Chapter 1:
Seeking Sustainability: A Synthesis of Research in SANREM CRSP- Southeast Asia, 1993-98

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Origins of the SANREM CRSP

It is barely more than a decade since the UN Commission on Environment and Development (the "Brundtland Commission") presented its famous definition of sustainable development as "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs". In pursuit of that goal, the Commission identified the needs to conserve exhaustible and renewable natural resources and to ensure the conservation of plant and animal species (WCED 1987). Though these ideas were neither new nor fully articulated, the report generated a great deal of momentum for activities addressing interactions between development and environment. Some of these were research and educational ventures, many of which began to bear fruit in the mid-1990s, as can be seen in the surge of publications on development and environment in the second half of the 1990s. Others were policy initiatives both at national and international levels, the latter reaching a peak with the 1992 Earth Summit held in Rio, Brazil.

In the U.S., the Brundtland Commission report can be credited with having helped motivate some searching re-evaluations of the use of environmental and natural resources in domestic agriculture (*e.g.* Pimentel *et al*. 1995; Karlen *et al*. 1997) as well as in developing country natural resource sectors (WRI 1989; TSC and WRI 1991). The Commission's emphasis on interactions between human and biological systems also resonated with a rapidly growing body of social science research that identified tensions between the goals of social and economic development and the use or misuse of natural resources in developing countries (*e.g.* Blaikie and Brookfield 1987; Southgate 1988; Anderson and Thampapillai 1990; World Bank 1989, 1990). These studies in turn drew upon a growing set of biological research findings that quantified the long-term trends of resource depletion and degradation in upland and highland agriculture, in forests and at forest margins, and in the hydrological systems that depend on them (*e.g.*, Lal *et al.*, 1986; Lal 1990; Blair and Lefroy 1991; IBSRAM 1995, 1996). A major, and as yet unresolved, question arising from interdisciplinary work concerns long-term development in natural resource-based systems. Is there a trade-off between economic well-being and the maintenance of stocks of natural and man-made capital such that future generations will not be left worse off than today?

A key insight for the environment and development debate was that sustainable natural resource use depends critically on the private decisions of primary resource managers,[1] such as farmers and fishermen. In developing countries, these individuals are typically poor, risk averse and highly constrained in terms of access to credit, information and technology. Their behavior is driven by the desire to maximize the well-being of their household, or at best of their local community. These actions may impose social costs when legal institutions (such as land tenure laws) are imperfect or absent, when markets do not convey clear and true signals of relative scarcity, or when their actions impose costs on others through downstream effects. In this setting, sustainable development cannot be achieved merely by signing national legislation and international conventions. Operationally, to achieve global or national goals, the sustainable development community must understand the actions of millions of individual resource managers and be prepared to engage them directly.

Within the U.S. development community, the aftermath of the Brundtland Commission report saw a concerted effort to think about sustainable agricultural development in relation to the resources and skills available. This was the beginning of the SANREM CRSP. In response to a request from the U.S. Congress, the Agency for International Development (USAID) created a new Collaborative Research Support Program (CRSP)[2] with responsibility for promoting sustainable agriculture and natural resource management— hence the acronym, SANREM. USAID then commissioned the National Research Council (NRC) to recommend a design and a set of research priorities for the CRSP. In defining sustainable agriculture, this panel adopted a modification of the Brundtland Commission phrase, in which *sustainable agriculture*

[1] We use this term as a general label for individuals and groups whose decisions affect the use of a natural resource, whether forest, land or water, in some way.

[2] Collaborative Research Support Programs (CRSPs) were created under the U.S. International Development and Food Assistance Act of 1975. This Act "supports long-term agricultural research of benefit to developing countries and the United States" (NRC 1991:vii), The CRSPs consist primarily of research grants to U.S. Land Grant universities and their developing country research partners.

connoted “approaches to agriculture that provide for the needs of current and future generations while conserving natural resources” (NRC 1991: 2). The panel then defined the mission of the SANREM CRSP as addressing

> ...the need to promote integrated, multidisciplinary, research across agroecological zones, among departments and institutions of U.S. universities, and in collaboration with other institutions, research institutes, national agricultural research systems, and the international agricultural research centers. Its principal objectives [are] to foster a truly collaborative and participatory approach to the design of research and to involve the ultimate beneficiaries of the research: the small-scale farmers and rural and urban poor in developing countries (NRC 1991: viii).

The panel reasoned that previous approaches to resource-conserving agricultural development had been flawed in failing adequately to involve primary natural resource managers as active participants in the design and implementation of research and action for sustainable development. Rather than prescribe a specific model, however, the Council chose simply to recommend that the SANREM program adopt as principles a “systems” approach to agricultural and resources research, interdisciplinarity, and a commitment to broad participation by farmers and institutions. It was also strictly results oriented; the panel concluded that the SANREM research approach

> ...must take into account those factors that influence the ability of people to improve their livelihood, income and health. It must make use of and strengthen existing pools of indigenous knowledge available for the design and adoption of sustainable production systems. Research projects [within SANREM] should seek to understand how physical, biological, economic and social factors interact and must be balanced to manage agro-ecosystems in a sustainable manner. The SANREM program should primarily seek to promote research that adds to this understanding and that works with the farmer and across disciplines and institutions to fashion the tools, perfect the techniques, and design the farming systems that can shape a sustainable future (NRC 1991: 21-22).

Responsibility for the implementation of SANREM was awarded to the University of Georgia (UGA), as head of a consortium of U.S. universities, NGO/PVO organizations, and developing country partners in 1992. In the spirit of the NRC recommendations, the UGA proposal set out a broad plan for participatory, farmer-focused and policy-oriented research directed at the diagnosis and rectification of problems of non-sustainability of agricultural and natural resource use, designed and conducted in ways sensitive not only to ecology but also to economic, social and cultural conditions.

The SANREM Approach to Agricultural Development

In SANREM, the ideas expressed in the NRC report and echoed by Agenda 21 are summarized in four "cornerstones" or research design principles: a landscape approach, interdisciplinarity, inter-institutional collaboration, and participation. The first three of these principles were justified in the SANREM proposal as follows:

> We propose to utilize a landscape ecology approach to the study of sustainable agriculture and natural resource management in the tropics. We use the term "landscape" to indicate the appropriate scale of our approach, which emphasizes interactions between ecosystems. The landscape is a mosaic of interacting ecosystems with both commonalities such as soils, climate, and natural vegetation; and uniqueness, such as biodiversity, land use patterns, and socioeconomic structure. The landscape is the niche with human beings as inhabitants, and, more significantly, as manipulators of the component ecosystems. In this way, these end-users become the "lifescape" that is superimposed onto the landscape. By definition, agricultural sustainability requires the recognition of not only the complex array of interactive processes ongoing within an ecosystem, but also of the interactions among ecosystems on a landscape scale... Additional requirements of this approach include integrating scientific disciplines more fully than traditional agricultural, ecological, or social science approaches, and inclusion and integration of service groups, such as private voluntary organizations (PVOs), into the research process (SANREM CRSP 1992: 1).

The fourth cornerstone, participation, underpinned a philosophical commitment within SANREM to a relatively new view of the farmer not merely as the beneficiary of research and development, but as the central player in a set of relationships linking researchers, policy makers and resource managers. The idea of "putting the farmer first" (Chambers 1983; Chambers *et al.* 1989) was expressed operationally as a commitment to farmer-led research, or "farmer-back-to-farmer research" (Rhoades 1984). In this view research begins with farmer-led identification of a research agenda and concludes with the results of research, carried out both on-site and elsewhere and in collaboration with farmers, being returned to the community in the form of usable innovations in technologies, practices and policies.

The commitment to a landscape approach, interdisciplinarity, inter-sectoral collaboration, and participatory, "farmer-back-to-farmer" research distinguished the SANREM approach from more standard procedures for conducting results-oriented scientific research in developing country agriculture. Conventionally, projects and programs are guided by a model that helps ensure that activities fit neatly within defined stages of implementation. In the SANREM case, neither a model nor a blueprint was prescribed in the original conceptual framework prepared by the NRC panel. Indeed, the panel had written that:

> "No single, established model exists for the successful conduct of the integrated, multidisciplinary research and development efforts that the SANREM program would require. Thus, the grant program should be designed so that maximum reliance is placed on the ingenuity of the researchers who will do the work (NRC 1991: 5)."

