Small-scale Forestry (2009) 8:77–93
DOI 10.1007/s11842-008-9068-9

RESEARCH PAPER

Guiding Principles for Small-Scale Forestry in a Watershed of the Venezuelan Andes: Constraints and Opportunities

A. Torres-Lezama · E. Vilanova · H. Ramírez-Angulo

Accepted: 9 June 2008 / Published online: 10 July 2008

Abstract In the Venezuelan Andes, some small-scale forest plantations have become an important resource basis for forest management. In this paper, the forestry management progress in the Mucujún river watershed is analyzed. Constraints and opportunities for sustainable management within national policies, local regulations, environmental features and social benefits are also examined. Plantation assessment, and biophysical, legal and socioeconomics information, are used for guiding small-scale forestry practices in this watershed, with emphasis on the main principles of landscape management. These plantations have become an important part of the socio-ecological landscapes with potential for wood production—in the context of low intensity and low environmental impact environmental services and amenity—because of the two protected areas within the watershed. Current forest stand conditions, however, reflect that management requires improvement. Furthermore, the analysis suggests that improvement of local livelihoods may be achieved with a small-scale forestry approach, taking properly into account the basic criteria of social involvement and management of planted forests, while maintaining ecosystem services including biodiversity and water supply.

Keywords Ecosystem services · Forest plantations · National policies · Socio-ecological systems · Sustainable management

Introduction

A new and more holistic approach to assess and improve forest management has emerged in recent years as a response to the critical status of world forests,

A. Torres-Lezama (✉) · E. Vilanova · H. Ramírez-Angulo
BIODESUS Research Team, Institute for Forestry Development (INDEFOR), Universidad de Los Andes, Merida, Venezuela
e-mail: torres@ula.ve

especially in the tropics. This evolution includes recognition of the crucial importance of environmental services, ecosystem management, governance and decentralization, and community forestry. Understanding forest ecosystems as sources of livelihoods and human well-being, poverty alleviation and social involvement are two key elements to address environmental issues as a 'social path' to facilitate the successful implementation of effective policies to manage natural resources in the context of twenty first century (e.g. see Mery et al. 2005).

Including a multi-stakeholder focus in forest management is fundamental to deal with ecosystem complexity and as an opportunity for change (Yuliani et al. 2006). This should consider the analysis of the needs, values and perspectives of the local people because they use, affect or otherwise have an interest in their local ecosystem. In some countries, the growth in relevance of social and people-oriented schemes has created a paradigm shift away from industrial forestry towards landholder-based forest management and community forestry (Harrison et al. 2002). Most forms of small-scale forestry embrace the concepts, in varying degrees, of local benefits for local people and one or more intensive forms of management to provide a wide array of outputs from the forested lands (IUFRO 2005). Especially in terms of land size and technology used, in many developing countries community forestry is more closely related to the concept of small-scale forestry (SSF) than industrial forestry. Although the term may be new and its meaning not universally understood (cf. Harrison et al. 2002), it is clear that for many years people have been gathering timber and non-timber forest products (NTFP) to support local economies and development.

Major demographic and economic changes have increased the pressure over natural resources in tropical countries and have strongly affected the relationship between people and their environment. Recently, after a new recognition of local governance and the power of decentralization, local communities have started to see real and potential commercial benefits from natural and planted forests as an opportunity for the development and improvement of life quality (Kaimowitz 2007). Also, community forest-based enterprises can create a wide range of goods and services that are not created by individual enterprises or private industry and that represent a unique advantage for the rural economy and forest conservation (ITTO 2007). For example, livelihood goals including food, potable water, health, education, housing and community and social integration are usually key elements of this small-scale approach, while other forestry forms (particularly industrial forestry) are based on only a very small fraction of these issues. In many ways, community forestry can be viewed as an aggregate of smallholders managing public land to produce multiple private and community benefits (Harrison et al. 2002).

In Latin America, there are several constraints—especially legal and economic ones—that may reduce forest benefits. For example, the lack of adequate financing for planning and technical assistance in Mexico (ITTO 2007), market competition with illegal logging in Ecuador (Romero 2007) and limited technical and managerial capacities in some cases of Guatemala (Stoian et al. 2007) have been highlighted. In Venezuela, a tropical country in which forest cover has varied greatly over the last two centuries, about 45% of the land is still covered by natural forests and there are nearly 800,000 ha of forest plantations (Torres-Lezama et al. 2008). An important resource base and a strong potential exists to develop and implement a new forest

management agenda that includes the small-scale forestry approach by using traditional long-term knowledge of local people to support local participation in the management and sharing of the benefits of forests throughout the country.

In the 1950s, the organization *Fe y Alegría* commenced a reforestation program in the *Instituto San Javier del Valle Grande*, located in the *Mucujún* river watershed, converting pasture land to forest plantations. In this paper the constraints and opportunities for sustainable plantation management are examined in the context of national policies, local regulations, environmental features and social benefits for local livelihood. Research results and exchange of information with Fe y Alegría, as a major stakeholder in this rural area, were used to detect future objectives and goals regarding forest plantation management and hence propose guidelines for small-scale forestry practices for this area.

The study site

The Mucujún river sub-watershed with a total surface area of about 19,400 ha (Silva-León 1999) is part of the Chama watershed system and the Maracaibo Lake influence zone, and is located in Mérida state within the Venezuelan Andes (8°35′02″–08°40′11″ N; 71°00′–71°08′ W). The Mucujún watershed represents a major source of water for agricultural irrigation and cattle in the upper parts and for domestic use for nearly 200,000 inhabitants in downstream Mérida city, the state capital (Fig. 1).

