channels of cooperation and coordination were established. In the process, we have produced "documents (and artifacts for thinking) and knowledge-enabling decision-making with regard to the system and its environment" (Kensing and Munk-Madsen 1993:78).

Better accuracy of our end products is desirable, and this can be achieved with greater investments with respect to time and money on better materials and further research. But considering what the Ifugaos have at present, this research offers the most comprehensive study of their problematic situation (as of now), and has created with them a tool to help find ways to improve it. And as Kensing and Munk-Madsen (*loc.cit.*) emphasize, I would give more weight to the “knowledge developed by the people as results.” The early Ifugaos did it for centuries with an oral tradition, but their society was very cohesive then; I found them doing it now with sketchmaps, but today’s multi-actor complicated conditions are very different. I proposed a GIS-assisted process among the different NRM actors to facilitate their debate and speed up their activities. Directly interpreting a satellite image and plotting their important landmarks on it with them offered a whole new way of looking at their place (see lessons learned in Chapter 6), despite the half-a-pixel geo-referencing and 200m GPS-plotting errors, and despite the crudeness of on-screen sketching. As pointed out in Chapter 6, different purposes require different degrees of accuracy.

The more important thing is, we (the researcher and the researched) were able to communicate meanings about the fragile space in which the Ifugaos today are desperately trying to live their lives; and we have established a link for local and provincial NRM actors to effectively channel their efforts in doing so. We did it by using geo-information technology and techniques, and by using participatory methods in designing a GIS with local resource managers. We have properly addressed the research problem I have posed at the start of this exploration— *to find out if GIS can provide tools to facilitate thinking, negotiation and active social construction of natural resources in shared learning and concerted decision making about NRM.*

On a similar problem in using GIS in multi-actor NRM, a report about the attempt (in Wicomico County, Maryland) to realize the Clinton administration’s policy to “reconcile and integrate all federal agency wetlands inventory activities,” concluded that despite member-agencies’ agreement on the importance of the wetlands management policy (*e.g.*, flood control, estuaries inventory, hazardous-waste clean-up), the four data sets they used “disagree in more than 90 percent of the area that at least one of the four data sets delineates as wetlands” … and that “even if the areas were extended by 50m in every direction (buffered in GIS), the disagreement is still 60%” (Shapiro 1995:xiii, cited in Harvey and Chrisman 1998:1689:.). This report shows that “social agreement on the definitions does not result in actually delineating the same areas on the landscape” (Harvey and Chrisman, *loc.cit.*). Again, the important thing is that they were able to “moderate differences and establish a shared understanding” of the common area to be managed. “Each may understand that others use the wetlands database differently, but they all join in the common social agenda of wetlands preservation” (*Ibid.*). They cited institutional or social arrangements, standards, and shared facilities as the ‘things’ that were created in the process to carry out their tasks despite the agencies’ differences in purposes, procedures, sources, definitions, and logic, among others. In short, GIS was used as a tool for constructing a “shared reality” despite the multiple realities that exist.

In the present research, we also viewed GIS in a constructivist light; we used it to create tools for explicit knowledge creation processes among the local and provincial NRM actors of Ifugao. The foregoing example gave me some kind of a gauge for what we have done in Ifugao’s similar problematic setting. We created important “channels” or “bridges” or “social arrangements” or “platforms” for joint-learning to facilitate the debate about the environment– see Fig.3.3, Fig.5.7a and Fig.5.7b, Fig.6.6, Fig.6.8, Fig. 7.13, Fig.7.21. As the early Ifugao success in interlocking technology and society showed, the “high-tech” GIS I am introducing to revitalize their “crude” GIS (and thereby address their problematic situation), needs to thrive in such “social arrangements.” I saw the real need for a joint-learning approach. There is so much for them to learn and unlearn about their environment as a people. As they have to do it now with others, the more they need a joint-learning approach. They are faced with altered circumstances that demand new practice and new tools. However, GIS can be a “technological integrator and separator at the same time” (Harvey and Chrisman *op.cit.*:1690), hence, the need to bridge participation in designing this GIS with the Ifugaos. We demonstrated how it can be done, despite data limitations. We have laid down the first span.