In practice, the lack of a "blueprint" for a project committed to wide-ranging participation and cooperation across disciplinary and institutional lines meant that the early years of SANREM were characterized by an exceptionally high degree of emphasis on *process*. Among the procedural questions debated were the exact meaning of the cornerstones in a specific setting, the relationship between the cornerstone principles and scientific method, the appropriate scope and type of participation in research activities, and the distribution of effort between research and "action" (extension, outreach, and advocacy). To the extent that the project is now able to present a "blueprint" for others with similar goals, it is due to having confronted these questions in the course of implementing site-based research. We return to these points, and to an evaluation of the project's achievements and methodological contributions, in Chapters 8 and 14.

The Southeast Asia Site

Addressing site selection criteria, the NRC panel had emphasized the need to identify and work in sites that are representative of a broad cross-section of ecological conditions, and stressed that "research must be responsive to local constraints and concerns…a learning process must take place, not only at the scientific level, but at the policy level, in the host country's capital" (NRC 1991: 45). The SANREM partners identified the southern Philippines as broadly representative of upland agricultural conditions in the humid tropics, and as displaying common forms of environmental stress associated with unchecked resource exploitation. From the set of feasible sites, the Municipality of Lantapan in Bukidnon province, Northern Mindanao was chosen for a variety of reasons relating to the landscape-based approach to SANREM research (see below).

By the early 1990s the extent to which the Philippines had depleted its natural resource base and environmental quality was beginning to become apparent. A major natural resources inventory conducted in the 1980s quantified the resource base and also indicated some ways in which it was being degraded (ENRAP 1994), as did several prominent studies by international organizations (*e.g.* World Bank 1989). Total forest cover in 1995 covered only 6.8 M ha in 1995, down from 11.2 M ha in 1980 and declining at more than 3% per year; closed forest covered only 6% of land area, and none of that was classified as frontier (*i.e.* undisturbed) forest (WRI 1998). Early concerns were being voiced about the potential costs of losses in biodiversity and watershed function associated with deforestation. Irrigated area had remained essentially unchanged for more than a decade, forcing agricultural expansion into unirrigated areas; and growth of agricultural yields, and especially that of rice, the main crop in lowland irrigated areas, appeared to be reaching a plateau, after many years of increase (Cassman and Pingali 1995).

The Philippines was undergoing several other forms of change that in retrospect made it a very valuable choice of location for SANREM field and research activities. At the same time, these other changing conditions have challenged and at times threatened the integrity and viability of the project's methods and activities. Most importantly, the Philippines -- like many of its Southeast Asian neighbors -- was undergoing very rapid economic growth and structural transformation during the period before 1997, and these changes had direct implications for deforestation rates, agricultural practices, and natural resource management in upland areas. Second, as a result of earlier economic and political crises, in 1991 the Philippines began a major change in its system of government. A sweeping revision of the administrative code led to wide-ranging devolution of power and authority from central government to provinces and municipalities. Local changes in administrative and political institutions engendered by this devolution have presented SANREM with arguably its greatest challenges and opportunities in the Philippines. Ultimately, key aspects of the project's methodologies and activities underwent a transformation as a response to these changes.

From a policy point of view, the timing of SANREM's inauguration in the Philippines was propitious. It followed by just a few months the establishment, by presidential decree, of the Philippine Council on Sustainable Development (PCSD). The decree, issued in September 1992, followed the Rio de Janeiro Earth Summit by just three months. One of the major tasks with which the PCSD was charged was that of converting the global Agenda 21 document into a set of specific analyses and recommendations for action in the Philippines (subsequently published as PCSD 1997). Thus a project emphasizing sustainable development in agriculture, a key sector of the Philippine economy, was welcomed at the national level as expressing goals consistent with the thrust of national policy.

Economic Growth and Structural Change

Within rural areas of developing countries, concerns about unsustainable development are keenest "at the margin" — that is, in areas close to the cultivated frontier, where poor households farm sloping lands that are frequently poorly suited to intensive cultivation. The "margin" thus represents a constellation of ecological, economic and political conditions in which stress is endemic and the security of human welfare, soil and water resources, and biological diversity is under constant threat. Until comparatively recently, settlement and cultivation at the frontier was driven primarily by demographic change -- rapid population growth and internal migration -- in relatively poor, unindustrialized economies. Upland populations relied almost exclusively on agricultural production and gathering of forest products, and were largely subsistence-oriented. The influence of government and the market were relatively weak, indirect and subject to the vagaries of weather and the passability of roads. Land use decisions, land expansion and agricultural technology were, therefore, largely driven by local demographic, economic and biophysical conditions.

Assuming, perhaps, that these conditions continued to apply uniformly in developing countries, early SANREM documents justified the choice of a regional research site in the Philippines largely on the grounds that its ecological conditions and state of agricultural development were broadly representative of Southeast Asian conditions. However, it quickly became clear that by comparison with other regions of the developing world, the Philippines and Southeast Asia offered another distinctive feature: the unusually rapid pace of their economic development. In this region of the developing world, economic conditions have changed fundamentally within the present generation, and sometimes in the space of just a few years. In the early 1990s the Northern Mindanao region as a whole experienced an accelerating rate of economic growth, matching that of the Philippine economy as a whole (Fig. 1.1). In addition to raising average incomes, growth was accompanied by improvement and expansion of infrastructure, markets, financial systems, and educational opportunities. Interregional and intersectoral labor mobility has increased. Rapid growth of urban population and employment, spurred in part by the globalization of trade and investment, generated high rates of demand growth for consumer goods, including an ever-increasing variety of agricultural products.

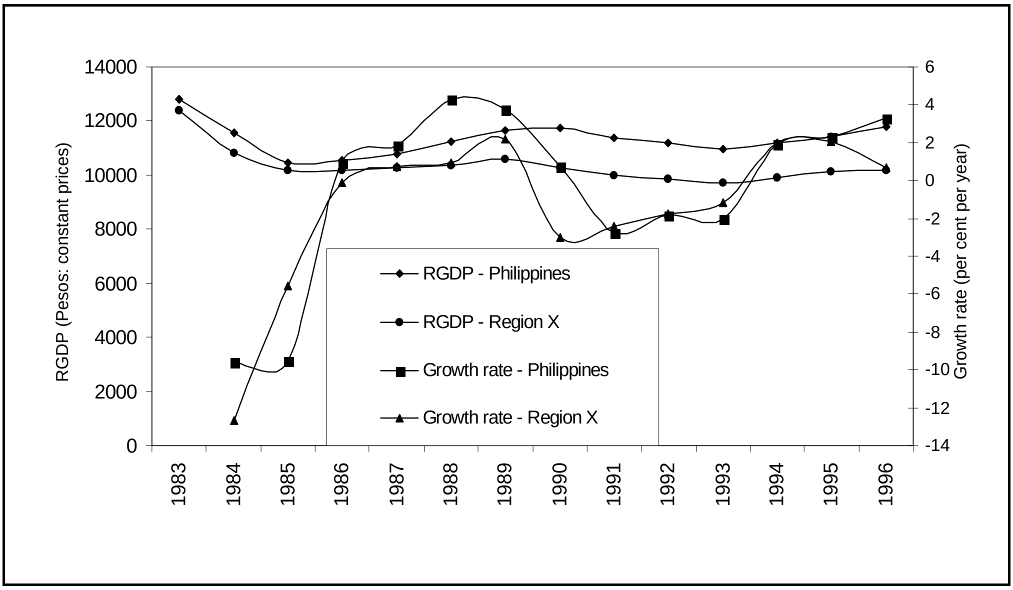

Fig. 1.1. Real per capita gross domestic product: Philippines and Region X. Source: World Bank

The changes due to rapid economic growth and transformation often imply major departures from established patterns of agricultural development. In particular, upland and highland communities have found their activities increasingly closely integrated with national and global markets. Resource managers in these formerly remote areas now receive market and related signals that play major roles in determining land use, technology adoption and adaptation, and investment plans, and thus exert a powerful influence over long-term environmental health and economic welfare.