The climate in the lake influence zone is strongly determined by altitude and moist air flow from the Maracaibo Lake and the Chama river watershed system. The zone can be classified as humid with an annual rainfall of between 1200 and 2000 mm with an average of 1600 mm. Annual temperature variation based on monthly averages (12–15°C) is determined by a large topographic variation, with elevation from 1800 to 4000 masl (Dugarte and Arzubialde 2002). Geologically, Mucujún river watershed is influenced by its location within the Boconó fault system, resulting in unstable slopes and high potential for seismic movements (Ramírez-García 2005). Its topographic conditions favour superficial runoff and in turn a high water production capacity of the watershed.

Soils are mostly medium to heavy, with higher development found in quaternary deposits in lower valley areas (Molina 2006). In 60–70% of the area, effective root depth is lower than 50 cm but may reach 80 and 90 cm in the pine plantations. Soils have extremely high acidity (pH 3.7–4.7) and high aluminum content in some sites. Soil organic matter content reaches an average of 5% in most sites. Soil calcium and phosphorus levels are low and magnesium medium to high (Torres-Lezama et al. 2006).

In the Mucujún river watershed, two micro-watersheds, *El Robo* and *La Boba*, cover nearly 1555 ha. Approximately 50% of the area includes conserved cloud forest containing high biodiversity and contributing to high quality water production and regulation through natural processes. Moor (*páramo*) vegetation combined with rocks and glacial lagoons are also important for water regulation Although occupying only about 5% of the land, residential, cattle and agricultural activities in the lower parts of these micro-watersheds have become an important human

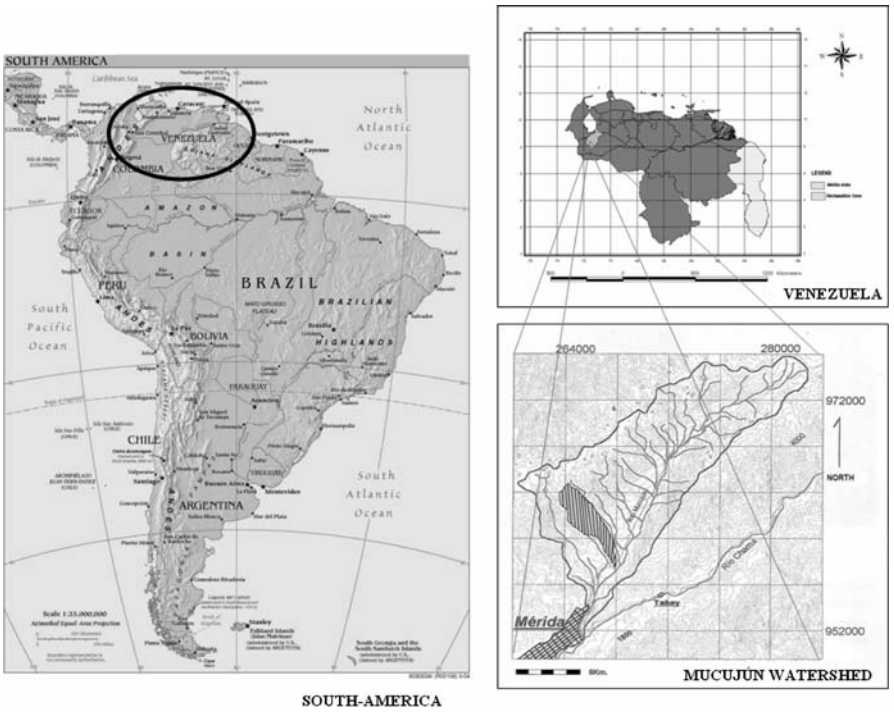

Fig 1 Regional, national and watershed location(shaded area) of study site. *Note*: the Venezuelan map include Guyanan territory claimed by Venezuela under the Geneva Agreement of February 7, 1966

pressure. In this area, about 1500 people live in four local communities (Arias 2006) (Fig. 2). In addition, these watersheds lie within two protected areas, the National Park *Sierra de la Culata* designated in 1989 (with elevation from 2440 masl) and the Protected Zone of the Mucujún river (PZM) designated in 1986 (from 1900 masl) which regulate land use.

Forest plantations in the two micro-watersheds account for approximately 115 ha representing almost 7.5% of the land area (Arias 2006). Three exotic species were planted originally for land conservation purposes, namely *Fraxinus americana* L. (white ash), *Pinus oocarpa* Schiede ex Schltdl. (yellow pine) and *Cupressus lusitanica* Mill. (Portuguese cypress). In the 1950s about 40 ha of pasture land were converted to *F. americana* plantations by Fe y Alegría. In the 1970s small size timber began to be used in the local wood workshops of the Instituto San Javier del Valle. In 1976 the National Reforestation Company (CONARE) established a small plantation of *P. oocarpa* in this mountainous area. Major features of these plantations are indicated in Table 1 and Fig. 3.

In the 1980s a forest assessment revealed moderate potential for wood production from *F. americana* (Vincent 1980); eventually, a Forest Management Plan (FMP) was submitted to the Ministry of the Environment in 2002, which represents an important development in the planning and management of mountain forest plantations in Venezuela (Dugarte and Arzubialde 2002). For *P. ooocarpa* and *C.*

