30

Three Levels of Conservation by Local People

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Introduction

There is no longer any doubt in our minds on the importance of tropical forests and about the need to understand them better. Hardly anyone objects to the overwhelming need to know and protect as much of the planet's biodiversity as possible, especially in the tropics. One question often raised is on the past and present role of humans on the management and conservation of biodiversity.

Management usually involves the sense of 'improvement' from a previous stage and conservation always involves maintenance of what exists. However, the meaning of management may be very different to different people, and in fact, may include conservation and even preservation (Gómez-Pompa and Burley, 1991). Our modern society has mainly been concerned with the issue of the preservation side of conservation and has paid little attention to the management side of conservation.

The biodiversity we have today is in great part the product of the actions of thousands of generations of humans on earth. They have tried all kinds of management approaches to 'improve' the production of the natural ecosystems of its basic needs for food, fibre, and housing materials.

History is full of examples of the successes and failures of past civilizations. Their attempts to modify their natural habitat to produce more and better goods drastically modified the ecological landscape of where they lived. Deforestation was a common trademark of most civilizations, including ours. The search for new fields to plough or wood to harvest has been the common denominator of humans. In doing so, the plants and animals of the 'natural' environment were pushed to other areas and most of their populations were drastically reduced, except for those species that found new niches in the human-modified environments. The original ecosystems were replaced in great quantities by human-made agroecosystems and large areas of disturbed ecosystems.

Humans in their search for better food production systems were able to find and select a certain number of species that were nutritious, taste better, were easy to harvest and most important, were prone to cultivation. These species in former times came mainly from the wild. The wild lands were the providers of food, medicine, and fibres. Humans since ancient times have been acknowledging the sources of their subsistence. Forests and other wild lands were frequently revered, respected and protected. Sacred forest groves are known from all over the world. Deities based on trees and wild lands are common in all cultures.

Biological conservation was an important component in the management of landscape in many cultures. Alcorn (1991) refers to this type of conservation as archaic conservation: 'Archaic conservation operates in subsistence economies by placing limits on the extraction of natural resources; local rules therefore tend to prevent destruction of nature because raw materials inputs derived from nature comprised the pre-eminent resource base'. This view contrasts with the prevailing view in some quarters of native people as destroyers of nature.

Our only option for the future is to find the precise role the human species plays and has played in the conservation, depletion, and enrichment of biodiversity. Humans should not be seen only as the destroyers of biodiversity but also as the managers of it (Gómez-Pompa and Kaus, 1992).

In order to properly manage anything we must know it well. Yet at the present time, we do not know enough about the processes that affect, reduce, increase, and maintain different kinds and levels of biodiversity in the world.

Unfortunately the issue of our ignorance is frequently misunderstood and misused. Questions raised concerning the estimates of alarming extinction rates of taxa are valid ones, and need to be addressed seriously; however, if we lose one species per year, or one species per day or one per minute is not the issue. The issue is that with the little information available we do know that we are losing them, and that the tropics in particular are especially vulnerable because of the high biological richness, the fast conversion rates of its ecosystems and the economic priorities.

We also know that major causes of environmental deterioration are human actions that can be changed. But also we know that there are human actions that not only prevent biological losses but in fact may be responsible for its enrichment. It seems that the study of human activities that conserve and may even enrich biological diversity is an utmost priority.

In this chapter I will discuss three levels of the role of humans in managing and conserving biodiversity in the tropics of Mesoamerica: (i) the management for conservation of large areas; (ii) the creation of new agroecosystems; and (iii) their role in the evolution and domestication of trees.

The three examples are from the Maya area of Mesoamerica but similar examples can be mentioned from many other areas of the world.

Level 1: The Conservation and Management of Large Areas: The Maya Forests

Much of our research is based on the puzzlement over how the Maya culture developed and flourished in the tropical lowlands of Mexico and Central America. The ancient Maya reached population densities estimated to be much higher than those which the same areas support today. Though there is some disagreement among archaeologists, an estimate of 200–500 people per km^2 in the rural areas for several centuries is widely accepted. Much higher numbers have been estimated for some specific sites (Turner, 1976).

What is intriguing is that this population density was apparently reached, without diminishing the biological diversity of the region. The Maya region is considered to be one of the most important centres of biodiversity in our continent. A new family of flowering plants, the Lacandoniaceae was discovered a few miles from the known archaeological sites of Yaxchilan and Bonampak, that were heavily populated for several centuries (Martínez and Ramos, 1989).

