Analog Forestry as a Conservation and Development Approach: Lessons Learned from the International Analogue Forestry Network

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ABSTRACT

The persistent alarming rate of tropical deforestation has lead governments, NGOs and academics to rethink approaches that seek to protect and revitalize the planet's dwindling forest resources. Whereas previous conservation efforts have been top- down, focusing on protecting lands from human intrusion, recent initiatives recognize the importance of integrating, and even catering to, the needs of surrounding local populations that may otherwise provoke forest degradation. There has been, in effect, a shifting paradigm away from a focus on *preservation*, which is seen as both impractical and potentially detrimental to local economies, towards *integrated conservation and development projects* that address both socio-economic and environmental concerns.

This paper will focus on one such approach, the innovative natural restoration system called *Analog* (or Analogue) *Forestry* designed by Dr. Ranil Senanayake, founder of the International Analogue Forestry Network. Analog Forestry seeks to restore degraded forest lands, often replacing inefficient slash and burn agriculture or cattle ranching, with highly productive and biologically diverse regenerated forests capable of meeting the extractive needs of local populations (e.g. firewood, fodder, fruits, nuts, subsistence crops, timber) while supplying them with a supplemental income and an ecologically stable environment. With hundreds of successful demonstration sites around the world, this approach offers a promising solution to recuperate lost biodiversity while addressing human development needs. However, successful implementation requires extensive planning, management, and a high level of commitment by landholders and may not be appropriate where these assets are not available.

> *A tropical rain forest is a supreme and infinitely varied work of art, but, with a touch of human genius, it can be converted into a forest garden system, even more beautiful and vastly more productive. That is why it is not enough merely to campaign for the preservation of the rain forest. It is a compound resource of potentially enormous value to humankind as a whole, if developed-not devastated-in a wise, constructive, sustainable way. Its vast diversity of vegetation, up to now so inadequately studied by science, could be used as a source of new and nourishing foods, of timber for building and crafts, of fibers and dyes for textiles, of medicines, of biomass for energy, of gums, resins and plastics, to meet all human needs, above all the basic soul-need of beauty.*
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> Robert Hart[1]

I. INTRODUCTION

It is likely that each year the planet loses over 17,000 species, mostly due to the destruction of habitat by humans (Olson et al, 1995. p.239). The most prominent example of habitat destruction is deforestation which totals some 16 million hectares annually (FAO, 2001), a land area larger than the size of Greece. Significantly adding to environmental degradation and loss of species, the World Resources Institute (1994) calculates that carbon dioxide levels in the atmosphere are 25% above pre-industrial levels, helping raise the Earth’s temperature by 0.3 degrees every decade. However, almost universal scientific

[1] Forest Gardening, Cultivating an Edible Landscape, 1996 ed. P.126.

recognition of climactic and environmental changes has lead to questionable actual policy changes (Earth Summit, 2002). Instead of requiring reductions in carbon dioxide emissions and providing the resources necessary to implement substantive conservation programs, governments and NGOs alike have been looking for “win win” conservation and development projects which meet conservation needs while providing a level of local economic development.

Starting in the mid-1980s, non-governmental organizations (initially the World Wildlife Fund) began experimenting with Integrated Conservation and Development Projects (ICDPs) which sought to turn the traditionally mutually exclusive goals of conservation and development into a mutually beneficial relationship in which the promotion of conservation would increase local economic prosperity (Hughes and Flintan, 2001). Implicit in the design of these projects was the understanding that most forest degradation is caused by surrounding rural inhabitants who regularly and unsustainably exploit forests for their natural resources (especially fuel wood and timber) and as a source of land for agriculture and cattle ranching (Wunder, 2001). As an example, the Brazilian government estimates that 69% of forest clearing in Amazonia is caused by cattle ranching and agriculture (Barbosa 2001, p.47). ICDPs seek to confront this use of forests as “safety nets” by supplying viable economic alternatives to forest clearing. The most common ICDPs include: employing park rangers in protected areas; nurseries and seed farms which promote afforestation efforts; eco-tourism projects; “extractive reserves” (protected areas designated for the extraction of non-timber forest products –NTFPs– such as fruits, nuts, tannins, resins, dyes, latex and medicinal plants); and agroforestry projects in high impact “buffer zones” (see Hughes and Flintan, 2001 for a review and bibliography of ICDP literature).

However, as Wunder (2001) points out, in most cases ICDPs have been based on “wishful thinking” rather than realistic goals. There is, in fact, general consensus in the current literature that ICDPs have mostly come up short, especially with respect to preserving biodiversity (Brannstrom, 2001, Hughes and Flintan, 2001, and Wunder, 2001). Initiatives that seek to prevent human invasion on protected lands typically suffer from insufficient funding to protect vast tracts of reservation grounds[2], especially in developing countries. Other “buffer zone” initiatives which increase earnings through economic alternatives to cutting forest, in many cases, actually encourage additional forest destruction (Wunder, 2001). A classic example is provided by Carpentier, Vosti and Witcover (1999) who show how a tripling in the farm-gate price of Brazil nuts (the most important Brazilian extractive product) was welcomed by Brazilian extractionists to buy more cows, leading indirectly to advanced forest clearing. As a Stanford University team demonstrated in 1993 (Kremen, et al. 1994), in a survey of 36 ICDPs only 5 showed a positive relationship between development efforts and the conservation goal of protecting endangered species.