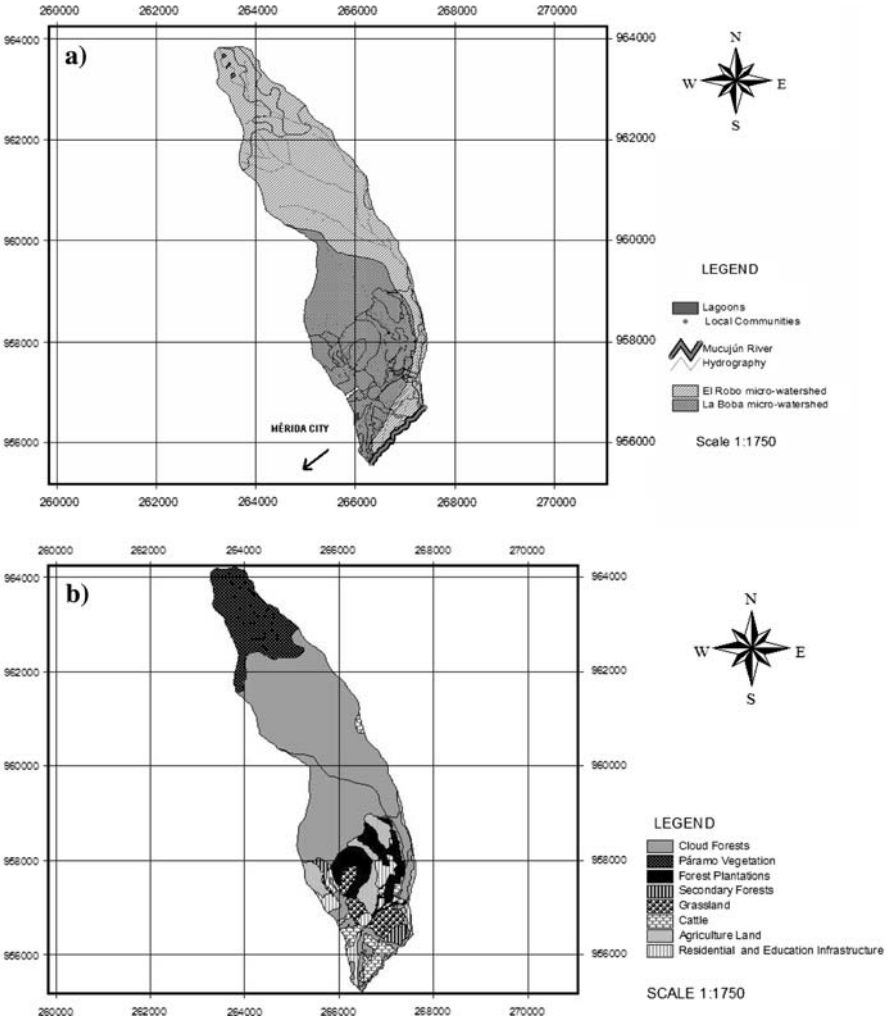

Fig 2 'El Robo' and 'La Boba' micro-watersheds (**a**) and actual land use (**b**). *Source*: Modified from Arias (2006)

Table 1 Five major features of forest plantations in Fe y Alegría, Mucujún river watershed, Mérida, Venezuela

Species	Age	Stand density	Regeneration potential	Slope	Other uses combined with timber production
F. americana	Disetaneous	Irregular	High	Low–medium (0–25%)	Cattle grazing
P. oocarpa	Coetaneous	Regular	Low	High (>25%)	Education and recreation
C. lusitanica	Coetaneous	Regular	Low	High (>25%)	Education and recreation

Source: Dugarte and Arzubialde (2002); own observations

Fig 3 General conditions of (**a**) *Fraxinus americana* and (**b**) *Pinus oocarpa* stands in San Javier del Valle, Mucujún river watershed, Mérida, Venezuela Source: Photos by Emilio Vilanova

lusitanica, common logging practices were forbidden from 1986 to 2002, because of their location in zones of high slope (>25%). Nowadays only naturally fallen trees are used for wood processing. Official approval was given by the central government in 2003 for an area equivalent to 16 ha of *F. americana*, 8 ha of *P. oocarpa* and 4 ha of *C. lusitanica* to be designated for management for wood production. Since 1970 only a small fraction of planted stands in San Javier del Valle have been considered for timber production, and there has been little monitoring and management.

Research method

Data for examining land-use management options were collected from primary and secondary sources. Existing information was collated from a comprehensive

analysis of the two micro-watersheds, including biophysical description and socio-economic conditions. This analysis included a survey of social perceptions of local inhabitants about forestry and agroforestry relevance for local livelihoods while maintaining the water supply condition of El Robo and La Boba micro-watersheds. In total, 84 families were surveyed in four of the local communities near the forested areas (Araque and Montaner 2006). Maps were produced from a process of overlapping variables including topographic variation, land-use patterns and a temporal analysis of forest cover using GIS software. Further details are reported by Arias (2006).

For this study only *F. americana* and *P. oocarpa* plantations are considered because of their relevance for Fe y Alegría. Over a total area of 16 ha of white ash and 8 ha of yellow pine, random sampling techniques were used to assess forest stand conditions. In total 60 square plots of 20 m by 20 m were established, 40 plots in the white ash stands for a sampling intensity of 10% and 20 plots for yellow pine (sampling intensity 20%).

All of the trees within each sampling plot were measured in 2005 for diameter at breast height (DBH) at 1.3 m above the ground, and total and commercial height; health conditions and bole shape of the trees were also assessed. Additionally, any particular feature such as dead wood, weed presence, cattle evidence and plant regeneration were recorded. Basal area and volume on a tree-by-tree basis were estimated for each plantation.

The previous analysis, together with the principles of ecosystem management (described in Pirot et al. 2000; FAO 2003; Andrade 2007) were used to develop a synthesis of opportunities and constraints for small-scale forestry (SSF) and ecosystem management (EM) in San Javier del Valle, Mucujún river watershed.