The vegetation and flora of the region have given us an understanding of the diversity that these areas once had and a rough estimate of the amount and rate of change. The study areas were also the sites of long-past human habitation.

Based on these studies the conclusion was reached that most of the mature forests of Mesoamerica were areas inhabited by humans; evidence can be found almost anywhere one looks.

There is very little doubt that most of the present day mature forests of the Maya area are the result of past management. The abundance and unexplainable distribution of useful trees, many of them with edible fruits, can only be explained by human intervention (Barrera-Marín *et al.*, 1977).

What kind of intervention?

In the process of studying these sites I also became aware of the extraordinary amount of traditional knowledge the farmers have on the plants, the vegetation, crops, and the diversity of their land use practices. We began noticing the abundance and dominance of useful trees in what were considered in our surveys as 'primary' vegetation in 'primeval' areas of the humid tropics of Mesoamerica. In addition, we found that the many species that were dominant in the forests were also abundant in the home gardens.

Several authors have suggested the influence of the old Maya in the present day vegetation in the archaeological sites. Puleston (1968) even suggested that a tree, *Brosimum alicastrum*, the ramon tree was in fact an important alternative staple food of the Maya. New evidences from present day Maya support that hypothesis (Atran, 1993).

Others have proposed that the ancient Maya had complex forest gardens similar to the present day home gardens where many species were encouraged, attracted, relocated, selected, protected, transplanted, domesticated, semidomesticated, eliminated, or introduced. In these forests wildlife was also managed, by favouring certain game-food plants (Wiseman, 1978). There are early descriptions of very sophisticated breeding methods for rare birds (Hamblin, 1984), including the famous Quetzal in the Maya forests (M. Aliphat, personal communication, Mexico City).

I have supported and contributed to this intriguing idea of the existence of extensive ancient forest gardens by proposing a silvicultural system of the ancient Maya based on the food production systems available and the resource management methods practised by Maya farmers today (Gómez-Pompa, 1987).

This mega-management of biodiversity by the ancient Maya was not the result of a centralized mandate. The explanation lies in the presence of a series of techniques and methods for their agriculture, silviculture, and wildlife management. These techniques were selected over time and practised by all. Something similar today is the worldwide acceptance of the modern techniques and methods for agriculture (green revolution), resource management, and conservation.

The large scale management of resources has been reported from some present day indigenous groups. One extraordinary example has been described from the Kayapo Indians of Brazil who have managed extensive areas for centuries and have influenced the composition of forests and in fact created what have been called 'anthropogenic forests' (Posey, 1985).

As in the case of the Maya, the findings for the Kayapó are not unique. According to Baleé (1989) 'at least 11.8% of terra firma forest in Amazonian Brazil is anthropogenic'.

Level 2: The Creation of New Agroecosystems: Home Gardens

This section briefly discusses this remarkable anthropogenic forest: the home gardens. These are a key component of the biodiversity conservation strategy by local people. They are known to be very efficient agroforestry systems very widely used by many traditional cultures of the world.

The home garden has been considered as the site of experimentation on plant introduction, plant cultivation, and animal breeding. Probably it was the site where the domestication of many plants and animals occurred and is occurring now. It is also the site par excellence of crop diversity conservation.

Each garden is an experiment in the design of a multispecies ecosystem in space and time. The kinds, number and individuals of each species, as well as the landscaping is done by each gardener. It is based on his/her tastes, needs, knowledge and curiosity, and previous experiences. The gene pool available comes from the local biota, other home gardens, or from local markets. The home gardens are composed by a mixture of the selected species with the local flora that is allowed to coexist in the garden.

Another important factor is the zonation found in their gardens. These vary from intensively managed areas to low management areas. In the latter 'wilder' areas many native species are spared and are able survive in the gardens.

Home gardens may comprise more than 10% of the total forested area of the State of Yucatan in Mexico. In a study of the home gardens at Xuilub 339 species of flowering plants were found living in 52 gardens. These gardens have an average size of 3800 m^2. This means that in 19.76 ha of home gardens comprise 30% of the flora of Yucatan (Herrera *et al.*, 1993).

Level 3: The Domestication or Semidomestication of Trees

In the studies on early domestication there are few examples on how some trees were domesticated. We know that many early pre-agriculture human groups lived in tropical forest environments (Hladik *et al.*, 1993). They were hunter–gatherers, whose survival depended on their knowledge of where to find abundant game and also areas where edible plants were abundant. The reliability of food sources was of utmost importance.