- For future research

The general research path shows promise, and as discussed above, paves the way for a broader spectrum of research topics concerning the use of GIS with rural communities, or more generally, GIS and society. Further research, especially after full implementation of the GIS-assisted NRM activities we designed, can confirm the following hypotheses (or tentative conclusions) that emerged from this exploration:

1. GIS can be used for comparing NRM practices across time.
2. GIS can be used to develop local knowledge processes.
3. GIS is a tool for making tacit knowledge explicit.
4. GIS can be used to support interactive learning processes.
5. GIS can help in formulating priority village projects.
6. GIS can be used to raise awareness about and affect priorities with respect to local environmental issues.
7. GIS can be used for scaling-up local perspectives on NRM.
8. GIS can help develop other ways of seeing the same phenomenon.
9. GIS can be used to reinforce rules (*e.g.*, new ways of monitoring) in common property resources.
10. GIS can only be effective in facilitating local knowledge processes if it is built into such knowledge processes.

The last item also addresses the observation that “research in GIS rarely takes account of the two-directional flow of GIS and society” (Chrisman 1999:3). This could be influenced by the rapid development in computer technology that the GIS discipline, which is in its early stage of maturity, has to catch up with. However, we may expect interest in this direction in the near future in evaluating results of the increasing number of GIS use with communities (see Chapter 4). More investigation into the interlocking relation between people and GIS, as shown in Fig.3.3, may be able to link people’s behavior and the technology they create and use— that is, the innovative use of GIS in different settings.

8.4 Final notes

- On the future of the terraces

Ifugao water as vital resource

The future of the terraces largely depends on the ability of the people to manage its water. As informants say, “Water is the key to life, it is the key to terrace life.” (see Chapter 7). By closely observing the neat system of terraces, one would notice that they are in fact, water-management devices to produce food on steep slopes. And the early Ifugaos have demonstrated that an equally neat organization of people is needed to maintain a terraced ecosystem. They had the systems of *baddang* (construction and maintenance), *mun-unod* (monitoring), *arak* (water impounding), rules and watchers, and their organization into "water districts" to maintain this neat arrangement. Since the decimation of their forests, water remains their sole abundant resource. Being a wet region with 3,700mm annual rainfall, Ifugao did not suffer as much as the rest of the country during the 1998 El Niño (PDI 1999). As soon as the El Niño was over, abundant water began cascading down the mountainsides again (Fig.8.1). In fact, I miss the sound of the river running beneath the PRRM office. I find it silly that stores in the province are importing bottled water from factories in Manila when Ifugao can supply pure mountain spring water to the rest of the island.

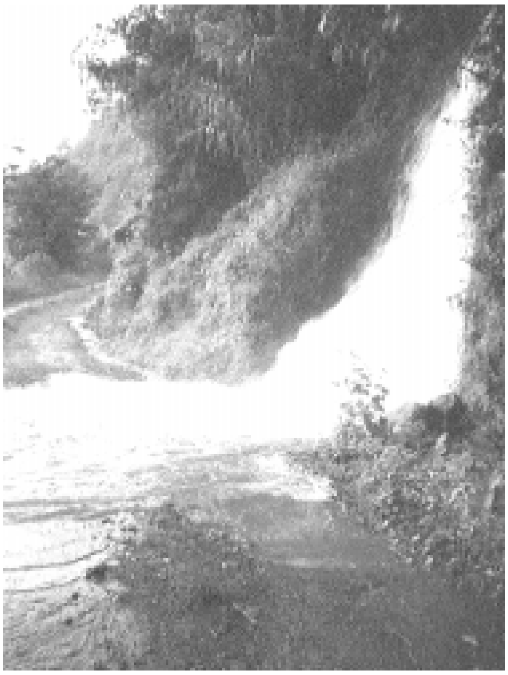


Fig.8.1 Water is the remaining abundant and vital resource in Ifugao.