Results and discussion

Forest plantations assessment

For 'white ash' stands, tree density was found to be highly variable (Table 2). Most of the trees are in diameter classes lower than 30 cm DBH, which may be explained by abundant advanced natural regeneration and slow stand growth. No information has been found from earlier monitoring or inventorying. Stands contain trees of several ages (disetaneous) and have low basal area and volume. More than 20% of the trees have twisted trunks and more than two boles above DBH (illustrated in

Table 2 General statistics for *F. americana* and *P. oocarpa* stands in San Javier del Valle, Mucujún river watershed, Mérida, Venezuela[a]

Species	Density (trees/ha)	DBH (cm)	Total height (m)	Basal area (m^2/ha)	Timber volume (m^3/ha)
F. americana	512.39 (291.32)	19.56 (6.80)	12.93 (5.58)	17.14 (8.15)	84.11 (46.32)
P. oocarpa	528.75 (229.02)	35.05 (6.55)	23.56 (3.97)	49.44 (11.18)	451.77 (100.64)

[a] Values are means, and standards deviations are in parentheses

Fig. 3a). Similarly, about 20% of the trees show visible foliage damage. In the thinner stands, the presence of grasses and shrubs including the cultivated *Morus nigra* L. and *Psidium caudatum* Mc Vaugh is common. Pasture growth and survival, and understorey natural vegetation, are limited in the more dense white ash stands, reducing the protective role of forest plantations as well as their potential agroforestry function. Although no data about soil moisture content were available at the time of plantation assessment, a deterioration in white ash stands due to fluctuations in soil moisture supply in upper and steep slopes similar to those in San Javier del Valle was reported in Woodcock et al. (1993).

Forest stands of *P. oocarpa* plantations have a high density considering their age, and a high productivity potential expressed in a basal area of 49.44 m^2/ha. Wood volume is also high (Table 2). Despite high stand density, 80% of the trees show strong vitality. A low standard deviation of tree height (of 3.97 m) is an indicator of a regular stand. Mean tree height was 23.6 m. Revolorio Quevedo (1996) found a similar value (>23.5 m) in a natural stand of the same species, considered to be of high productivity, in Guatemala.

A mean slope of 43.4% was estimated in yellow pine stands. Nonetheless, there is a distinct variation in space occupation, with lower densities and smaller trees found on steep slopes (above 40%). A high proportion of these stands exhibit senescence or ageing signs, with some standing dead trees. Wind effects are evident and wind may be a major cause of weakness in trees. Boshier and Cordero (2004) in fact reported that trees of *P. oocarpa* are highly vulnerable to falling especially in areas with strong wind. Taller and healthier trees are found in areas with slopes below 40%. The correlation between slope and plantation productivity was not statistically estimated. However, Revolorio Quevedo (1996) reported that in *P. oocarpa* stands in Guatemala, where this species is native, the position in and shape of the slope are closely related with several other variables including soil moisture and root depth, which together have a strong influence over tree growth and development for this species.

A deep accumulation of pine needles at various levels of decomposition covers the entire surface of the yellow pine plantation, with the presence of other species observed mainly in natural gaps and in those areas with a lower tree density. In addition, fire marks are evident in a high proportion of the trees, and fires may have reduced plantation productivity. Negative effects of burning over nutrient cycling and surface runoff as well as increased soil loss in yellow pine natural stands have been reported in Hudson et al. (1983a, b).

Current conditions of *P. oocarpa* stands in San Javier del Valle analyzed in an ecological context seem to indicate a threat to ecosystem stability. Inventorying and visual assessment of health conditions reveal the existence of a high proportion of tall but weak trees (with almost 50% of trees presenting signs of twisted or rotting boles). Also, trees of *P. oocarpa* stands have been affected by adverse topographic conditions, suggesting that urgent silvicultural measures should be taken. For example, yellow pine stands could be improved through dead wood extraction and thinning. The creation of gaps could induce the establishment of other local species allowing an increase in plant diversity.

Notably, the lack of knowledge of previous management practices in the area constraints global understanding of plantation history and further planning and

decision-making. This analysis suggests that the combination of earlier management practices and site quality conditions are, indeed, two major drivers affecting growth and performance. A continuous process of monitoring will be required to assess properly, a possible declining process in both *F. americana* and *P.oocarpa* stands, based on growth and mortality rates. However, bringing together analyses about regulatory, biophysical and socio-economic aspect assists in determining the urgent need for stand management to assure future benefits of planted stands.

Guiding small-scale forestry practices in San Javier del Valle

The principles of ecosystem (landscape) management (EM) (as described by Pirot et al. 2000; FAO 2003; Andrade 2007) represent a guiding path to strengthen and promote a new way of thinking about sustainability of the ecosystems with regard to environmental issues in complex areas such as the El Robo and La Boba micro-watersheds analyzed here. However, for small-scale forestry to be a useful component of EM, it is crucial to achieve a consensus between all stakeholders about the relevance of long-term maintenance of environmental services (biodiversity, water supply and carbon storage) and to guarantee housing and employment for local communities.

These issues are key elements of positive or negative effects for enabling forest management, not only in the study area, but in the Mucujún river watershed as a whole. To reach this agreement, the current situation of legal regulations that determine land-use patterns in this watershed has to be re-analyzed in order to update the information and in this way to guarantee a reliable dialogue process while promoting timber production, increasing land conservation and supporting local livelihoods. The options for effective management through principles of landscape management, including reduced impact logging, small-scale and low intensity management, and increased land conservation and timber production, are now analyzed.

The role of local communities in managing forest plantations at San Javier del Valle

According to official data, between 1961 and 2001 the population in the two micro-watersheds increased by 71.1% (or 1.78%/year) (INE 2001). Legal restrictions regarding limitations mainly for expanding crops and cattle areas have led to a high concentration of people in the lower parts of El Robo and La Boba micro-watersheds and a strong need for housing and basic services (Arias 2006).