Despite this growing body of evidence, the selling value of “win win” conservation with development projects continues to generate high levels of interest and funding for ICDPs (Wunder, 2001). While considerable effort is being placed on determining which ICDP model provides the greatest ecological and social benefits (Hughes and Flintan, 2001), one potentially valuable approach, Analog Forestry, has been almost completely overlooked. Unlike other ICDP approaches, Analog Forestry seeks the complete ecological restoration of degraded or cleared forestlands while providing economic benefits to small farmers. In contrast to typical agroforestry “buffer zone” projects (IPE, 2001) or extractive reserves (Browder, 1992), which place a priority on income generation, Analog Forestry treats income generation and ecological benefits on equal terms, potentially overcoming ICDP shortfalls.

This paper outlines the potential of Analog Forestry (AF) as both a conservation and development tool. Part II defines the major elements of AF and discusses the traditional forestry practices on which it is designed. Part III describes the history and functions of the International Analog Forestry Network, which is currently implementing AF in 9 countries around the world. Part IV discusses both some positive and negative aspects of AF highlighting both ecological and social benefits as well as some major challenges. Experiences of Analog Forestry in South American tropical forests are used to highlight some important

[2] In 2000 the Brazilian government announced a plan to actively preserve 10% of the Amazon by placing guards on vast tracts of land. See CNN report at:
http://www.cnn.com/2000/NATURE/05/14/brazil.rainforest/

issues confronting the implementation of Analog Forestry. A conclusion in Part VI offers some thoughts on the future of Analog Forestry.

II. ANALOG FORESTRY

Defining Analog Forestry

The term Analog Forestry was coined by systems biologist Ranil Senanakaye in 1987 after several years of experimentation with sustainable forestry systems in Sri Lanka. As defined by Senanayake (1997),

> *"Analog Forestry is a system of forest management that seeks to establish a tree dominated ecosystem analogous in architectural structure and ecological function to the original climax or sub-climax vegetation community. It seeks to empower rural communities both socially and economically, through the use of species that provide marketable products."*

In practice, Analog Forestry systems restore degraded forestlands, often replacing inefficient slash and burn agriculture or cattle ranching, with highly productive and biologically diverse regenerated agro-forests capable of meeting the extractive needs of local populations (firewood, fodder, fruits, nuts, subsistence crops, construction materials, timber) while supplying them with a supplemental income and an ecologically stable environment.

According to Senanayake's definition, species are selected for planting which mimic the "architectural structure and ecological function" of the natural forest. That is, AF asks "What trees? When? Where? and Why?" and looks at the natural system to provide the answers. Using the process of natural regeneration in the local ecosystem as a guide, species are selected which meet the identical ecological requirements (i.e. species family, physiognomic characteristics and habitat functions) but which may also provide human needs. It is important to note that these species may be either natural or exotic, the only determining factor being whether they adequately mimic endogenous species in the surrounding forest. Particular emphasis is placed on *keystone species* which provide essential ecological functions, such as food and microhabitat, on which the rest of the system relies.

Increased biodiversity is the underlying goal of any AF design. The idea is that increased biodiversity is essential for the stability and productiveness of the system. This implies that a significant portion of the analog forest species will have no direct human use. In terms of plantings, Senanayake (2001) maintains that a minimum of 10 to 20 percent of plantings are non-target species, having purely ecological value. Other colonizing species are encouraged as an implicit part of the design. *Indicator species*, which may be non-plant such as frogs, snakes or insects, are monitored to determine the overall health of the forest.

Conversion from pasture or agricultural land to full canopy forest may take several decades to develop depending on the particular ecosystem, climate, weather and the needs and management capacities of the land managers. The transformation from the original ground cover vegetation to more diverse shade producing plants, bushes and trees occurs in successive stages over time as plants compete for light, water, nutrients and space (Senenayake, 1998). Eventually, low shade tolerant plants will give way to higher canopy trees and shade tolerant plants in a process known as seral stage succession (see figure 1).