The government, provincial as well as national, must be able to understand the importance of sound water management as exemplified by the early Ifugaos. As I gathered from the NIA personnel in Bangaan, the government simply provides the structures (impounding, canals) and leaves maintenance to the inhabitants (see Chapter 7). But such a detached arrangement has spoiled the people into project-job-contract dependence. The GIS-assisted terrace monitoring system may be a step to reverse this trend, as it emphasizes the need for vigilance in terrace wall and canal upkeep and the vital role of the *mun-unod* in assessing the overall condition of the structures for maintenance. Terrace walls are in fact, water-impounding devices. The El Niño springs that we have mapped must be targeted for investments in protection and enhancement as they have proven their worth at the time of extreme drought. Through participatory GIS, we have demonstrated a start in this direction. PRRM and the rest of the provincial government can take the lead in following up on this matter, as it can be easily replicated with the rest of the *barangays* by simply asking them to recall their water sources during the El Niño. GIS plays a big role in mapping them in more detail and in planning a system based on the water district and *baddang* concepts. The importance of Ifugao as a vital watershed for the Magat Dam should also be prioritized in Ifugao's overall development effort.

The recently concluded World Water Forum comes to my mind, as it emphasized the importance of "empowered multi-stakeholder basin organizations managing surface and groundwater" in order to improve the productivity of water in agriculture and have "more crop per drop" (Water Forum 2000:viii). These "basin organizations" correspond to the Ifugaos' water catchment *baddang*. Clearly, the results of our GIS-assisted learning approach in watershed management have traced that the Ifugao's age-old water management practice are in line with today's international water management thinking. This should open the minds of our NIA.

Ifugao rice as product of a heritage

I was curious about the "Basmati rice from India" which is being sold in groceries in The Netherlands, and bought a 500gm package for 3.99 Dutch guilders (80 Philippine pesos). Although people's tastes differ, I am confident in stating that native Ifugao rice tastes better and has a far sweeter aroma. The point is that a similar packaging for Ifugao rice can add value to the terraces' singular crop. Ifugao rice is solely for local consumption as it does not even sufficiently provide for that local demand. Ifugaos buy lowland rice (14 pesos – 26 pesos per kilo, depending on the varieties that range from the ordinary to fancy). Surely, "Ifugao rice from the Philippines" is more than qualified to be priced better than the so-called fancy varieties.

The manual labor spent in planting, harvesting, and hauling organically grown Ifugao rice from the World Heritage terraces should be justly compensated (see Fig.8.2). PRRM has a big role to play in organizing and establishing a network for *barangay* cooperatives' access to market such a precious product of a heritage. I am optimistic that a little research for links with the affluent neighborhoods of Manila could find a niche for packaged Ifugao rice.

Fig. 8.2 Transporting individually picked panicles of 'hand-crafted' rice.

Space for alternative crops

The Ifugao Terraces Commission has identified investment programs to address the low productivity of the rice terraces. One of the programs includes a "terrace land use zoning project" to allocate areas for "pilot testing of alternative high value crops (*e.g.*, vegetables, cutflowers) and small livestock" (ITC 1994:10). Participatory use of GIS can play a role in joint-planning for this project. It can follow the way that site-selection exercise was done in Chapter 7, where local criteria were considered in querying the database of soils, other landscape characteristics, species preferences, and manpower information. In this case, market information is needed.

Ifugao landscape as a living museum for eco-tourism

PRRM recently joined (as of 1998) in the current movement towards responsible tourism, called "eco-tourism." It is a kind of tourism that "emerged simultaneously with the rise of environmental protection movement and in reaction to mainstream commercial tourism" that often disregards its impact on the environment, hence the prefix eco- for ecological tourism (PRRM 1998:15). This movement is very significant for Ifugao, and PRRM added development issues to it, hence, the term became "ecodev-tourism" for PRRM purposes. The argument is that tourism should not be developed in isolation but integrated in the whole development process in order to keep the local community in control of tourism in their area (*Ibid.*). Commercial tourism earns a lot, but it is easily observable that the bulk of the revenues from this industry benefits big travel operators in Manila more than Ifugao; tourists come in buses (sometimes even with their own bottled water and food), take pictures and go. Local handicrafts do earn, but the earnings do not compensate for the damage to Ifugao's forests (see Chapter 7).

More importantly, considering that tourists come to Ifugao to admire the pristine beauty of its landscape, maintaining and protecting it and its poor communities must be foremost. Ifugao must directly earn from tourism to this end. PRRM came up with the idea of involving tourists in reforestation projects. Tourists will be planting tree seedlings in designated areas, and local inhabitants would take care of their growth. Participatory GIS has a role to play in this undertaking as areas are designated and progress is to be monitored. Aside from reforesting the hills, this is an opportunity for knowledge interaction between tourists and natives about trees and the environment, and each other's cultures. This could also be an opportunity for both of them to recall and appreciate the history behind the terraced landscape, which is an equally important attraction, and thereby make tourism a fruitful learning experience. The recent news (see Box 5.1) about re-directing Ifugao's elementary school curriculum is a step in this direction as the new generation themselves need to learn their history. My experience in using the computer with Ifugao farmers revealed their enthusiasm in learning about their place. This is much more worthwhile than the meaningless TV shows that they are presently being exposed to (Fig.8.3).