Land-degrading patterns of agricultural growth are often taken to be promoted by adverse economic conditions -- poverty -- and malfunctioning institutions -- tenure insecurity or open access to land without restraints on the uses to which it is put. The combination may cause land managers (such as small farmers) to discount the future very heavily, or to adopt very short planning horizons, thereby introducing a bias in favor of short-term land uses. Rates of return to long-term investments in perennial crops and soil-conserving structures are also reduced by high capital costs in 'thin' local credit markets. For these reasons and more, farmers in steeply sloping upland areas close to the frontier of cultivation or in the buffer zones of forested areas are frequently observed to engage in land-degrading agricultural practices, even when they are clearly aware of the long-term consequences of their actions.

Unfortunately, recent Southeast Asian experience makes it clear that economic growth alone is not automatically a panacea for unsustainable upland land management practices. In some of Southeast Asia's very rapidly growing economies the demand for new products, especially temperate-climate vegetables, is now driving the conversion of land to intensive commercial vegetable garden systems in upland areas where climatic conditions make cultivation possible (Hefner 1990; Lewis 1992; Librero and Rola 1994; Scott 1987). Although the area planted to such non-traditional crops is relatively small, their expansion is nevertheless highly influential since it represents a move in the most ecologically fragile areas from soil-conserving tree crops, pasture and long-fallow systems to highly intensive vegetable gardening in which frequent tillage and thorough weeding greatly increases the exposure of soils to the leaching and eroding effects of monsoon rains. Moreover, pesticide and fertilizer use levels on vegetables are extraordinarily high under conventional crop management regimes.

Similarly, burgeoning meat demand by growing urban populations is fueling massive expansion of feed-corn production in upland areas. Under typical technologies -- that is, without special allowances for the erodibility of sloping land in the form of contour plowing, hedgerows or other erosion-inhibiting structures -- corn cultivation is a major contributor to soil erosion in the uplands and highlands of Southeast Asia. Moreover, continuous or long-term corn cultivation is known to generate large demands on soil nutrients; their (partial) replacement by means of the application of inorganic fertilizers can itself contribute to further long-term soil quality decline through acidification, diminished cation exchange capacity and possibly irreversible acceleration of soil weathering (Barak *et al.* 1997). The same trends may underlie observed long-term declines in yields of monocropped rice and corn in experiment stations, a very disturbing trend that has only recently come to light (Cassman and Pingali 1995; Kim *et al.* 2000).

These instances of the expansion and intensification of upland agriculture also have national policy dimensions. Grain production is supported by special policy measures in most Southeast Asian countries, and expansion of potato, cabbage, and other temperate climate crops in the steep lands of the region has been stimulated by widespread import restrictions and input subsidies aimed at promoting expanded production of such 'high-value' crops. Accumulated evidence suggests that while overall economic growth rates are important predictors of declines in poverty-related migration and land degradation, crop-specific and sector-specific policies (or policy failures) exert substantial influence over land resource allocation and soil management, even in apparently remote upland areas.

Changing Role of Government

Economic and market development throughout Southeast Asia is also extending the reach and responsibility of all levels of administration, imparting a new emphasis on government as both resource manager and market intermediary. In the Philippines, the devolution of fiscal and planning powers to provincial and municipal levels that began with the passage of the revised Local Government Code in 1991 presented local officials with new challenges as well as opportunities. For the first time they (and those who elect them) can take major decisions affecting local economic and social development. Devolution has a price; however, local governments are increasingly responsible for raising the revenue required to fund local infrastructure, health, education and social services. In upland and highland areas where reliance on the natural resource base as a source of income remains high, the responses of local governments to this ongoing devolution of power and responsibility will be critical determinants of long-term trends in economic welfare and environmental stresses. For local administrations, the question of a tension between economic growth and the conservation of natural resources and environmental quality is not abstract and academic, but a very real policy challenge.

A little-recognized aspect of this problem is that devolution -- in the Philippines and elsewhere -- is typically incomplete. Shifting responsibility for resource management and infrastructure development (among other functions) from central to local governments without a corresponding outward shift of the power to raise revenue and decide on its distribution raises the problem of overlapping "control areas". Local initiatives to pursue environmental policy might be undermined by lack of funds. Alternatively, local regulations or other efforts to influence forest, land and water use in a sustainable direction might be undermined by central government actions, for example agricultural policies that raise the prices received by farmers for crops that are erosive, or that are very demanding of inorganic fertilizers or pesticides.

Finally, the rapid development of markets for old and new agricultural products as well as the development of new market institutions poses additional challenges to local administrations. Even in relatively remote areas, governments in decentralizing political systems must now continually re-evaluate and redefine their roles in relation to changing economic and institutional conditions. As an example, the recent deregulation of the Philippine banking sector has brought about a rapid increase in the number of banks, the spread of rural bank branches, and the range of products and services offered by the banking system. This trend is bringing highland farmers within reach of affordable long-term formal-sector credit, arguably for the first time. Local governments must now seek ways to maximize the benefits that this opportunity presents by providing the necessary institutional underpinnings of a successful financial system. Another example of specific interest in our study site is the spread of agribusiness ventures that promote wholesale land use changes, such as the establishment of industrial and plantation crops. Such arrangements often also entail a loss of individual control over land use (as when farmers lease their land long-term to companies). In these cases local government increasingly finds itself thrust into the unfamiliar role of acting as intermediary between corporations and a variety of community interest groups.

Baseline: Lantapan

Within the Philippines, the main center of SANREM activity is the Municipality of Lantapan, in Bukidnon province, Northern Mindanao. The Lantapan economy and political system, and the landscape of the upper Manupali River watershed in which they are located, all exemplify the tensions we have just surveyed between rapid growth, economic change, and environmental stresses.

Landscape and Population

The study site, Lantapan municipality, is located in a river valley that is crossed by Mindanao's major north-south highway some 15 km south of the Bukidnon provincial capital Malaybalay, and 100 km southeast of Cagayan de Oro, the closest city and port (Fig. 1.2). The site is an hour's drive from the campus of Central Mindanao University in Musuan, Bukidnon, which has served as a base for many SANREM operations. Lantapan is contained wholly within the Upper Manupali River watershed (Fig. 1.3). Its northern border is the boundary of a major national park —

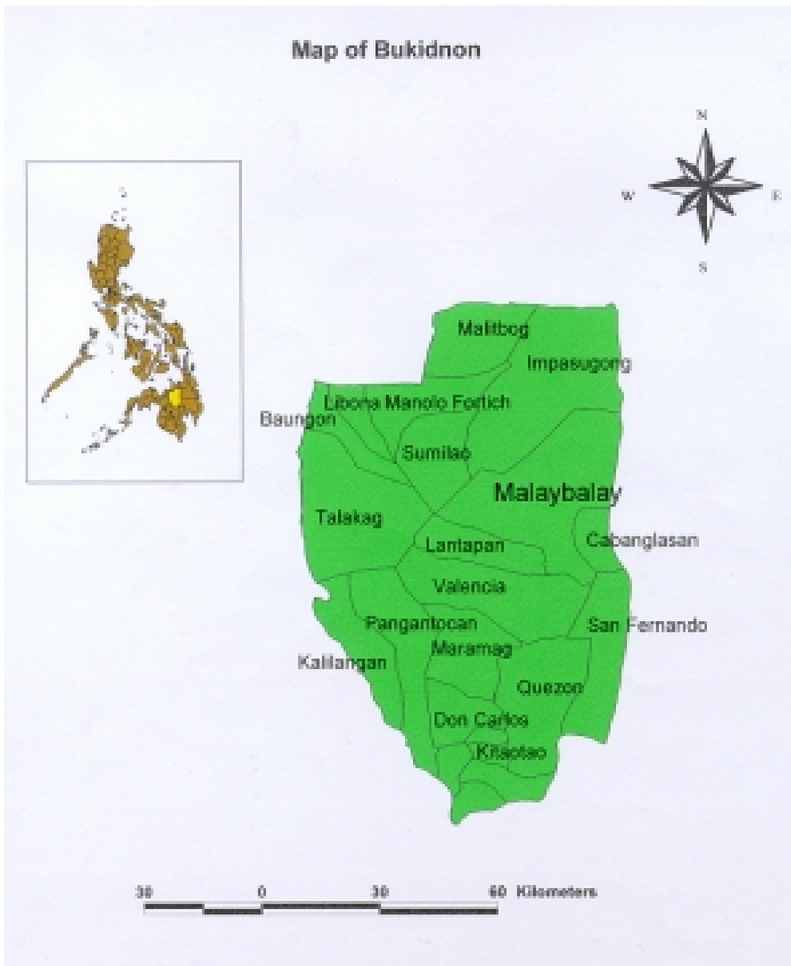

Fig. 1.2. The Philippines and the study site.