Fruit trees were without doubt a staple food source. They were the reliable sources of food. The knowledge of their phenology became important to ensure food through the year.

The gathering of fruits and seeds of trees became a routine activity for centuries and maybe millennia. The knowledge of germination of seeds was a logical event that may have occurred in their temporary home sites or even in the forest. Seeds of many trees from the rain forest have no dormancy, they germinate very soon after they fall.

It is not difficult to believe that an intelligent hunter–gatherer might have learned the advantage of planting seeds of edible tree species or even selecting seeds from individual trees or populations of a favourite species. Nor is it difficult to visualize the initial management of forests by the keen observers of the forests. It does not take much to realize that if some inedible trees are eliminated, the edible ones will have an advantage and in the near future more food could be gathered. If the useful edible trees were not there, they could be planted. This is the most logical scenario as to how the 'anthropogenic forests' were born. This was in fact the beginning of a domestication process by hunters and gatherers. Even though hunter–gatherers may not have domesticated plants or animals, they domesticated the environment in which these species grow (Yen, 1989).

The result of all these activities created the original forest home gardens and also the initiation of what I called the mega-management of forests.

In this scenario, the trees introduced to home gardens were not very different from their wild relatives. However, over time, certain genotypes were selected by different human groups, based on taste, cooking preferences and ecological advantages (drought and pest resistance, etc.). These genotypes have been inherited, maintained, and developed further by the many ethnic groups around the world that have conserved the cultural traditions and the genetic and biotic patrimony from their ancestors.

The cacao story

The cacao story is an example of a sophisticated domestication of a tropical rain forest tree (Gómez-Pompa *et al.*, 1990).

Landa in 1566 wrote about the Maya in Yucatán in his *Relaciones de Valladolid* the following: 'They have sacred groves where they cultivate certain trees, like cacao'. Gaspar Antonio Chi (1582) wrote: 'the lands were in common . . . except between one province and another because of wars, and in the case of certain hollows and caves, (plantations of fruit trees and) cacao trees'. Several other early chroniclers mentioned the presence of cacao trees in northern Yucatan.

These reports of cacao from the state of Yucatan, Mexico, have intrigued scientists for a long time, since the regional soil and climate (1300 mm of rainfall per year) are not appropriate for the cultivation of such a species so well-known for its high demands for humidity. Obviously the only way cacao could be grown in this area would be in areas where the soil humidity could be kept constantly high by natural conditions or by irrigation.

This contradictory information made us start an intensive search for microhabitats where cacao could be grown in this northern region of the Yucatan Peninsula. Our search was based on the belief that cacao or a cacao-related species was grown there and remnant trees would still be found in special microenvironments.

Two possible sites were chosen. One was the home gardens of the present day Maya, these sites are very rich biologically and irrigation is a common practice. Unfortunately, no living specimens have yet been found. This environment is still a possible site, since soils and humidity are controlled.

Another place we looked for cacao was in the sinkholes and large cenotes with deep soils. We suspected that these sites could have been the place for ancient cacao cultivation in northern Yucatan. These microhabitats have high humidity and rich soils available and frequently have water in the bottom. Those with water are the famous 'cenotes' of the Maya area, known in Maya as 'co'op'.

Our hunch and subsequent efforts were rewarded and in the town of Yaxcabá, an old informant told us that in a sinkhole named 'kuyul' in his community there were some trees of cacao. We visited the place and we found cacao trees, one of which was in flower. After that discovery we have been able to find more sinkholes in the same region with cacao trees.

Our informants told us that those trees have been there ever since they can remember, and they protect them as they always do for useful trees found in the forests of the cenotes.

The cacao collections were identified initially as *Theobroma cacao* subsp. *cacao* forma *lacandonense*. Is this a wild cacao? Wild cacao is difficult to distinguish from the cultivated ones. In fact, most of the collections of wild cacao we have been studying are called wild only because they were found in a forest and not in a plantation. But most of the wild cacaos are very similar to the cultivated ones.

The cacao populations of Yucatan are the relics of ancient forest gardens in sinkholes mentioned by the chroniclers. They have been reproducing there through the centuries, providing the genetic continuity through time. These trees have been managed and introduced into human-made environments since remote times. Recent studies (de la Cruz *et al.*, 1995) using random amplified polymorphic DNA (RAPD) genetic markers were used to determine the genetic diversity and relationships between and within wild and cultivated cacao trees. The results of this study indicate that wild accessions are genetically different from the cultivated varieties. The cacao from Yucatan have diverged genetically from domesticated cacaos, and from wild cacaos from Mesoamerica and from the Amazon region. This is a remarkable example of an ancient conservation practice of great potential economic value.