Economic activities and local incomes are supported mainly by tourism (guiding, accommodation and craftwork) and labour demands for commercial activities in the nearby Mérida urban area. Also, agriculture on a small fraction of local properties is undertaken for self-consumption. A survey of local communities indicates that San Javier del Valle forest plantations represent an important part of the ecosystem, especially for environmental services including soil conservation, carbon storage and recreation. However, Araque and Montaner (2006) reported that local residents expressed concern about actual conditions and fate of *F. americana* and *P. oocarpa*

stands and how these planted forests can become effective in supporting local livelihoods.

Analysis of reforestation projects covers a wide range of topics, regarding especially threats to biodiversity, water supply and soil fertility (Cossalter and Pye-Smith 2003). In the case of San Javier del Valle, the growing of plantations of exotic species is viewed by local communities as a threat to quantity and quality of water supply (Araque and Montaner 2006).

In the Mucujún area, local and regional communities are being urged to deal with a broader range of social and environmental issues than in the past. In recent years, the formation of several local groups from tourism cooperatives, farmers, water associations and irrigation committees into community partnerships or *Consejos Comunales* is taking place, as a new approach for local organization. The existence of several community organizations that can incorporate a knowledge-based adaptive management approach provides an opportunity to promote small-scale forestry activities not only in San Javier plantations but in all Mucujún river watershed. Wood production in the area has a moderate potential to contribute to local livelihoods while ecosystem services are maintained. However, current official policies reflect a high level of central government intervention, imposing limitations on individual timber growers and on processing and trade of forest products in the area, to prevent adverse environmental impacts. In fact, logging and extraction of non-timber forest products are still highly restricted activities within the two protected areas. There has been a strong emphasis on 'top–down' mechanisms which has reduced effective participation of local communities and local stakeholders in decision-making processes.

Environmental issues related to small-scale forestry

The Venezuelan central government has considerable experience in legislation that addresses environmental issues. Environmental Impact Assessment (EIA) is frequently carried out but is not technically strong to support management and in many cases amounts only to fulfilling legal requirements without appropriate monitoring. Other similar cases where EIAs have not properly included conservation and biological sustainability in Latin America are discussed in Astorga et al. (2007).

Although policies to improve forest management have been widely introduced, poor logging practices remain prevalent in many developing countries (Smith et al. 2006), and good practice is the exception rather than the rule in most of these countries (Putz et al. 2000). There has been substantial research into the urgent need to reduce environmental impact in forest operations in natural and planted forests, especially in lowland areas. However, logging operations in high altitude areas in a commercial and small-scale context remain poorly documented.

Following resilience and ecosystem recovery as two basic concepts, the appropriate management of La Culata National Park and Mucujún Protected Zone can be an effective way to promote and guarantee reduced impact logging for timber production. From this perspective, ecosystems can be managed within the limits of their functioning through reduced impact logging (RIL).

As Rockwell et al. (2007) have observed, there is usually a strong tendency to impose management practices of large commercial operations onto smallholder systems without a proper knowledge of socio-economic conditions of small-scale operations. For example, small-scale operations are based on considerably lower harvest volumes and a greater reliance on local labour compared to industrial-scale logging. Nonetheless, several basic aspects need be included in forest management planning to promote small-scale forestry operations within the two protected areas, including pre-harvest inventory, road and log landing construction, and directional felling.

In 1997, a first attempt was made at wood production from *P. oocarpa* stands, with a view to 'sustainable management' and plantation improvement with low intensity thinning and pruning (Fe y Alegría 1996). However, this plan was discontinued due to legal restrictions. Using the recent assessment of *F. americana* stands, RIL operations are suggested for the plantation as a whole but with special emphasis in zones where slope exceeds 30%. Above this limit an environmental impact assessment (EIA) is required where potential impacts are examined and mitigation measures identified. After the first logging operations, an EIA is desirable to assess post-intervention ecosystem response.

A proposal for planning and zoning for small-scale forestry operations in San Javier del Valle is presented in Table 3. Based on slope stratification, three areas require distinct management actions. In those areas of 0–30% slope, and 30–60% slope, logging for timber and non-timber products is proposed, though in a more restricted form in the latter. In both cases, soil restoration and sanitary thinning are suggested. Above 60% slope, considerations based on ecosystem services management are included. As a matter of fact, high potential for payment of environmental services exists in all of Mucujún watershed, especially for water supply (Perez-Roas 2006). However, a more detailed analysis to assess the ecosystem services generated and the demand for these services is needed. In all three cases, low intensity

Table 3 Proposed zoning and planning for management through small scale forestry in San Javier del Valle, Mucujún river watershed, Mérida

Zone	Slope range (%)	Type of management	Management actions
I	0–30	Low intensity management with reduced impact logging	Thinning.
			Mixed use with properly managed semi-intensive cattle grazing (agroforestry).
			Restoration of degraded soils using vegetal components.
II	30–60	Low intensity with restricted RIL	Extraction of standing and fallen dead trees.
			Thinning.
			Extraction of non-timber forest products (such as bark and resin).
III	>60	Conservation area	Management for environmental services (water supply, carbon storage, biodiversity, ecotourism).

management must be an important guiding principle because forest plantations are one of many landscapes included in the protected areas within El Robo and La Boba micro-watersheds. This new approach can promote strengthening of conservation in protected areas while timber production and other uses are under way.