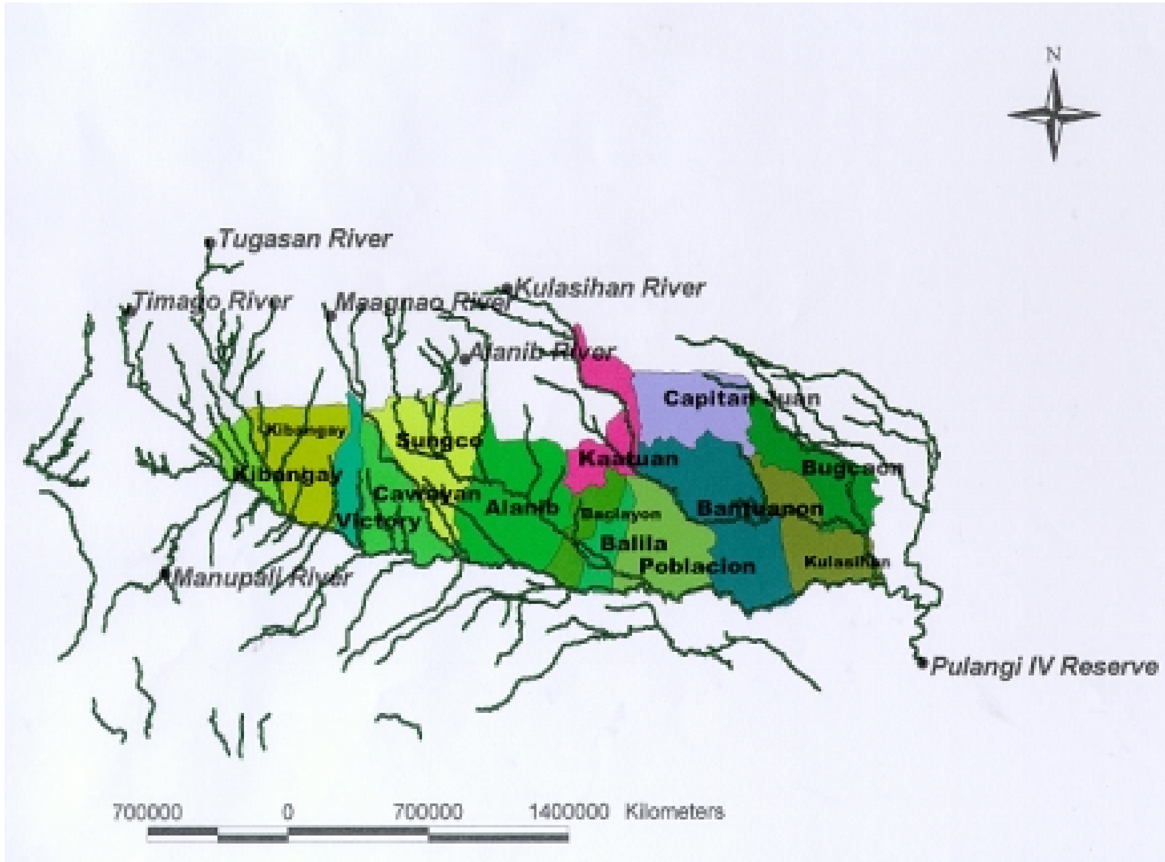

Fig. 1.3. Lantapan munipality.

the Mt. Kitanglad Range Nature Park. Peaks in the Kitanglad Range rise as high as 2500 m, among the highest in the nation. Lantapan's southern boundary lies on the left bank of the Manupali river. The municipality thus consists of several sub-watersheds draining south or southeast from the Mt. Kitanglad range to the Manupali river. In the lower part of the municipality, the river runs into a dam that diverts flow into a network of canals comprising the Manupali River Irrigation System (MANRIS), a 4000-ha system constructed by the National Irrigation Authority in 1987. The entire system ultimately drains into the Pulangi River, one of the major waterways of Mindanao Island, a few kilometers upstream from the Pulangi IV hydroelectric power generation facility.

Lantapan's landscape climbs from river flats (400-600 m) through a rolling middle section (600-1100 m) to high-altitude, steeply sloped mountainsides (1100 m-2200 m). A SANREM soil survey identified four broad geomorphic units: mountains, upper footslope, lower footslope, and collu-alluvial terraces. Soils in all units are generally well-drained, have clayey surface and subsoil horizons, are slightly to moderately acid, have low organic matter and high P fixation capacity, and have a low capacity to retain nutrients (West 1996). Differences among soils in each of the units are related to the age of ash deposits from which they are formed, with soil age and development increasing downslope (West 1996).

Lantapan is relatively wet, with annual rainfall of 2,470 mm. While the onset of the rainy season occurs during the first two weeks of May, monthly rainfall approaches a bimodal distribution because of dry spells during the months of July and November. The wettest month (369.7 mm) is August and the driest is November with 92.9 mm (Fig. 1.4). Across the landscape, air temperature and solar radiation decrease with elevation. The coolest months are January and February, with temperature ranges from 15.2°-19.2°C. April and May are the hottest months with temperature ranges from 24.5°-32.1°C. Air moisture content is lowest during the months of March and April and highest during the months of June and August (Laurente and Maribojoc 1997).

Population data on Lantapan are available only from the first census after its establishment (in 1966), but they reveal a rate of increase even more precipitous than that for Bukidnon as a whole. In the decade from 1970 Lantapan's population increased at an average annual rate of 4.6%, from 14,500 to 22,700 (NSO 1990); in 1994, municipal records show that the population was 39,500. Since 1980 the annual population growth rate has thus averaged 4%, much higher than the Philippine average of 2.4%. Ethnically, the population is a mix of about 15% Talaandig indigenous people, 51% *Dumagat* (in-migrants from coastal areas and other islands), and 32% from Bukidnon and other groups (Rola *et al.* 1996).