What is the relation of the cacao to the forest management of the Maya? It is one additional forest system managed by the Maya in the past and kept by the present-day Maya. The species in these groves are a mixture of three groups of species: wild species (for example, species of *Ficus, Melicoccus, Bursera*), native useful species (species of *Achras, Pouteria, Annona, Brosimum, Castilla, Quararibea*), and useful exotic species (coconut, *Citrus*).

Three Levels of Conservation

There is a remarkable similarity between the species composition of the cacao groves to the home gardens of the Maya and to the anthropogenic forest gardens of the Maya area.

We are uncovering a continuum that goes from the protected species, to the small home garden to the large home garden and from the forest gardens away from home to the 'natural' forests. The dominant tree flora is very similar in all cases.

These findings help to explain the abundance of useful species in mature forests all over the tropical lowlands of Mesoamerica. If a human occupied area is abandoned, as we know happened several times in the past in that region, the species with the most ecological advantage are those that are already there (Gómez-Pompa and Burley, 1991). Native species will have an additional advantage, and abundant species would have even more of an advantage. The forest dominants will be the tallest and with the longest life span.

In the recovery process that occurs over the centuries, the same trees may not remain, but the populations that will replace them will be direct descendants of the original trees (as the case of the cacao from Yucatan). Many other trees may come from distant places by long-distance dispersal, but the most abundant propagules will come from managed trees from seminatural forests nearby.

The regeneration of the abandoned area will be strongly dominated by the available tree flora which today, as in the past, comes from forest fallows, forest gardens, and other managed or semimanaged areas. If the tree flora is diversity-poor, a poor forest may regenerate. But if the number of tree species is large the forest may be richer.

This is the type of forest Landa (1566) saw and wrote about so eloquently when he said that the Maya had so many kinds of trees that they use and protect that it is frightening. Not so surprisingly, this human-influenced biological richness in mature forests is widespread throughout the tropics of the world.

Final Comments

The three examples from the Maya region are only the 'tip of the iceberg' on the role of traditional people in biological and genetic conservation. The traditional systems of agriculture, and pastoral systems have been based on the diversity of options available and have produced an impressive number of traditional cultivars and land races that are part of a strategic patrimony of humanity as a whole: the thousands of land races of rice in the paddies of Asia, the races of corn and their relatives in the Americas, are examples of this biological wealth. The coexistence of traditional cultivars with their wild relatives is a well-known fact; the gene flow in both directions is an ongoing process that needs to be protected.

However, the conservation of this biodiversity has been left to the local people, without a major effort to support and reward their activities. Local people are indeed the custodians of the most important gene pool for the future of humankind, their archaic methods of conservation have proven successful.

Unfortunately the future does not look very promising. The promises of a better life through intensification of production via green-revolution methodologies are producing a dangerous change in many areas of the world. The change from traditional to modern has had its toll by the loss of many traditional cultivars and land races. 'The principal cause of genetic erosion has been the widespread adoption of modern crop cultivars within areas of ancient agriculture' (Oldfield and Alcorn, 1987).

It is obvious that we urgently need a strategy for the conservation of the genetic pool of plants and animals used by local people all over the world. We have to preserve also the systems of resource management that have provided the environment for the production and conservation of the human-made biodiversity. Unfortunately we lack proven approaches to do this.

Oldfield and Alcorn (1987) described a few approaches that have been proposed that include a system of land village custodians, freezing the genetic landscape, the setting up of a world network of large strips of land under traditional agriculture, subsidies to traditional farmers, scientifically controlled *in situ* reservoirs of crop populations in experimental stations located in the original environment, *in situ* conservation and research stations independent of private farmers and *ex situ* reserves.

In Mexico we are experimenting with a new strategy called the 'Tripartite Alliances for Conservation and Development' that consist of a network of traditional conservation projects of farmers funded through the Mexican

NGO (PROAFT A.C.) which combines several suggested approaches (del Amo *et al.*, 1993). The farmers are encouraged to continue their old conservation methods and PROAFT provides resources to increase the quality of life of the community (land use planning, local reserves, marketing advice, development of local products, education, health services, etc.).

However, this can not be accomplished if local knowledge is lost. This knowledge represents a bank of potential alternatives to be used in combination with present day environmental, economic, and social conditions. Any effort to conserve the genetic resources of traditional systems has to be complemented with research that documents this knowledge.

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