Seral Stage Succession
Source: Counterpart International

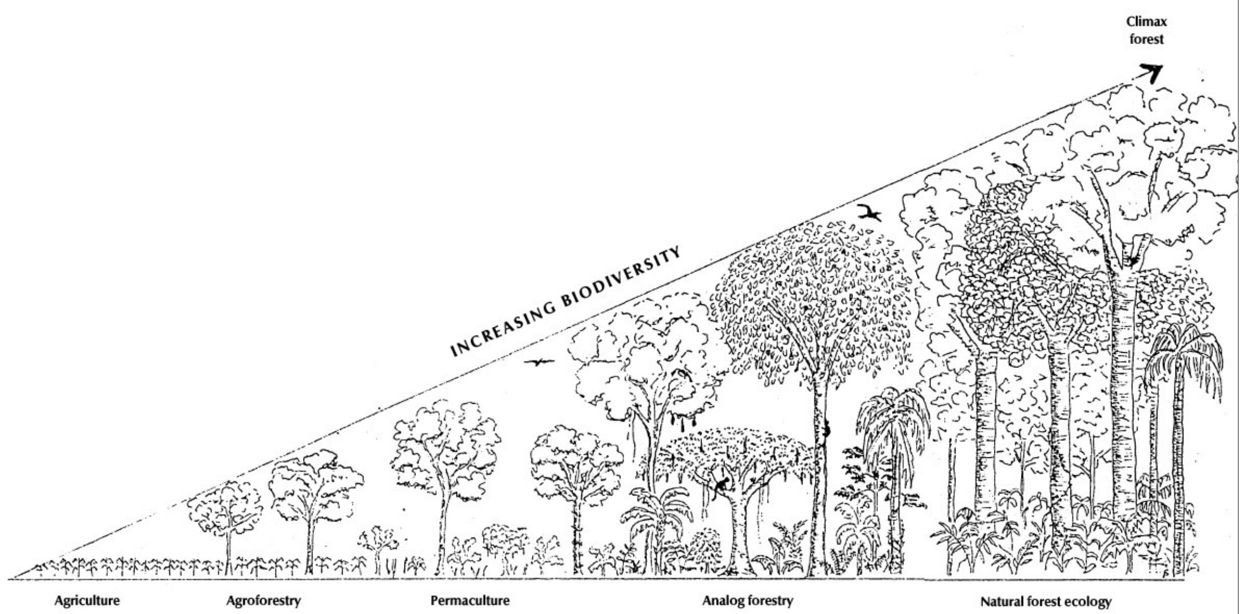

Figure 1. Successive seral stages provide increasing soil stability, biodiversity and canopy cover.

In total, 7 strata may be identified in analog forests which provide a complex supply of forest products (Hart, 1996 ed.) including "the canopy" (timber, latex, resins, or bark-used for medicine), low growing trees (fruit, nuts or building materials), the shrub layer (berries, coffee, tea, bamboo), the herbaceous layer (herbs, vegetables and spices), the ground layer of plants (including herbs and medicinal plants), the shade tolerant "rhizoshpere" of root plants (vegetables) and the vertical layer of climbing vines (construction materials). This diversity of products under climax or sub-climax forest is the ultimate goal of small farm analog foresters. By focusing on systems maturity, AF seeks the maximization of forest productivity and stability for the particular landscape.

As a conservation approach, Analog Forestry, when successfully implemented, provides more ecological benefits than other farming systems because it focuses on the development of mature, multi-strata, full canopy, biologically diverse forests which provide an optimum of ecological functions. These include increased biodiversity, improved nutrient cycling, soil and water conservation, pest control, and carbon cycle benefits. Thus, Analog Forestry systems may be distinguished from other cultivated re-vegetation land management systems, such as plantations, agroforestry or permaculture, in that they reap the environmental benefits of mature ecosystems. According to Senanayake, agroforestry is primarily economically motivated while permaculture is "more a system of agriculture than forestry" (Senanayake, 1998. p.56)[3]. Senanayake (2001) identifies a focus on non-target biodiversity and systems maturity as the

[3] Analog Forestry is in fact referred to as a system of Permaculture on the Analog Forestry website: www.forestgarden.org. While Analog Forestry certainly resembles Permaculture, a distinction may be made in terms of the focus of the design. Permaculture often aids the natural restoration process in buffer zones between the intensely managed agricultural plots and the surrounding ecosystem in order to increase the sustainability of agricultural production. Analog Forestry, on the other hand, may be seen as the intense management of these buffer zones to produce a maximization of both human and ecological benefits. Most Analog Forestry designs incorporate polyculture agricultural plots outside of the analog forests to meet the subsistence needs of the land managers. It seems that for Permaculture, ecological

AF's two most distinguishing characteristics. Analog Forestry may also be one of the most effective ways of sequestering carbon. Senanayake argues (2001) that 99 percent of forest biomass is something other than trees. This would suggest that plantation forestry projects, totaling over 3 million hectares annually (FAO, 2001), may do little, in comparison, to capture and store atmospheric carbon. This attention to the ecological functions of fully regenerated forests provides significantly greater ecological benefits with Analog Forestry.

Traditional Forest Management Practices

Sustainable forestry has been practiced by traditional societies for thousands of years in many parts of the world. In the rural Amazon, for example, pre-Columbian societies outnumbered current Amazonian inhabitants, yet they managed to live within the forest ecosystem without causing massive losses of biodiversity or forest degradation (Smith and Fik, 1995 p.251). These were not merely hunters-gatherers, but highly sophisticated land managers with an intimate knowledge of the ecological requirements of the plants within their forest environment. The Kayapo of Brazil, for example, are legendary for walking the forest with a small bag tied to their hip filled with seeds, which they plant when the conditions for successful germination are right (Shulz, et al., 1994). Other areas are burned and planted with successive plant and tree species which maximize the productivity of the land (taking advantage of edge effects between seral stages[4]). In Tanzania, on the sides of Mount Kilimanjaro, snow melt is captured by the Chagga in a complex array of irrigation canals to create seven tiered forests planted with over a hundred different species. These forests are capable of maintaining most of a family's dietary needs, in addition to subsistence crops, building materials and medicine, even though plots average only 0.68 hectares (Hart 1996 ed. P.118). Such traditional forest management systems have been described as "structured caos" (Shultz, et al. p.61), or "ecosystem domestication" (Michon and de Foresta, 1999). These pseudonyms are also appropriate for Analog Forestry, which seeks to recreate the complexity and harmony of nature using a blend of traditional knowledge and science. In this way, Analog Forestry is intimately tied to the sustainable forest management practices of indigenous peoples around the world.

Analog Forestry is particularly modeled after Sri Lankan homegardens (or forest gardens), which are highly productive small plots located near the home in traditional rural communities. With limited land resources and an ever increasing island population, Sri Lankan homegardens are an important part of rural tradition and an important economic generator. According to Senanayake, these plots are a "product of generations of farmer experimentation, cultural and spiritual beliefs, and economic necessity" (Sananayake and Beehler, 2001). As an example of the productivity of Sri Lankan homegardens, one plot is reported to have contained 20 species, of which 18 are exotics (as apposed to the Kayapo system in which all species are native[5]), which produce such high value crops as nutmeg, mango, cashew, black pepper, coffee, ginger, tea, cardamom, and rattan (Senanayake and Beehler, 2000). This emphasis on high value crops suggests that if Analog Forestry is to be carried out on a large scale, sophisticated marketing and distribution channels need to be developed. Partly for this reason, the International Analog Forestry Network was created.