Other critical aspects for small-scale forestry in San Javier del Valle

The process of detecting critical features of forest plantation management through effective monitoring can contribute to proposed approaches to policy formulation and facilitate local information gathering for successful management (Kaimowitz 2007). However, as in many other developing areas, in Mucujún river watershed there is no effective link between the scientific community and the general community or policy-making. Many stakeholders in the Mucujún area, including those in the forestry sector, may see this new openness as an important opportunity for changing and promoting local livelihoods. In fact, multi-stakeholder processes have basically offered a new work mechanism introducing a broader understanding and encouraging respect among all stakeholders (Yuliani et al. 2006). Further consideration about new schemes for the consensus and dialogue process for Mucujún river watershed is actually taking place, with a proposal for Forest Model development following international and regional experience (as reported by IMFN 2003).

Fe y Alegría's forest plantations and its future management together represent a complex scenario where it is crucial to address the question of how important the negative environmental externalities of small-scale forestry operations are, and will become. For example, *F. americana* plantations in their current condition are a potential resource base for sustainable forest management, but at the same time there is a risk of productivity decline. In order to protect landscape values and environmental services of the two protected areas, silvicultural actions are needed to maintain current plantation condition and future sustainability.

In summary, this analysis indicates that adopting ecosystem management principles and a multiple land-use approach, a new and innovating small-scale forestry path may lead the way for better management practices in the Mucujún river watershed. Also, as an adaptative management approach, a new forest management plan for *F. americana* plantations should include periodic assessment and monitoring. However, it is evident that the legal procedures and requirements for logging and wood transportation have become an impediment to the development of the FMP. The lack of an effective linkage between plantations and local organizations with an added legal restriction for wood trade between Fe y Alegría and communities are two major constraints for improving livelihoods through small-scale forestry.

The contribution of forestry to employment is more than double that generally given in global statistics when the small-scale, community and informal sectors are included, but only a few tropical countries have had favourable conditions in place for a sufficiently long time to enable development and viability of community forest management (ITTO 2007). Following FAO guidelines for Market Analysis and Development (MA&D) (Lecup and Nicholson 2006) and ITTO (2007), one important approach to deal with environmental and social complexity in the

Mucujún river watershed can be the creation of community forest-based enterprises (CFEs).

Based on multiple land use and ecosystem management (e.g. wood production, agroforestry, payment of environmental services), the development of CFEs by local communities in the Mucujún watershed will have to deal with new social, economic and environmental conditions. This will require local people to restructure land tenure, promote new political institutions, shift economic decision-making from the household to the collective level, and begin a much deeper participation in the market economy (McDaniel 2003). Property rights to land are currently recognized for most local communities, including Instituto San Javier del Valle. As Arias (2006) found, since the Mucujún Protected Zone decree was issued in 1986, lower areas of the watershed have experienced increased pressure for housing, agriculture and cattle grazing, modifying land-use patterns. In order to accomplish the potential creation of CFEs an adequate re-analysis of legal regulations and an updating process of Mucujún river watershed land-use are needed.

Constraints and opportunities for sustainable plantation management in the Mucujún watershed

Since plantations were established in the Mucujún watershed, for which conservation objectives were the main basis for management, several changes have operated. Firstly, the creation of two important protected areas during the 1980s pursuing high-mountain biodiversity preservation on the one hand, and assuring water supply on the other, is an important fact that represents a major constraint to natural resource management in the area. Secondly, there has been little management of planted forests and lack of attention to planning, except for the case of Fe y Alegría Forest Management Plan (FMP).

Three major positive factors determined a partial implementation of this plan, namely a strong need for timber, the availability of a resource for wood production, and periodic monitoring of operations. Timber, especially from *F. Americana* stands, is used for wood-based craftwork production in the Instituto San Javier del Valle Grande for educational purposes and commercial trade. Additionally, monitoring established a periodic process to detect information needs to adapt forest management in San Javier del Valle. However, a shift in institutional objectives, tighter legal restrictions and, more importantly, a lack of social linkage between planted ecosystems and local communities near forested areas, have recently become leading restrictions to forest management planning. For Fe y Alegría, educational purposes and food production are two major goals for which a potential small-scale forestry approach will be supported by both local communities and policy-makers. Also, in a regional context, increasing population and local demand for water have emerged as crucial elements to address future management and conservation within the Mucujún river watershed's protected areas.

As noted by Sayer and Maginnis (2005), ecosystem principles should be interpreted in the sense of seeking to modify ecosystems in ways that will favour the best possible combination to social and ecological outcomes. In spite of its novelty,

the ecosystem approach in Latin America has merged with other initiatives including Biosphere Reserves, Forest Models, Integrated Management of Watersheds and Biological Corridors (Andrade 2007). Instead of dealing exclusively with only a few aspects for management of complex landscapes, a broader and holistic approach is needed to assess and understand how local people can become a major factor for success or failure of sustainability. An argument advanced in many cases, including the Mucujún river watershed, is that the creation of protected areas can be seen as a means by which particular interest groups secure recreational, amenity or non-use values. Yet an increase in population, an obvious need for livelihood improvement and the lack of an adaptive focus may threaten the preservation of protected areas.

In order to achieve small-scale forest management of planted forests in the Mucujún watershed, five major elements have to be carefully considered as potential drivers of positive or negative change for forest management:

1. Broadening forest management objectives: at all scales, from local communities to global enterprises, forest owners and managers are being urged to deal with much broader social and environmental issues than in the past (Sayer and Maginnis 2005). Mucujún watershed management requires a set of options to deal with this complex reality based on a more integrated conception of land use.
2. Decentralization and devolution: although sometimes it takes time to develop local capacity to manage natural resources, a more decentralized system in this watershed would be a sound option to achieve local integration and improve decision-making.
3. Governance: in many developing countries, institutions are weak and incapable of dealing effectively with the conservation and regulation of protected areas (Wright et al. 2007). A sincere process of dialogue and consensus among all stakeholders regarding the Mucujún watershed may be a crucial context in which small-scale forestry is supported.
4. Planning: in forestry, administration and management processes require a tool strong enough to address the conditions of natural resources being managed and flexible enough to deal with temporal variation of ecological, social and economic conditions. Although Fe y Alegría's FMP is an important example for management in San Javier del Valle, a more integrated plan could include the creation of a small forest company with social participation for local livelihoods and multi-functionality of ecosystems as a basis for dealing with complex scenarios that will emerge in the future.
5. Monitoring: this periodic assessment of SSF management can provide feedback on how well management policies and techniques are working. It is also a useful tool to observe trends in—and improve the ability to predict—ecosystem conditions (Sayer and Maginnis 2005).