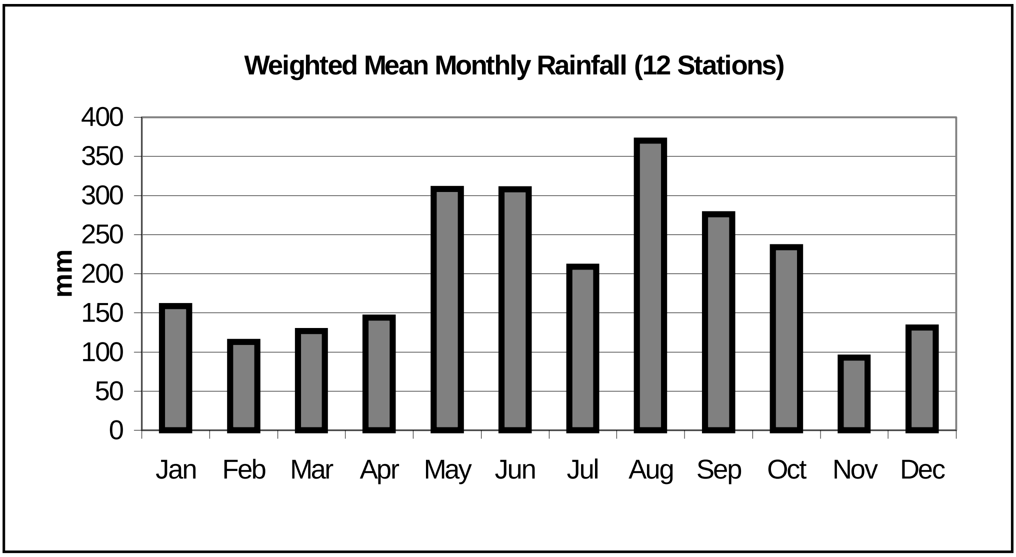

**Fig. 1.4. Monthly average rainfall in Lantapan, 1994-1998.
Source: Lauente and Maribojoc, 1997.**

Economy and Land Use

In spite of rapid growth in recent decades, agriculture continued to dominate the economy of the municipality and of the province. In 1988, 71% of provincial employment was in agriculture, 5% in industry, and 23% in services; agriculture provides the primary income source for 68% of Bukidnon households (NSO 1990). In Lantapan, dependence on agriculture almost certainly exceeded the provincial average. Farm sizes were small by upland standards: in 1980, the modal farm size class (1-2.99 ha) contained 46% of farms, and 75% of all farms were smaller than 5 ha. Most households therefore lived close to the poverty line; in 1988 food, fuel and clothing accounted for 59, 4, and 5% respectively of household expenditures in the municipality (NSO 1990).

Lantapan's agricultural land area in 1980 totaled 14,400 ha, more than half of which was classified as being under temporary crops. A small fraction of this, at the eastern boundary of the municipality, was irrigated; this area was devoted almost exclusively to rice production. The moderately sloped and rolling lower footslopes immediately to the west produced corn and sugarcane; further up the watershed sugarcane planting diminished as increasing distance and lower road quality raised the cost of travel to the Bukidnon Sugar Milling Corporation (BUSCO), rendering production of this high-valued crop less profitable. In the upper footslopes that made up the largest agricultural area of the watershed, corn was the dominant crop. At middle altitudes coffee is an important secondary crop, while at higher elevations corn was planted alongside coffee and temperate-climate crops: beans, tomatoes, cabbages and potatoes. Other minor agricultural enterprises included cassava, abaca, and tree plantations for firewood, livestock and non-timber forest products.

In addition to expansion at forest margins and intensified use of agricultural land already cultivated, the history of land use in Lantapan since the 1950s involved substantial crop substitution in response to new commercial opportunities. At the end of World War II, most sloping and high-altitude land was forested. Agriculture in the mid-and high altitude *barangays*[3] consisted primarily of corn, cassava and coffee production — and presumably the harvesting of logs and non-timber forest products. Corn and cassava were grown primarily for subsistence, and to a lesser extent for feed, sold locally to Bukidnon's cattle ranching industry.

In the 1950s, migrants from Benguet province in Northern Luzon introduced commercial cultivation of potatoes, cabbages, and other temperate-climate vegetables to the locality. In 1977, construction of the BUSCO sugar central about 25 km south of Lantapan spawned the sugar sector now dominant in the lower reaches of the watershed. More recently, improved integration of the Bukidnon economy in national agricultural markets, coupled with increasing demand for some crops, has ensured that commercial agriculture in the province continues to adapt and thrive. Road improvements and the 1986 expansion of the Cagayan de Oro port stimulated agricultural exports from Northern Mindanao to markets in Cebu and Manila. These infrastructure investments greatly increased the profitability of growing corn and (especially) vegetables for processing or sale in Manila and Cebu, where formerly transport costs and bottlenecks had maintained relatively low returns to such activities. Corn production has flourished, becoming primarily a commercial crop where formerly it had been little traded outside the locality. Vegetable cultivation also continued to increase in area and economic importance; the upper watershed area of Lantapan is now sometimes described as a "second Benguet", a reference to the Philippines' primary temperate-climate vegetable production area in Northern Luzon.

[3] *Barangay* (village) is the smallest political unit in the Philippines.

Land Use Change and the Environment

Agricultural expansion has largely involved the replacement of forest and permanent crops by annual crops. This can be seen very clearly in data constructed from satellite imagery in a SANREM study conducted in 1994 (Fig. 1.5). Over a twenty-year period to 1994, the area of permanent forest shrank from about one half to a little over one-fourth of the total area. Part of the converted land went into shrubs or secondary forest, but a much larger part was converted to annual agricultural crops, especially corn and vegetables, which expanded from 20% to 40% of total land area.

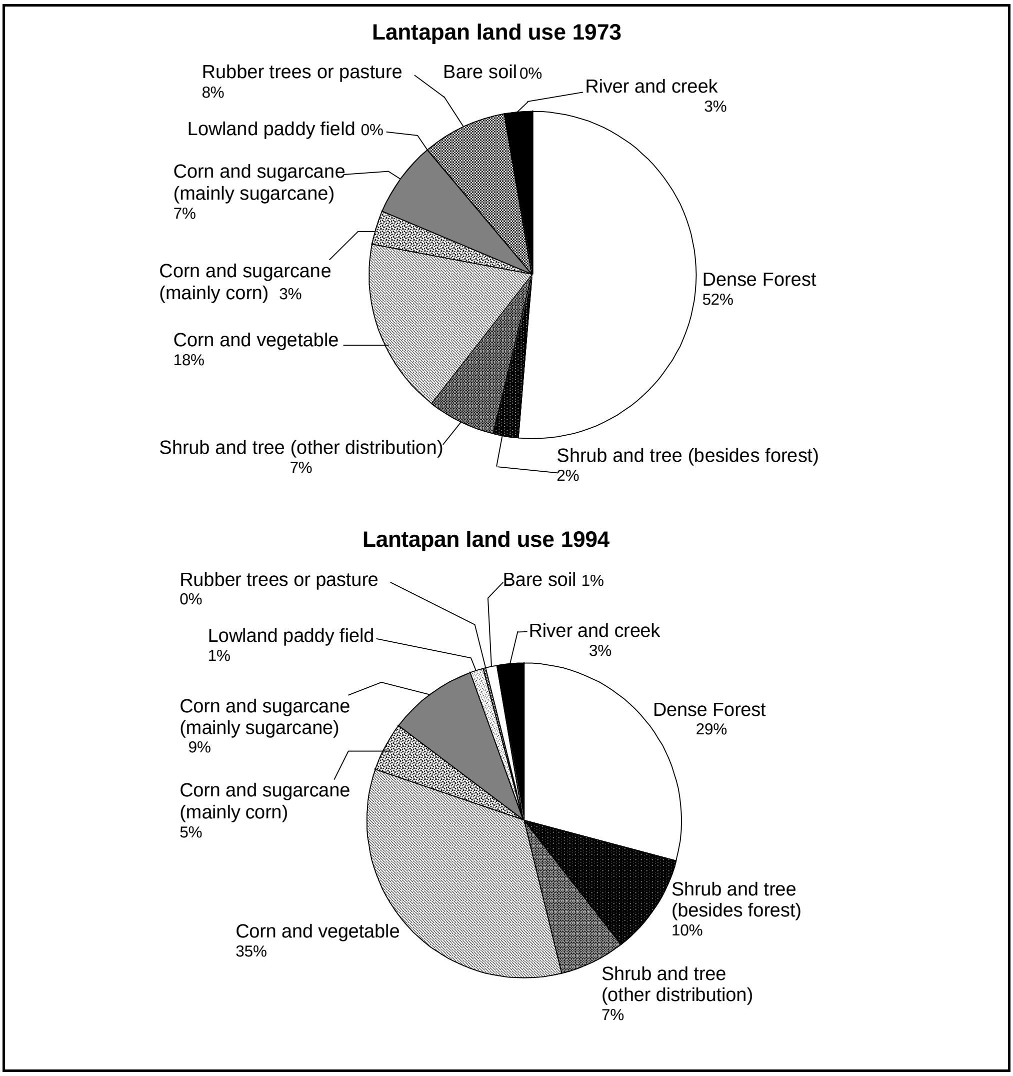

Fig. 1.5. Lantapan land use, 1973 and 1994. Source: Li Bin 1994.