III. THE INTERNATIONAL ANALOG FORESTRY NETWORK

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restoration is necessary to provide security for agricultural production, while for Analog Forestry, agriculture is necessary to provide security for the ecological restoration process. Senanayake recognizes this overlap and in fact calls on a synthesis of ideas between Analog Forestry, Permaculture and Agroforestry.

[4] "Edge effects", commonly encouraged in permaculture, take advantage of the highly productive stage of vegetation development when one species overtakes another. The Kayapo assisted in this process by cutting back or eliminated plants that had surpassed maximum production, keeping the overall system "young".

[5] Here the size of land mass may be important. The Amazonian dwelling Kayapo had at their disposal plant species which covered an area the size of Europe and are known to have traded seeds with other indigenous peoples throughout the Amazon. Sri Lanka, on the other hand, with a land mass roughly the size of the state of Nevada (65,000 sq. kilometers) provided obvious barriers to finding useful analog species.

The beginning

After receiving his Ph.D. in systems ecology at the University of California, Davis in 1978, Ranil Senanayake returned to his native Sri Lanka to put his knowledge to practice. Already a third generation social activist[6], Senanayake was confronted with the paradigm of "green revolution" thinking by the government and multi-lateral organizations which were promoting monoculture tea and coffee plantations as well as monoculture plantation forestry (Eucalyptus, Teac and Pine) on the island. Mr. Senanayake was appalled at both the environmental degradation this caused, as well as the loss of traditional farming practices and a dependency on industrial farming inputs. In 1980, Senanayake co-founded the Neo-Synthesis Research Center (NSRC) on a small tea farm in Mirahawatte to prove that traditional farming practices could be both more productive and actually help restore the natural environment. Using the Sri Lankan homegardens as the model, the NSRC sought to create a system that could be replicated in other areas through scientific research, to study and improve upon the system, and farmer-to-farmer extension. According to co-founder Jerry Moles (2001), "the focus was on intensifying the production of the forest gardens by selecting planting materials based on yields, changing the gardens' species compositions to increase incomes, improving the processing of existing crops, introducing new crops compatible with the ecology of the gardens and cultural practices, and composting to provide additional nutrients." These principals lead to quick and significant results.

The NSRC research demonstration plot became the principal teaching tool. Farmers were invited from neighboring farms to share experiences and to learn sustainable farming techniques that would improve their output and increase profitability. Through these initial experiences "the scientists became farmers and the farmers became scientists" (Senanayake, 2001). To help market the increased production Senanayake created an organic foods company called Lanka Organics which would become the largest organic food exporting company on the island. Soon, this blend of traditional farming practices, scientific input and business savvy caught the attention of an increasing number of farmers, leading to an increasing demand on the extension office and nursery which could no longer handle the demand for information and planting materials (Moles, 2001).

With a limited budget Senanayake turned to the international community for support. He began teaching the principles of what he called *Analogue Forestry* (1987) at Monash University in Australia in order to finance NSRC's research and extension work in Sri Lanka (Senanayake, 2001). Two years later, he became the director of the environmental policy NGO called the Environmental Liason Center International (ELCI) in Nairobi, Kenya. Here Senanayake met organizations from around the world interested in confronting the monoculture plantation paradigm. ELCI proved fertile ground for the propagation of Analog Forestry on an international scale.

The International Analog Forestry Network

In 1994, ELCI became the coordinator for the International Analog Forestry Network which was established to assist local organizations in countries around the world to adopt Analog Forestry. Through experimentation, and taking into consideration local sustainable forest management practices around the world, it was soon found that the basic principles of Analog Forestry were applicable in a broad range of climates and environments. The first International Workshop on Analog Forestry was held in Sri Lanka in April of 1995 with participants from 7 countries (Both Ends, 2001). An Analog Forestry Manual (Falls Brook Center, Canada, 1995) was provided to participants who carried the ideas back to their home countries. While Senanayake published a formal textbook on the subject in 1998, the manual has served as the principal learning material for interested NGOs and land managers.

Implementation typically requires an initial workshop sponsored by a local NGO followed by an extensive survey of the area's autochthonous plant species. Once the important keystone species (for ecological

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[6] Ranil's father, Upali Senanayake, founded the National Heritage Trust of Sri Lanka which organized 50,000 farmers in revolt against the government to gain better access to water resources in the 1960s. He also successfully organized 640,000 school children to participate in volunteer days to help weed rice paddies in the tradition of Sri Lankan farming. Upali's father was famous for leading the struggle against British domination a generation earlier.

stability) and high value species (for food or income) have been identified based on species analogous or identical to ones found in the natural system, a nursery is established to provide the necessary seedlings for planting. This nursery will eventually provide a small income for the farmers who may sell the seedlings to other farmers. The next step requires land managers to accurately map their forest garden design using the species that have been identified using a "basket" approach (Chambers 1997). That is, the farmers are given a "basket" of options to choose from in order to successfully plan their design. At this point, as Becker and Goldman (2001) point out in their analysis of Analog Forestry projects, "Program personnel must take time to build relationships with the people among whom they will work, gaining their confidence and trust. Only dialogue, requiring critical thinking, is capable of producing critical thinking. Without dialogue, communication is impossible." This classic Freirean "participatory" approach engages farmers to make the decisions that best suit their needs. Once the project has been successfully implemented on a demonstration plot, with clearly visible benefits, other farmers are likely to adopt AF practices on their own lands, with the help of farmer-to-farmer exchanges.