Conclusions

Many people have argued the logic of applying ecosystem principles to plantations and trees outside forests, and the environmental impact of exotic species plantations.

Additionally, the potential for plantations to contribute to biodiversity conservation and provide ecosystem services has been often underestimated. The ecosystem approach as presented here combines a large number of relatively new concepts for forest management in Latin America. Strong efforts are needed to ensure that these emerging concepts are properly understood and effectively applied.

At present, planted forests in San Javier del Valle have become a significant part of the socio-ecological landscapes in the Mucujún river watershed appreciated by local communities and representing an opportunity to preserve environmental services and amenity because two natural protected areas embrace this watershed. In addition, *F. americana* and *P. oocarpa* stands could represent an important resource for wood production within the context of low-intensity harvesting and low environmental impact. However, the productive condition of planted forest stands reflects the need of improved management. This could be accomplished through an adequate re-analysis of forest management plans, legal status of land-use patterns and social involvement. With a strong emphasis on ecosystem management principles, it is suggested that improvement of local livelihoods in the Mucujún river watershed may be achieved with appropriate small-scale forestry management of planted forests while maintaining ecosystem services including biodiversity and water supply.

Acknowledgments We gratefully thank *Fe y Alegría* institutional support for this research. We thank Jesús Arzubialde and Simón Dugarte for data and information about the forest management plan in *Fe y Alegría*. This study was partly funded by the *Instituto Nacional de Investigaciones Agrícolas, región Mérida (INIA-Mérida)*, under the Project *Desarrollo de modelos agroforestales sostenibles en el estado Mérida*, and the *Consejo de Desarrollo Científico, Humanístico y Tecnológico, Universidad de Los Andes* (CDCHT-ULA).

References

Andrade A (ed) (2007) Aplicación del enfoque ecosistémico en Latinoamérica. CEM – IUCN, Bogotá

Araque M, Montaner M (2006) Diagnóstico socioeconómico de los centros poblados de las microcuencas 'El Robo' y 'La Boba', subcuenca del río Mucujún, municipio Libertador del estado Mérida, con el propósito de promover alternativas de uso múltiple de la tierra. Informe de pasantía. Universidad de Los Andes, Escuela Técnica Superior Forestal, Mérida

Arias M (2006) Análisis integrado de las microcuencas de las quebradas La Boba y El Robo, Subcuenca del río Mucujún, Estado Mérida. Technical report prepared for the Instituto Nacional de Investigaciones Agrícolas (INIA), Mérida

Astorga E, Soto L, Iza A (eds) (2007) Evaluación de impacto ambiental y diversidad biológica. UICN Serie de Política y Derecho Ambiental N° 64, Gland, Switzerland

Boshier D, Cordero J (2004) Manual de Árboles de Centroamérica: *Pinus oocarpa* Schiede ex Schltdl. Proyecto OFI-CATIE. Available in: http://herbaria.plants.ox.ac.uk/adc/manual/manuespecies.asp (January 15, 2008)

Cossalter C, Pye-Smith C (2003) Fast-wood forestry: myths and realities. Centre for International Forestry Research (CIFOR), Bogor

Dugarte S, Arzubialde J (2002) Plan de Ordenación Forestal en Plantación de Fresnos en San Javier del Valle Grande (Fe y Alegría) Mérida. Instituto San Javier del Valle, Mérida

FAO (2003) Sustainable forest management and the ecosystem approach: two concepts, one goal. FAO Working Paper FM 25, Rome

Fe y Alegría (1996) Contribución al manejo sostenible de las masas de pino en San Javier del Valle, Mérida. Memoria Ejecutiva del Instituto San Javier del Valle Grande, Mérida

Harrison S, Herbohn J, Niskanen A (2002b) Non-industrial, smallholder, small-scale and family forestry: what's in a name? Small-scale forest economics. Manage Policy 1(1):1–11

Hudson J, Kellman M, Sanmugadas K, Alvarado C (1983a) Prescribed burning of *Pinus oocarpa* in Honduras I. Effects on surface runoff and sediment loss. For Ecol Manage 5(4):269–281. doi:10.1016/0378-1127(83)90032-4

Hudson J, Kellman M, Sanmugadas K, Alvarado C (1983b) Prescribed burning of Pinus oocarpa in Honduras II. Effects on nutrient cycling. For Ecol Manage 5(4):283–300. doi:10.1016/0378-1127(83)90033-6

Instituto Nacional de Estadística (INE) Censo de población y viviendas (2001) Available in: http://www.ine.gob.ve/poblacion/censopoblacionvivienda.asp, accessed May 28, 2008

International Model Forests Network (IMFN) (2003) Guide for forest model development. Ottawa

International Tropical Timber Organization – ITTO (2007) Community based forest enterprises: their status and potential in tropical countries. Technical Series 28, Yokohama

IUFRO (International Union of Forestry Research Organizations) (2005) Multilingual Glossary Forest Genetic Resources. FAO Forestry Department and the IUFRO SilvaVoc Terminology Project, Vienna