Fig.8.3 Local enthusiasm with the computer offers an alternative to badly done TV shows.

- On replicability

During my presentations of this research to several fora, one question (or similarly posed question) that always crops up is: "How many GIS-knowledgeable individuals will be willing to do GIS in this kind of participatory way?" or if some are willing, "To what extent can this experiment be replicated?"

In the first instance, I did not know how to answer this question, and I honestly said, "I do not know, because it depends on what the individual wants to do with what he/she learned." Then, I backtracked and analyzed that, if not for the challenge posed by Prof. Röling, "Go to the people with your GIS, and see what happens," I would not be writing this kind of thesis now, considering my original proposal. Therefore, it largely depends on the vision of a leader (in this case, a supervisor) with a commitment to do things interactively with the people. The answer can also be traced to one's education, and it does not necessarily mean one's schooling. This issue actually touched the root cause of Ifugao's present situation. When the Americans colonized our country in 1900, they brought along a shipload of teachers, established public schools throughout the country, and in the process conquered even our way of thinking. One of those teachers, Barton (1919/1969), was himself ambivalent about his mission as he attested to the alienation of the people from their roots in the process (see Chapter 1). What he saw with the Ifugaos was the successful interlocking of pristine community and habitat— where people and expertise are in touch with the ground, even literally.

This brings an interesting research topic: Whether expertise and secondary information is enough to design effective practice; whether technical knowledge and methodology can be taken separately and still be effective when practiced; or whether interactive technology design promotes better practice— as I have to keep in mind that some of this research's outputs still needs to be tested on the field before being fully implemented. Many issues will surely emerge in practice. The question also touches the issue about the new emerging role of scientists in designing participatory approaches— as shown by the literature, participatory design and participatory technology development are fast spreading (see Chapter 4). This question also touches the issue about GIS education which is also another interesting research topic. I searched the Internet to find that American secondary school students learn GIS in the field with "real world" problems. GIS is a tool for exploring our environment, and it helps a lot in finding new relationships and arrangements in real world environments.

The pages of this book can answer the second question, as I detailed the steps I did in exploring the terraces with the Ifugaos. I did it with the hardware (PC, laptop, printer, GPS), software (ILWIS), maps, aerial-photos, and a satellite image, and the determination to learn from the people about their own way of utilizing space and spatial information. And from my experience, large scale maps and aerial photographs are desirable, but their absence can be overcome by "on-screen sketching" people's understanding of their space in order to engage in spatial dialogue about their environment. At this period, GIS use still depends on a knowledgeable individual who has to direct the mouse clicks of others. But I believe that the future could bring a GIS that can be operated by touching the screen as already available in tourist offices today. The rapid developments in object-oriented programming and object-oriented databases offer much promise in this respect. And as discussed in Chapter 3 and demonstrated in Chapter 6, a constructivist approach in the development of a GIS makes a big difference in opening a black box and encouraging the development of a more effective human-computer interaction. This is an issue for further research.

- On being an isolated society

Before leaving Ifugao, Barton (1930:296) wrote:

> "There is nothing in their habitat that would lure Civilization— neither gold nor pearls nor diamonds nor camphor nor purchasing power— only bleak forbidding mountains that yield frugally at a cost of much sweat. No, nothing that we want now. But some day, if we, ourselves attain a higher civilization, we may long— and very keenly —for just such beauty spots of primitive culture as now, in our passion for making other folk like ourselves, we are destroying."