Currently, through the work of the International Analog Forestry Network, hundreds of villages are implementing AF through the Network's affiliate organizations in nine countries (Sri Lanka, Australia, the Philippines, Kenya, Canada, Mexico, Costa Rica, Ecuador and Peru). A key partner for the IAFN is Counterpart International, Washington D.C. which administers funds from the US Agency for International Development through its Forest Gardens Initiative (explained below).

Counterpart International and the Forest Gardens Initiative

After the International Workshop on Analog Forestry in 1995, AF began to encounter the same growing pains it had experienced in Sri Lanka when the Neo-Synthesis Research Center could no longer keep up with demand. As organizations began to implement AF in rural areas around the world it became increasingly necessary to find an outside source of funding to facilitate extension services, start up capital, marketing and technical assistance. In 1997, IAFN came to an agreement with Counterpart International (CI) to establish the *Forest Gardens Initiative* with a five year matching grant from USAID. The project was designed to assist participating NGOs in developing sustainable farming through (Senanayake and Beehler, 2000):

- *A network of seedling nurseries and community seedbanks* – These are locally developed to provide farmers with the necessary plant and seed stocks.
- *A seeds-and-tools fund* – This microcredit scheme helps to alleviate the initial cost burden of implementing the new farming system which may not produce immediate results.
- *Technical assistance and training* – Technical assistance is provided by the local NGO with the help of locally trained extension agents, who may be the farmers themselves.
- *Companion rural educational materials* – These locally adapted "popular" educational materials may include instruction in "improved farming, farm-based enterprise, nutrition, family health and management of the local environment"
- *Certification* – A system of environmental certification was established for Forest Garden Products (FGPs) "which guarantees all products are produced using organic principles and that such products come from systems that benefit rural environments" (see below).
- *Marketing* – Extension officers help seek out markets for products produced on AF farms, assist in product design for crafts (if produced) and do quality control for eventual certification and marketing of certified Forest Garden products.

Counterpart International was incorporated to address some of the most pressing needs to launch Analog Forestry on a global scale. Because project participants are usually poor rural farmers with extremely limited resources, even the smallest amount of capital investment may prove prohibitive unless significant benefits are guaranteed (Becker and Goldman, 2000). With the additional input provided by local NGOs, Counterpart International and other aid organizations have established a platform for technical and financial assistance which provides project security by building on the needs of farmers and establishing long-term production goals. Primary among these goals is the maintenance of family food security. A market for surplus crops is then established locally until improved capacity allows for regional or even national distribution.

The end goal of certification as Forest Garden Products for international distribution is one that is taken calmly. The high demands for producing export quality products fit for certification is always recognized from the beginning. However, in Sri Lanka, where Analog Forestry has been in place for over twenty years, a market for certified organic forest products has been established over time as production capacity and markets have been solidified. Certified Forest Garden Products produced in Sri Lanka (including coffee, tea, honey, nuts, spices and syrup) are currently being sold in Sri Lanka, Australia, and Canada and are being sold on an experimental basis in Europe to niche markets. Certification and marketing have increasingly become a focus of the IAFN to encourage the viability of Analog Forestry. The idea is that by implementing Analog Forestry, not only will farmers benefit from increased productivity, income diversification, and a healthy environment, but they are granted support from an international network of NGOs which will help them market their products on a regional, national and possibly even global scale.

Figure 2. Official FGP Logo

In short, the International Analog Forestry Network has established a support system to promote Analog Forestry in rural communities around the world. The long-term feasibility of Analog Forestry as a conservation and development tool will depend largely on the success of demonstration forest plots to achieve the desired ecological and social benefits as the forest gardens mature and to encourage other farmers to follow the lead of Analog Forestry pioneers on their own. The next section will look at some of the factors which may influence the overall success of Analog Forestry projects.

IV. ANALOG FORESTRY: BENFITS AND CHALLENGES

Ecological (Conservation) Benefits

The ecological benefits of Analog Forestry are manifest in its design. As a forest management system which restores degraded lands to approximate the architectural structure and function of natural forests, it is clear that all major ecological services can be restored if properly managed.

At the local level, water cycling and soil stability are improved through improved nutrient cycling created by increased plant and animal biomass (Jones Sauer, 1998, p.154). Soils are both retained and rebuilt as the nutrient cycling increases through successive seral stages of forest growth. The increased biodiversity leads to dramatic increases in litter fall from shade producing trees. On one cacoa farm in the Brazilian Atlantic forest, litter fall increased by 400 percent after introducing AF techniques while 17 creeks appeared on the land where previously there were none (Shultz et. al, 1994). This is not surprising as forests may absorb over 85% precipitation which is converted to aquifers and stream flow (Jones Sauer, 1998, p.131). These soil and water improvements form the basis for the other important ecological benefits of increased biodiversity and carbon sequestration which have more far reaching implications.