Kaimowitz D (2007) Aspectos Críticos para la Forestería Comercial en Pequeña Escala. In: Memorias de la conferencia Desarrollo de Pequeñas y Medianas Empresas Forestales para la Reducción de la Pobreza Oportunidades y Desafíos en Mercados Globalizantes. Serie técnica. Reuniones técnicas no. 12. Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), Turrialba

Lecup I, Nicholson K (2006) Community-based tree and forest product enterprises: market analysis and development. Revised booklet B introduction: defining where you want to end up. FAO, Rome. Available in: ftp://ftp.fao.org/docrep/fao/009/j8712e/j8712e00.pdf, accessed May 15, 2008

Mery G, Alfaro R, Kanninen M, Lobovikok M (2005) Changing paradigms in forestry: repercussions for people and nature. In: Mery G, Alfaro R, Kanninen M, Lobovikok M (eds) Forest in the global balance: changing paradigms. IUFRO World Series vol 17, Helnsinki

McDaniel J (2003) Community-based forestry and timber certification in Southeast Bolivia. Small-scale forest economics. Manage Policy 2(3):327–341

Molina Y (2006) Programa de educación ambiental para la cuenca del río Mucujún: una ventana para la extensión universitaria. Educere 10(34):471–482

Perez-Roas J (2006) La Experiencia Venezolana en Esquemas de Pagos por Servicios Ambientales. Informe para el proyecto CI-CIFOR sobre la factibilidad de PSA en el corredor Norandino. CIDIAT, Mérida

Pirot JY, Meynell P, Elder D (eds) (2000) Ecosystem management: lessons from around the world: a guide for development and conservation practitioners. IUCN SADAG, Bellegarde-sur-Valserine

Putz F, Dykstra D, Heinrich R (2000) Why poor logging practices persist in the Tropics. Conserv Biol 14(4):951–956. doi:10.1046/j.1523-1739.2000.99137.x

Ramírez-García R (2005) Zonificación geomorfológica utilizando el concepto de estabilidad relativa aplicado a la microcuenca Los Tapiales, río Mucujún, El Vallecito, Mérida, Venezuela. Rev Geografica Venez 46(2):235–252

Revolorio Quevedo A (1996) Evaluación de la calidad de sitio para Pinus oocarpa Schiede en la zona de amortiguamiento de la Reserva de Biosfera Sierra de Las Minas, Guatemala. MSc Thesis, Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), Turrialba

Rockwell C, Kainer K, Marcondes N, Baraloto C (2007) Ecological limitations of reduced-impact logging at the smallholder scale. For Ecol Manage 238(1):365–374. doi:10.1016/j.foreco.2006.11.002

Romero M (2007) De Proyecto a Organización Independiente: la Prestación de Servicios Forestales para el Manejo del Bosque en el Centro-Sur de la Amazonía Ecuatoriana. In: Memorias de la Conferencia Desarrollo de Pequeñas y Medianas Empresas Forestales para la Reducción de la Pobreza Oportunidades y Desafíos en Mercados Globalizantes. Serie Técnica. Reuniones Técnicas N° 12. Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), Turrialba

Sayer J, Maginnis S (2005) Forests in landscapes: expanding horizons for ecosystem forestry. In: Sayer J, Maginnis S (eds) Ecosystem approaches to sustainability. The Earthscan Forestry Library, London, pp 177–191

Silva-León G (1999) Análisis hidrográfico e hipsométrico de la cuenca alta del río Chama, estado Mérida, Venezuela. Rev Geografica Venez 40(1):9–41

Smith J, Colan V, Sabogal C, Snook L (2006) Why policy reforms fail to improve logging practices: the role of governance and norms in Peru. For Policy Econ 8(4):458–469. doi:10.1016/j.forpol.2005.08.001

Stoian D, Rodas A, Donovan J (2007) Desarrollo de Empresas Forestales Comunitarias en Guatemala: Un Estudio de Caso de la Cooperativa Carmelita R.L. In: Memorias de la Conferencia Desarrollo de Pequeñas y Medianas Empresas Forestales para la Reducción de la Pobreza: Oportunidades y

Desafíos en Mercados Globalizantes. Serie Técnica. Reuniones técnicas N°. 12. Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), Turrialba

Torres-Lezama A, Ramírez-Angulo H, Bastidas M, Larez N, Ramírez I, Vilanova E et al (2006) Avances sobre el manejo de plantaciones de fresno en montaña y perspectivas de uso múltiple de la tierra en San Javier del Valle, Estado Mérida, Venezuela. Memorias del Simposio – Taller: Experiencias en Agroforestería ejecutadas o en proceso por el INIA, Maracay

Torres-Lezama A, Ramírez-Angulo H, Vilanova E, Barros R (2008) Forest resources in Venezuela: current status and prospects for sustainable management. Bois Foret Tropiques 295(1):21–33

Vincent L (1980) Fresno en San Javier del Valle de Mérida y la problemática de las plantaciones particulares. Avance Forestal 12(1):27–29

Woodcock H, Patterson WA, Davies KM Jr (1993) The relationship between site factors and white ash (*Fraxinus Americana* L.) decline in Massachusetts. For Ecol Manage 60(3–4):271–290. doi: 10.1016/0378-1127(93)90084-Z

Wright S, Sánchez-Azofeifa A, Portillo-Quintero C, Davies D (2007) Poverty and corruption compromise tropical forest reserves. Ecol Appl 17(5):1259–1266. doi:10.1890/06-1330.1

Yuliani E, Tadjudin D, Indriatmoko Y, Munggoro D, Gaban F, Maulana F et al (eds) (2006) Multistakeholder forestry: steps for change. Center for International Forestry Research (CIFOR), Bogor