From the same source we see that land conversion has also meant the spread of annual cropped area into higher-altitude areas (Fig. 1.6). Given the topography of the site, this also means that agriculture has spread up-slope (Fig. 1.7). Studies conducted in other Philippine watersheds and elsewhere in the humid tropics identify annual crop expansion and the intensification of cultivation on sloping lands as the causes of dramatic increases in soil erosion rates (David 1988; Lal 1990).

SANREM Research, Findings and Impacts

Overview of Project Activities

SANREM work in the Philippines began with an informal survey of ecological and economic conditions in the Manupali watershed and Lantapan municipality. The organization of this activity emphasized participation as opposed to mere data gathering, and its scope stressed human interactions with the environment. To reflect these concerns, the project described this activity as a *participatory landscape-lifescape appraisal* (see Bellows *et al.* 1995). Subsequent meetings of interested researchers, community members and NGO groups used the PLLA to formulate broad guidelines for SANREM research and development activities at the site. Proposals were solicited and work began in earnest in the first half of 1994.

The work plans funded in Phase I, with summary details of their institutional partners, duration and funding, are listed in Table 1.1. Since the later chapters will present more detail on the major research activities, we will limit ourselves here to a very brief overview of the types of work that were funded, the relationships among these, and their overall relationship to the conditions of the research site and the goals of the SANREM CRSP (parenthetical numbers refer to entries in Table 1.1).

Several work plans were funded initially to provide a characterization of the watershed, community, and natural resource or agricultural practices, both in the Philippines and in other SANREM sites [G7, G8, P9, P12], and to work with the community and local institutions to increase awareness of the project and its goals [P1, P5, P14 and P15].

Other research efforts were explored biophysical and social relationships with the goal of producing information about resource use, or techniques or technologies promoting more sustainable resource use [P5–P8; P10-P13; P16]. Some of this information was intended for direct use by farmers; others for the consumption of researchers, policy analysts and policy makers in local and national government units. The output of

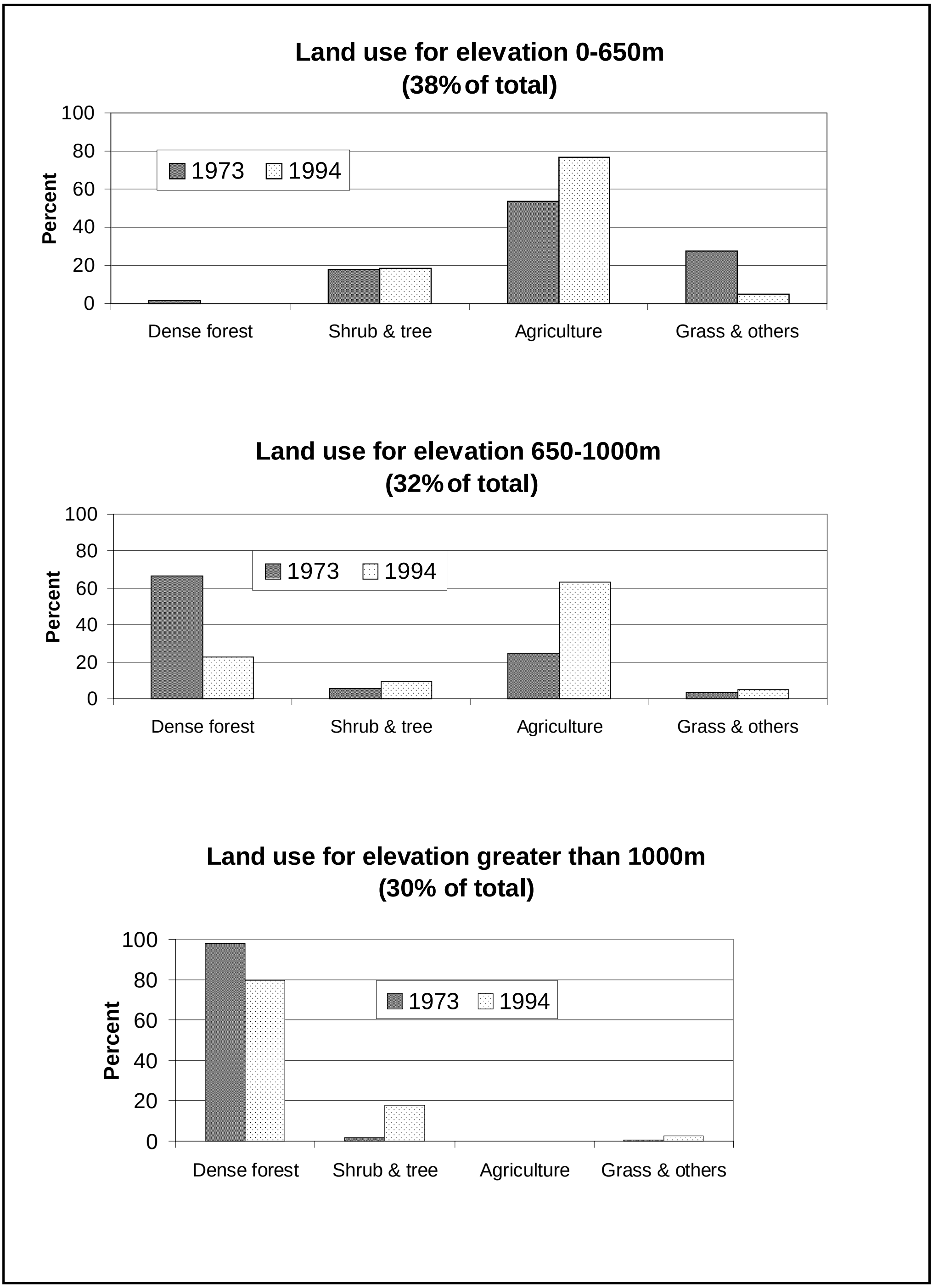

Fig. 1.6. Lantapan: Land use by elevation, 1973 and 1994.
Source: Li Bin 1994.

Table 1.1. Workplans funded by SANREM CRSP-Philippines, 1994-97.

G1 –	Communication and Information Exchange. PIs: C. Neely and G. T. Cameron, UGA
G2 –	SANREM CRSP Monitoring and Evaluation: Expectations, Reality and the Value of an Iterative Plan. PIs: Jim DeVries, Heifer Project International and C. Neely, UGA
G3 –	SANREM CRSP and INFORUM Collaboration on an Electronic Conference of Indicators of Sustainability and in the Development of SARD-FORUM. PIs: R. D. Hart, INFORUM
G4 –	Learning in the Lifescape: The Gender/User Working Group of the SANREM CRSP. PIs C. Flora, Iowa State, R. Rhoades, UGA, I. S. Barbeau, Silva Associates and R. Montee, Western Carolina University
G5 –	Indicators of Sustainability. PIs: W. R. Butcher and B. Bellows, Washington State University
G6 –	Linking Research and Education: The Global Working Group. PIs: W. Deutsch, Auburn University and C. Neely, UGA
G7 –	Characterizing the Climate of the SANREM CRSP Research Sites. PIs: I. D. Flitcroft and E. T. Kanemasu, UGA
G8 –	Using Geographical Information Systems as a research tool in the SANREM CRSP program. PIs: I. D. Flitcroft and E. T. Kanemasu, UGA
G9 –	An Assessment of Modeling Needs. PIs: D. M. Swift, Colorado State University
G10 –	The Center for PVO/University Collaboration in Development Western Carolina University. PIs: R. B. Montee, R. Gurevich, M. L. Surgi, R. Hussein, W. Collins, Western Carolina University
G11 –	Engaging the Whole: Operationalizing the Spread Effect at SANREM CRSP Sites. PIs: M. G. Buenavista, W. D. Dar, PCARRD, H. Valdebenito, San Francisco University, W. Deutsch, Auburn University, R. Rhoades, UGA, C. del Castillo
P1 –	The Priming Program of SANREM CRSP/Philippines. PIs: J. L. Orprecio, Heifer Project International, R. Banaynal, Network for Environmental Concerns, Inc. G. Tan, SHAISI Foundation, Inc.
P2 –	Enhancing Biodiversity Conservation and Family Security through Homegardening and Sustainable Field Production of Vegetables: Community-based Pest Management for Sustainable Vegetable Production. PIs: G. Prain, CIP-UPWARD and L. Ramos, NOMIARC-DA
P3 –	Towards Optimizing Land Use Through Water Quantity and Quality Modeling. PIs: E.T. Kanemasu and I. D. Flitcroft, UGA
P4 –	Integration of Gender Activities in Work Plans. PI: R. Balakrishnan, Virginia Tech
P5 –	User-First Research for Sustainable Development and Natural Resource Management. PIs: J. Shumaker, Heifer Project International, J. Orprecio, Heifer Project International and L. Ramos, NOMIARC-DA

Table 1.1. Continued.