The restoration of natural biodiversity is particularly beneficial to the surrounding ecology as habitat for endangered species increases the likelihood of species survival. This would indicate that promotion of Analog Forestry in “hot spot” corridors would be particularly attractive in endangered South American forests such as the Brazilian Atlantic forest where less than 8% of the forest cover remains (Bright and Matton, 2001). Recent efforts to restore some of the most precious corridors in Brazil have attempted agroforestry designs (Cullen, 2001) to provide agroforestry “buffer zones” around existing stands of endangered forest fragments. The idea is that the agroforest surrounding the forest fragment will be able to supply the extractive needs of the local population (e.g. fuel wood, food, fodder) instead of depleting forest resources from within. However, despite the popularity of these projects (Wunder, 2001) they have generally failed to show improvements in increasing biodiversity (Kremen, et al. 1994). According to

Brannstsrom (2001) the reason for this failure is due the fact that these projects "poorly define environmental problems, deploy poor conceptions of spatial scale, and propose untenable resource-governance schemes for agro-pastoral landscapes." As an example of how these projects may work, one such "buffer zone" project provides a nursery supplied with multiple-use trees seeds of which 60% are planted in the buffer zone according to the needs of the landholders. While this is a very participatory approach, there is no analysis as to What trees? Where? When? and Why? If this project is indicative of other similar projects, then it seems that implementation Analog Forestry concepts may be able to increase the ecological benefits.

When properly adapted to local needs, Analog Forests will also limit the demands on the surrounding forest to provide timber and non-timber forest products (NTFPs). Analog Forests are designed to meet the extractive needs of the local community to provide food, fuel, fodder, medicinal herbs, timber and construction materials for both consumption and income. According to Lorena Gamboa of IAFN affiliate Rainforest Rescue in Ecuador, one participating pastoral community of colonists in the highlands near Peru has reduced tree felling in the surrounding forest by 80% since incorporating Analog Forestry into its regular activities—the other 20%, according to Gamboa, is only for household construction materials. This is due to increased income opportunities generated through the sale of other AF products, in this case fruits, nuts and handcrafts. This represents a common trend in Latin America indicating that agriculture is more profitable than logging (which only fetches between $10 and $50 per tree depending on the tree — Cofer and Byron, 2001, p.34). According to Porro (in Cofer and Byron eds. 2001, p.305), "logging companies also are sources of cash for colonists who have trees to sell but the income obtained is small compared with that of agricultural production. With increased income opportunities and a constant supply of forest products, extraction from surrounding forest becomes unnecessary with analog forests.

Another of the most important ecological benefits of Analog Forestry is the potential for analog forests to sequester CO2 from the atmosphere through the accumulation of forest biomass. While monoculture fast-growing production plantations are still "the major response to deforestation worldwide" (Senanayake, 2000), Mr. Senanayake showed in a recent study published for the World Bank (Senanayake, 2001) that 99% of forest biomass is "something other than trees", notably soil and vegetation. Senanayake (2000) adds:

> *"For the purpose of sequestering carbon the most productive forests are those that have a long standing life as well as a high potential to develop deep organic soils. Commercial monocultures have a disadvantage in this respect as they are harvested for timber after a set period of time and develop deep organic soils very rarely. A better model is provided by a polyculture with long rotation times, such as that seen in some forms of traditional forestry, where a high diversity of tree species with good development of organic soil has been recorded. Further, as the trees used in this approach to forestry are crop species, which will produce larger yields as the trees mature, there is a disincentive to fell the trees unless they are diseased or very old."*

The significance of this research could be great if an international market for carbon trading is established as described under the Kyoto protocol. The winner of the debate over which forests provide the greatest carbon sequestration will likely reap the benefits of this potential multi-billion dollar industry (WRI, 1994) which will award carbon credits (worth potentially millions of dollars in tax savings) to companies that successfully mitigate their carbon emissions. In a recent 15 million dollar deal between General Motors, American Electric and the Nature Conservancy, 10,000 hectares of land were set aside for reforestation in an effort to capitalize on future carbon trading (Bright and Matton, 2001). This market, if established, could provide unheard of sums of money to fund reforestation efforts, such as Analog Forestry, in the near future.

Social (Development) Benefits

The conversion of degraded land into highly productive Analog Forests provides some significant social benefits. An Analog Forestry project sponsored by Rainforest Rescue in Ecuador serves as a useful example below.

The community homesteaded a fifty-hectare plot (the minimum size for homesteading) in the highlands of Ecuador approximately 30 years ago (Gamboa, 2001). In order to show that the land was in productive use —a government requirement— the colonists burned the land and converted it to pasture for cattle, as is typical of the area. As a result of these practices, only roughly one third of Ecuador's original forest remains (Bright and Matton, 2001). Cattle are used for both meat and milk, however due to increasingly poor soil conditions, production is extremely low. According to Lorena Gamboa, Rainforest Rescue's director, virtually all the milk is sold locally to Nestle for a minimal profit (22 cents per liter) leaving no milk for local consumption. Gamboa adds that Analog Forestry has been a welcomed alternative to this "cycle of poverty", providing significant social benefits.

Most significant among these social benefits are improved food security and health. According to Gamboa, the community previously imported all of its food, whereas now it produces 60% of what it consumes. The diversity of food crops grown in the AF system (e.g. staple crops including rice and yucca, vegetables, fruits, nuts, herbs and spices) has added to a diversified, more nutritious diet. Additionally, local exchange of food products has been established creating a small local market for forest garden products. Medicinal plants are also grown in the community. "Now", says Gamboa, "when (the farmers) get sick, the first thing they do is go to the medicinal herb garden". Thus, Analog Forestry has helped meet the minimum health and nutrition needs of the community.

In addition to these benefits, surpluses are sold in local markets. This extra income has helped the community to expand its production capabilities and now produces handcrafts made from bamboo and other building materials produced on the farms which are sold in a small store run by Rainforest Rescue in the banking district in Quito. While the quality of production is not good enough for export as Certified Forest Garden Products, Quito provides an important and stable market. With newly generated income the farmers have also been able to reduce the amount of milk sold to Nestle and convert it to consumable products such as cheese and *manjar de leche.* It is hoped that continued production will enable the community to negotiate for electrical power to the village which will further increase the standard of living and production capabilities by allowing refrigeration (for milk products) and small electric tools for handcraft production. Analog Forestry has clearly allowed the community to diversify its income generation possibilities over the course of the year.