Barton's genuine regard for the Ifugaos is admirable, and I am very thankful that he volunteered to take the Ifugao assignment. I got significant leads in tracing

Ifugao's glorious past from his writings, which also revealed his resentment with what his government sent him for. However, I would not agree that the Ifugaos should be left in isolation to preserve their culture (for the curiosity of the "civilized"?). The "people of the earth" have to explore and realize that they belong to the rest of the earth. And as this documentation shows, problems arise if a powerful nation imposes and inflicts "development" on a weak people; if the ulterior motive is to rob them of their treasures and their humanity. From my field experience, I believe that external influence is not bad as long as mutual respect and sovereignty prevails. There is so much knowledge to be shared with others. Technology, even of external origin, is available to extend our understanding of this world, and it is desirable to help indigenous peoples acquire it if they find it useful. Thanks to external influence, the local farmers were able to help make my computer work in their remote rural setting (see Chapter 4).

The presence of a computer during my discussions heightened the excitement of participating farmers and curious onlookers. They were enthusiastic to learn something about a novel artifact, and what it offers them and their place. I recall two women who walked a 2-km distance to see my presentation on a bigger screen; they had seen it before, but on my laptop screen. Such enthusiasm needs to be sustained to enhance their understanding of the space they are managing; that they are now managing with others. There was lively exchange of points of view, jokes, and teasing during the meetings with them. There was pride in the ability to manage forest better than others do. Participatory use of GIS played a role in generating this awareness.

The Ifugaos' ancient skills in managing space, in utilizing spatial information, and in adapting to their fragile environment can be greatly facilitated by GIS for joint-learning to extend their understanding of their changed circumstances; for communicating this understanding with other NRM actors; for gathering support from other NRM actors and for defining responsibilities in co-managing their delicate landscape. Their landscape has become a common resource to manage since the opening up of Ifugao to the rest of the world; as it has become evident that the Ifugaos have to be compensated for converting a hazardous landscape into a productive habitat. It produces the country's staple food.

However, the Ifugaos have to re-learn and regain their dignified past which is being obliterated from their memory. As a step in this direction, we were able to use GIS techniques in tracing their traditional resource management unit, the "water district" (see Chapter 5). We were able to design a *baddang*-inspired terrace monitoring system, and systematized their trial-and-error reforestation effort (see Chapter 7). Reinforcing their world-renown tradition in soil and water conservation may help the present attempts to save their ecosystem, as well as save Magat Dam—the biggest power source of the island. We have established a joint-learning link between the *barangays* and the provincial government by demonstrating at both levels the roles they play in coordinated NRM activities that are supported by GIS technology (Chapter 5 and Chapter 7). There is much to be explored with the Ifugaos, and participatory use of GIS can help a lot in the exploration. They are not to remain an isolated and neglected people. They are a part of the greater community of peoples that must play a role in making difficult choices for the imperative of creating a sustainable society. They are, in fact, a reference in the continuous search for a more sustainable society.

Propositions:

1. "We see because we know." *Manang Virgie (Ifugao community organizer)*
   "We know because we see, we feel, we do." *Andy Clark (American professor)*

2. GIS development requires both social scientists and GIS technology professionals to reach out to each other. *This thesis*

3. Whatever technology is being introduced, the kind of social dynamics in which it will operate largely determines whether it will be empowering or marginalizing poor communities. *This thesis*

4. A process of simple, but joint, concerted action can spell sustainability for generations. *This thesis*

5. GIS is an effective tool to demonstrate the constructed nature of reality, thereby allowing divergent/conflicting perspectives to develop other ways of seeing. *This thesis*

6. ITC, with its unique combination of geo-informatics forte and delicate mission to teach and train people of developing countries, is in a strategic position to realize participatory technology designs toward a sustainable society of our fragile planet. *In getting the training and support for this thesis*

7. When trekking around treacherous ravines and terrace walls, the determination to learn from its people and a warm reassuring hand to hold on to can help overcome acrophobia. *In doing fieldwork for this thesis*

8. Colored wires and +/- signs on jacks are social constructs that do not affect the actual polarity of electric current. *In using a reverse-colored jack for a jeepney-battery-powered computer during fieldwork for this thesis*

9. Eating carrots while working with the computer will not prevent deterioration of your eyesight. *In processing this thesis*

10. "If we knew what it was we were doing, it would not be called research, would it?" *Albert Einstein*

Propositions presented with the doctoral thesis:

PLATFORMS AND TERRACES
Bridging participation and GIS in joint-learning
for watershed management with the Ifugaos of the Philippines