P6 – The Economics of Sustainability: Production, Prices, and Policies in the Manupali Watershed, Bukidnon, Philippines. PIs: I. Coxhead, U. of Wisconsin-Madison and A. C. Rola, Center for Policy and Development Studies-UPLB

P7 – Sustaining Commercial Vegetable Production in the Manupali Watershed, the Philippines. PIs: D.J. Midmore, AVRDC and L. Ramos, NOMIARC-DA

P8 – Farming Systems Interactions in the Landscape/Lifescape of the Manupali Watershed in Lantapan, Bukidnon, Philippines. PIs: A. R. Josue, Central Mindanao U. and D. Carandang, Farming Systems and Soils Resources Institute-UPLB

P9 – Characterization of the Soil Resource in the Lantapan Area of the Manupali Watershed. PIs: L. T. West, UGA and the Philippine Bureau of Soil and Water Management

P10 – Water Resource Management and Education in Watersheds of Bukidnon, Philippines. PIs: W. G. Deutsch, Auburn U. and J. Orprecio, Heifer Project International

P11 – Assessing and Developing the Contribution of Home Gardening to Biodiversity Conservation and Household Nutrition. PIs: G. Prain, CIP-UPWARD and L. Ramos, NOMIARC-DA

P12 – Sociodemographic, Technological, and Economic Factors Affecting Biodiversity in Lantapan, Philippines. PI: A. C. Rola, Center for Policy and Development Studies-UPLB

P13 – The Ethnoecology of the Manupali Watershed. PIs: V. Nazarea, UGA and L. Burton, Xavier U.

P14 – Environmental Awareness Of, By, and For Empowerment of the Manupali Watershed Farming Families. PI: G. Tan, San Herminigildo Agro-Industrial School

P15 – Assembling the Elements for a Realistic Buffer Zone Resource Management Plan in the Philippines. PIs: D. P. Garrity, ICRAF and R. Banaynal, NECI

P16 – Development of Sustainable Production Systems for Different Landscape Positions in the Manupali Watershed. PI: V.P. Singh, International Rice Research Institute

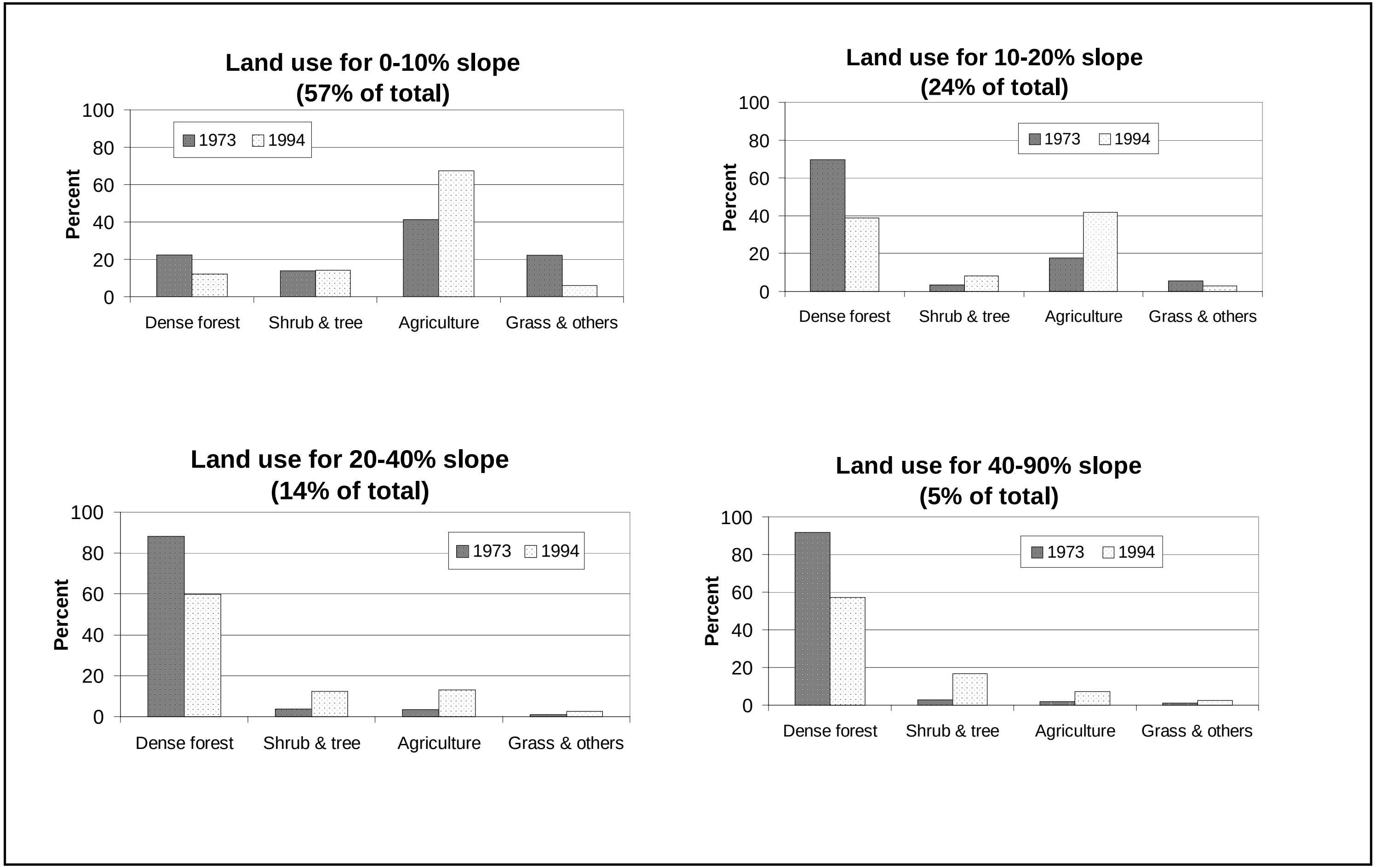

Fig. 1.7. Lantapan: Land use by slope, 1973 and 1994. Source: Li Bin 1994.

key work plans in this group is presented as Chapters 3-7 in this volume.

Other work plans emphasized outreach and extension, including the adaptation and transfer of existing information or technologies to the community through a variety of channels [P5, P11, P14]. Some other activities were directed more at the project itself rather than at conducting research *per se*. These included a work plan on the integration of gender activities in work plans [P4], and process documentation. Finally, a work plan developed by the Lantapan local government addressed directly the goal of sustainable development [P17], and a survey-based activity towards the end of Phase I sought to assess the impact of SANREM activities on NRM and environmental awareness, attitudes and actions by the Lantapan communities.

As this list has revealed, several work plans combined more than one activity. As an example, participants in the water resource management work plan [P10] not only conducted research (water quality monitoring and analysis, Chapter 7), but used the activity as the core of an institution-building effort that led to the formation of a community-based environmental NGO (see Chapter 9). Moreover, there was some interaction among work plans in which research results from one activity informed the research design, outreach strategy or policy advice provided by another.

In the remainder of this section we provide a brief integrative overview of SANREM research reported in Chapters 2-7. Discussion of the research process is reserved for Chapter 8, and Chapter 14 provides a synthesis and critique of the accomplishments of the project as a whole.