In addition to the social and economic benefits associated with increased food and crafts production, Gamboa notes many cultural benefits as well. Because the increased land management activities require the participation of the entire family, everyone must be involved in project planning and implementation. This means that women and children play a particularly important role in the new farming system allowing for more equal participation by all family members. Additionally, the community benefits from improved technical abilities and the accompanying social status with surrounding communities. According to Gamboa[7],

> "On a social level we notice that (the farmers) are proud of their work and have gained new social status and a sense of community for being self-sufficient. There has also been a significant increase in their knowledge and we have seen some of them become quite capable technically. They can explain the changes on their land and this has allowed them to gain social status. People come to visit their communities to learn from them."

Gamboa counts these less tangible outcomes as the most fulfilling part of her participation in the project. Certainly, there are other social benefits that go unnoticed.

In summary, using the Ecuadorian demonstration plot as an example, it seems that the positive outcomes may be sufficient to allow for the successful implementation of Analog Forestry in other areas. Keeping all these benefits in mind, however, it is important to recognize the many challenges that confront Analog Forestry and its widespread implementation.

Challenges

Not all Analog Forestry systems are successful. Senenayake (1998) outlines in detail a project that was abandoned in Australia due to poor land management practices which left the plot insufficiently weeded. Becker and Goldman (2001) also mention a rate of project withdrawal, though it is not clear how often this occurs from the available literature, almost all of which is produced by the IAFN[8]. There are, in fact, many factors which may limit the potential success of an Analog Forestry project. Any one of which, when

[7] Translated from interview in Spanish (Gamboa, 2001).

sufficiently strong, may prevent the project from achieving its initial objectives or result in project abandonment. Because every project is different, risk analysis is an important consideration for project design.

Perhaps the most important limitation of Analog Forestry projects is simply their nature as (conservation and development) projects. A project needs external inputs (information and capital) in order to function. In the case of Analog Forestry this means that relatively high levels of technical and financial assistance are necessary to get the projects off the ground. Counterpart International provides considerable project support including financing for nurseries, a *seeds and tool fund* (which implies a credit dependency), extension services, educational materials and marketing assistance. This dependency on outside assistance (especially foreign assistance) may preclude poor farmers from adopting Analog Forestry practices on their own. It is also not certain what will happen when Counterpart International's five-year matching grant from USAID runs out in 2002. If AF projects do not demonstrate their sustainability (i.e.independence from external funding sources) the IAFN will face the very real threat of abandonment by funding agencies (for an example of this see the Fair Trade analysis below).

This problem is exacerbated in poor communities with little knowledge of the forest ecology, such as is the case South American colonist communities in the tropical forests. In Sri Lanka, Analog Forestry incorporates traditional forest management practices. In South America, however, indigenous populations, holders of a great wealth of ethnobiological knowledge, have been largely decimated in tropical forest communities. According to Roberts (1993), "The single biggest danger to the Amazon may well be the loss of the indigenous knowledge." The current inhabitants, on the other hand, have rarely lived on the land more than two generations, and have almost no knowledge of non-utility species, which may be critical to the AF design (Senanayake, 2001). In fact, AF often requires that some productive exotic species be brought in to replace essential non-productive keystone species. The problem here is not the land managers will be reluctant to plant an exotic species which will proved them with forest products, but that the science to determine which exotic analog species may actually replace a native species requires a dependency on extension agents to provide this information and to help with the project design. This dependency on external inputs requires a network of organizations, sufficiently funded to provide these services. It cannot be expected that farmers will readily pass their knowledge on to others without some kind of incentive (i.e. payment) which poor farmers will likely not be able to provide to more successful farmers, or at the least, that adoption of these techniques will occur quickly without some kind of outside assistance.

Not only is there a dependency on extension agents for funding and information, but also the ability of the extension agents to form trusting relationships with farmers is a crucial element of project success (Becker and Goldman, 2001). Farmers may be reluctant to experiment with new land management techniques if they are not confident that changes will achieve the desired results. This level of confidence and belief in the system is crucial as proper land management requires extensive planning, land preparation, planting, nursery tending, weeding, composting, water management, thinning, harvesting, marketing and product design and experimentation. Undertaking this endeavor is no small task and requires a high level of faith that the risks are low. But of course, there are many 'wild card' factors, such as bad weather, market fluctuations, political uncertainty, land tenure issues and socio-cultural factors, which add risk to the project. Farmers need to be confident that they will be able to overcome these risks before investing large amounts of time and money in adopting new technologies.