Rhodora M. Gonzalez
7 June 2000

Samenvatting*

Bij het beheer van natuurlijke hulpbronnen in complexe probleem situaties waarbij meerdere actoren zijn betrokken, is het essentieel dat de actoren met hun verschillende kennisprocessen eerst komen tot een gezamenlijk begrip van, en akkoord over, het probleem voordat samen actie kan worden ondernomen. Dit is het collectief leerproces voor het beheer van natuurlijke hulpbronnen. Geografische informatie systemen (GIS), met het vermogen te integreren, analyseren en visualiseren, bieden mogelijkheden dit soort processen te ondersteunen. Echter, ze zijn sterk afhankelijk van experts die het systeem ontwikkelen en het hanteren. Hierdoor wordt de participatie van actoren zonder computer vaardigheden uitgesloten. Deze beperking van GIS kan lokale afhankelijkheid van extern geplande interventies stimuleren. In dit onderzoek, heb ik gekeken naar hoe participatieve methoden gebruikt kunnen worden om GIS te ontwerpen zodat verschillende actoren op lokaal niveau kunnen leren over hun natuurlijke hulpbron, en dit op provinciaal niveau communiceren. Het ontwerpproces versterkt de collectieve inspanning benodigd voor het begrijpen van, onderhandelen over, en actieve sociale constructie van natuurlijke hulpbronnen.

Het collectief leren begon toen Ifugao boeren en ik samen de geschiedenis van het gebruik van natuurlijke hulpbronnen in het studiegebied in de noord Filippijnse hooglanden van Ifugao traceerden. Dit was nodig om te leren hoe de traditionele ruimtelijke informatie systemen hadden bijgedragen aan het succesvolle beheer van het terrassen ecosysteem dat al meer dan 2000 jaar geleden onstond. Via de gedocumenteerde geschiedenis, interviews met ouderen en visualisaties van de territoria, kreeg ik inzicht in de oude ruimtelijke verdeling van verantwoordelijkheden van de Ifugao die via onafhankelijke 'waterdistricten' liepen. Door ruimtelijk dialoog, ondernamen de boeren luchtfoto en satelliet foto interpretatie en hielpen bij the ontwerp van een prototype GIS dat gebaseerd was op de succesvolle '*baddang'* werkgroepen in de water districten. Door persoonlijke deelname aan collectieve planning van natuurlijke hulpbronnenbeheer, identificeerde ik processen die ondersteund kunnen worden door GIS, bijvoorbeeld het monitoren van de conditie van terrassen en bossen, en het systematiseren van herbebossingpogingen, die met veel vallen en opstaan gepaard waren gegaan. De GIS eigenschappen die deze activiteiten kunnen ondersteunen (bijvoorbeeld locatie selectie, data aggregatie, kaart generatie) en de rollen de actoren op lokaal en provinciaal niveau daarbij hebben (bijvoorbeeld samen condities monitoren, gekarteerde data analyseren, formuleren van plannen en beleidsmaatregelen) werden gedemonstreerd en besproken. Hiermee konden wij samen een schematisch inter-actor communicatieproces definiëren voor het gemeenschappelijk beheer van het fragiele landschap, d.m.v. het winnen van steun, het identificeren van mogelijkheden en het definiëren van verantwoordelijkheden.

Dit onderzoek leidde tot het identificeren van de ruimte voor lokale participatie in expert-afhankelijke methodes zoals GIS. Tegelijkertijd demonstreerde het de afhankelijkheid van expertise uit verschillend disciplines voor een GIS toepassing die binnen de context van een multi-actor natuurlijke hulpbron probleem kan worden ingezet. Verder werd een andere kant van GIS onderzoek duidelijk, GIS niet als kaartengenerator of datamanager, maar GIS als een collectieve constructie van de 'wereld' die we willen beheren. Dit laatste aspect is belangrijk omdat beter begrip van onze complexe wereld via het uitwisselen van diverse perspectieven kan leiden tot collectieve actie voor een beter beheer van natuurlijke hulpbronnen. Uit de pogingen om participatie en GIS nader te tot elkaar brengen onstond een interessant onderzoeksthema– 'Is expertise en secondaire informatie genoeg om te komen tot goed gebruik van door GIS gesteunde lokale ontwikkeling, of zal interactieve technologie ontwerp leiden tot betere door GIS gesteunde ontwikkeling?'

* Thanks to Irene Guijt for translating this summary into Dutch.