Economic and Demographic Development

SANREM analyses demonstrate that demographic trends, ill-defined land rights and poverty (the need to assure subsistence) have all contributed to agricultural land area growth and intensification in Lantapan. Demography has clearly been a major factor associated with agricultural expansion (see Chapter 2). However, the rate of population growth within the municipality is subject to several important influences, including *in situ* property rights, the prevailing economic environment and of the opportunities presented by increasingly reliable and sophisticated physical and market infrastructure. The uplands of Bukidnon, only sparsely populated in the postwar years, constituted the Philippine land frontier through the 1950s-70s, an era during which economic growth strategies generated disproportionately small growth in non-farm employment for a rapidly growing labor force. Subsequent infrastructure and market improvements further encouraged in-migration by presenting farmers with a range of commercial opportunities in corn and vegetable markets (Chapter 3). Clearly, then, "population pressure" is not a *fundamental* cause of unsustainable rates of resource exploitation. Net migration, a large component of overall population change, is a set of responses by individuals and households to economic opportunities within the watershed compared with those outside. In Chapter 4 we explore some of the ways in which regional labor market conditions influence land use and land management practices in Lantapan.

Turning to the economic and market context of Lantapan agriculture, SANREM-sponsored research reveals that the cultivation and spread of corn and vegetable crops has received considerable encouragement in form of restrictive trade policies and price supports (Coxhead 1997, 2000). Trade protection for Philippine producers of corn, potato and cabbage have raised domestic prices for these crops; conversely, direct and indirect export taxes on coffee, an important commercial crop in the watershed in previous years, have discouraged its cultivation. As a result, the stock of coffee trees has deteriorated in both quantity and quality, and processing and marketing infrastructure, extension support and other assistance to the industry have all but disappeared.

How important are such economic factors in determining land use? Although soil quality, moisture, temperature and (for some vegetable crops) the presence of soil-borne pathogens are important constraints, farmers in the municipality most frequently explain their land use decisions in terms of the relative profitability of different crops. Since land use decisions directly impact deforestation as well as on key indicators of environmental quality such as soil productivity and water quality, it is necessary to understand not only how and why farmers respond to prices, but how those prices are formed. SANREM research in Phase I built a large data set of commodity and input price trends and farmers' responses. These have been used to examine the farmers' land use responses to price signals, and also to identify the potential contribution of Philippine government trade and commodity pricing policies to recent land use shifts (Chapter 3). This and related research (Coxhead *et al.* 2001) reveals the importance of farmer characteristics, especially wealth and capacity to withstand shocks, as important constraints on their land use decisions. For example, poorer farmers typically opt to grow corn since this combines lower levels of uncertainty about price and yield with the "safety-first" option of consuming their product in the event of total market failure. Less risk-averse farmers demonstrate a preference for a mix of corn and vegetables. Changes in prices, and in the variability of prices and yields, are thus likely to have differential effects on land use by different groups of farmers.

Environmental Consequences of Agricultural Development

In Lantapan, recent expansion of sugar and corn cultivation at low altitudes, and of vegetable and corn at higher altitudes, has occurred substantially at the expense of perennial crops, whether pasture/grassland, forest/bush fallow, or coffee. Other things equal, the replacement of perennial land uses with short-season and annual crops on sloping lands is associated with rapid increases in soil erosion and land degradation. Field measurements and experiments with the cultivation of corn and vegetable crops under a range of management regimes in Lantapan confirm rapid soil erosion rates and depletion rates of soil nutrient and organic matter content in soils that, although initially fairly rich, are readily depleted of nutrients and organic matter (Midmore *et al.*, Chapter 5 this volume; also West 1996).

In spite of an obviously widespread perception of the soil productivity-depleting effects of annual crops, few farmers display deep knowledge of soil degradation relationships. Land fallowing and rotation is rare and usually undertaken only when yields of commercial crops decline to the point of economic losses in the current season. Although soil erosion and land degradation problems appear to be widespread, very few farmers report significant investments in soil-conserving structures or technologies (Chapter 3, Chapter 5).

Agricultural intensification without adequate soil management has negative effects both on-site, as documented above, and off-site. Intensive cultivation of annual crops in general, and the increased use of fertilizer, pesticides and other chemicals on vegetable crops in particular, are likely to degrade water quality and may create health problems for farm families and those living downstream. The results of Lantapan-based water quality monitoring reported in Deutsch *et al.* (Chapter 7) reveal both qualitative and quantitative evidence of water quality degradation. Perceptions of pesticide residues have made some residents reluctant to water animals in streams during or after rainfall events. Measures on total suspended solids (TSS) across sub-watersheds were considerably higher in those where agricultural cultivation was more widespread, in spite of much lower average slope, and seasonal TSS peaks appeared to coincide with months of intensive land preparation activity. Deutsch *et al.* report that many of the more noticeable changes in water quality and seasonal flows have occurred “well within human memory”.

Other consequences of rapid and increasing soil erosion rates can be seen in the deterioration of the two water impoundment structures, the MANRIS diversion dam and the Pulangi IV hydroelectric power installation on the Pulangi River, a few kilometers below the debouchment of the Manupali. The Pulangi reservoir has become about half-filled with silt in less than a decade since its construction, and National Power Corporation (NPC) staff report that water supply and quality problems prevent the facility from running at full capacity for more than short periods. Erosion-related problems have also plagued the MANRIS irrigation network. In 1987 the Asian Development Bank funded the construction of a diversion dam and network of concrete-lined irrigation canals with a nominal service area of 3350 ha. However, as early as 1991, National Irrigation Authority data showed the area actually irrigated about 1000 ha in the wet season and about 790 ha in the dry season (CRC 1993). According to the staff of the National Irrigation Authority, the major reason for this very rapid degradation of the irrigation service area is sedimentation in the diversion dam and siltation of canals and other structures. Increased seasonal variance of water supply to the system—a problem exacerbated by more rapid rainy season runoff from denuded upland areas—may also play a role.

Finally, the unchecked expansion of agricultural production at the margins of the remaining forest systems poses a potential threat to the integrity of those systems, with possibly serious consequences. These include reductions in water retention capacity of the upper watershed and thus changes in the quantity and seasonal distribution of water flow in springs and rivers, and possibly irreversible changes in biodiversity. In the early postwar years, encroachment on forest areas was driven primarily by commercial logging, with occasional forest fires contributing to a large-scale deforestation by 1983. Both logging and forest fires facilitated agricultural expansion. In recent decades, however, the profitability of commercial vegetable cultivation has been the primary impetus for forest encroachment, with decisive contributions from road development and the lack of well-defined and enforced property rights in land (Cairns 1995). Concerns about the loss and degradation of forest resources include such specific phenomena as watershed degradation (especially with logging in the headwaters of creeks) and the loss of wildlife habitat and sources of forest-based foods and raw materials, as well as more general, and less easily quantified, phenomena such as the reduction in measures of biodiversity (Garrity *et al.*, Chapter 6 in this volume).

In summary, evidence gathered by SANREM researchers and their partners provides emphatic support for two arguments. First, the natural resource base of the Manupali watershed is undergoing degradation of a nature and at a rate without modern precedent, with potentially serious consequences especially for water quality. Second, much if not most of the degradation can be attributed directly or indirectly to the spread of intensive agricultural systems based on corn and vegetables, without the concurrent adoption of appropriate measures for the prevention of soil erosion and land quality deterioration.

Clearly, some aspects of these environmental trends are specific to the study site. Most, however, are also to be found with minor variations in many sites across Southeast Asia and elsewhere in the developing world (Scherr 1999; WRI 1998). It follows that a research-based strategy for dealing with them in one location should result in methodologies that are applicable, either directly or with minor modifications, to similar sites in many other locations. The development of such methodologies was a major preoccupation, but also arguably a major achievement, of the project's first five-year phase. We return to a detailed discussion of methodological and process issues in Chapter 8, which also introduces several chapters dealing with institution building, local administration, and related concerns.

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