There is also a very real possibility that land managers will prefer a particularly productive seral stage of succession (for example when fruit trees are dominant) over a tree dominated high canopy mature forest sough after with Analog Forestry. As Smith and Fik note (1995) "few agroforestry fields appear to be

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[8] This is by no means any fault of the IAFN and should not imply that IAFN members produce overly glossy literature. The IAFN members are acutely aware of project limitations and have demonstrated this in their available materials. The problem is that, as mentioned earlier, AF has been almost completely ignored by academic literature. An analysis of several academic databases for "analog (or analogue) forestry" resulted in only one citing, Ranil Senanayake's 1998 book, "Analogue Forestry, an Introduction", Monash University Publications, Australia.

commercially productive (in the Brazilian Amazon) with more than 15 species, presumably because of competition for light and nutrients". Small farmers with limited land resources may be particularly reluctant to dedicate precious land to mature forests. Senanayake (2001) and Gamboa (2001), contend that both a belief in the system and the promise of certification will encourage farmers to follow through with full implementation of AF (where land is available). While it is difficult to challenge the first assumption, the second is much easier. Certification relies on the establishment of niche markets to sell products at a premium price. As has been demonstrated with other Fair Trade products, this market share is difficult to establish and requires considerable marketing services (Oxfam, 2000). In Europe for example, despite intensive efforts through a solid network of NGOs, distributors, importers, and labeling organizations[9], overall sales have stagnated in recent years (EFTA, 2001). While the sale of some FT products is on the rise (e.g. coffee, tea and chocolate) other products have taken a sharp downturn in sales, particularly handcrafts. Some major FT distributors have even closed their doors (Oxfam FT in the U.K. and Alternativ-Handel in Norway) leaving hundreds of producer communities without a market. In short, linking the success of Analog Forestry to the production of high quality marketable certified goods seems like an unrealistic goal and less bio-diverse forms of agroforestry may provide less risk and higher returns for small farmers.

There are other major agro-business related hurdles to cross for the successful marketing of products produced in analog forests. When considering the five most profitable species in the Amazon, for example, none of them would be appropriate for production in analog forests, even for sale in local markets —*Brazil nuts* require a very particular micro-habitat, *latex* is grown on large scale plantations and has synthetic substitutes, *palm hearts* require the entire plant to be cultivated and take many years to grow, and *Cupuaçu* and *Guarana* are perishable fruits that cannot be transported over any considerable distance). It is also important to note that as a polyculture system, AF produces small yields of many products, resulting in difficulties establishing markets, high transportation costs and a lack of consistent supply that most buyers want.

These difficulties bring us back to other forest management and sustainable agricultural practices such as agroforestry and permaculture. While Analog Forestry may indeed supply a maximization of ecological services, this may well not be the priority of land managers interested in increasing production outputs. Analog Forestry requires extremely intensive land management which may not be desirable, or even possible, for most land managers, including small farmers. Permaculture design and management in the style of homegardens may be an attractive alternative (although still highly labor intensive) for farmers not interested in dense canopy cover.[10] Others may be interested in less ambitious agroforestry or polyculture systems depending on their needs. In the Amazon, for example, most polyculture systems have a maximum of four or five species intercropped; this is considered to be a maximization of production (Smith and Fik, 1995). Of course others will choose to invest in extensive tracts of land for monoculture tree farming in the belief that producing woody biomass is the best way of achieving CO_2 sequestration, and of course, profits.

These are only a few examples of the many challenges which may confront farmers implementing Analog Forestry. Each landholder of course will have very specific needs and ecological conditions to take into consideration when deciding whether to adopt this system.

IV. CONCLUSION: THOUGHTS ON THE FUTURE OF ANALOG FORESTRY

Analog Forestry offers a seemingly effective agroecological[11] approach to convert low output and environmentally destructive land use systems into highly productive and ecologically sound forest gardens[12]. By mimicking the natural forest ecology Analog Forestry optimizes the conservation of ecological functions such as soil stability, water and nutrient cycling, biodiversity and CO_2 sequestration. Additionally, land managers will benefit from the production of valuable food and utility crops which may

[9] Called FINE for the first letters of the organizations FLO, IFAT, NEWS! And EFTA

[10] AF forest gardens, according to Senanayake (1998), have at least 60% tree shade, while homegardens have under 40% tree shade.

[11] See Altieri (2001) for a complete discusion of agroecological principles.

[12] Some biologists may be concerned however, about the reliance on exotic species.

be either consumed or sold on local —and perhaps even international— markets. The blending of science and traditional knowledge makes this system particularly valuable and attractive in communities, such as Sri Lanka, with long established ethno-biological traditions. However, we have seen how the implementation of this system on a large-scale necessarily confronts a host of obstacles.

Yet Analog Forestry must not be viewed independent of other international movements working towards the adoption of agroecological principles. In the United States, for example, organic food production has undoubtedly moved into the mainstream. Thanks to scientific research, the ability of polyculture systems to preserve ecological services and increase output is now increasingly well recognized, though still only incipient (Altieri, 2001). Permaculture is quickly spreading across the globe as small-scale farmers become aware of the benefits of preserving natural ecological functions through bio-mimicry. Perhaps most importantly, traditional knowledge is increasingly being recognized as an essential element towards preserving natural environments. For those interested in preserving both the conservation of the environment and the economic development of rural economies, the question is, "how can farmers be convinced to replace existing strategies with new ones?" Unfortunately, the answer is not simply a question of whether the farmer has access to the appropriate information, which is in itself a major obstacle, but whether that farmer has the desire, or even opportunity, to take the risk of adopting a new land use system.

In the end, land managers will weigh their own cultural, ecological and particularly economic objectives when making decisions about land use. The use of demonstration plots, as exemplified by the work of the International Analog Forestry Network, is a potentially effective way to prove the viability of this system. However, there is a need for convincing evidence that the adoption of Analog Forestry, or any other agroecological system, provides significantly greater economic benefits over other possible land use systems given the costs and risks involved.

Analog Forestry, and indeed the concept of sustainable agriculture in general, is still in its infancy. Wide-scale implementation of this system will depend not only the success of the IAFN to demonstrate the viability of the system, but on a shift in the paradigm away from conventional high technological input farming towards more ecological approaches. In the meantime, Analog Forestry is a nice step in the right direction.

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