



4.7 Modernization of wood energy in northern Madagascar

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Introduction

In Madagascar, as in much of sub-Saharan Africa, wood is the most important source of domestic energy. It will likely remain so due to population growth and urban consumption. Charcoal is replacing firewood in urban centres, easily tripling the amount of wood that is extracted. This situation is worsened where low-efficiency conversion and combustion technologies are applied.

Firewood use and charcoal production from natural forests was threatening to turn fertile landscapes into moonscapes in the extreme north of Madagascar. The national government asked *Deutsche Gesellschaft für Internationale Zusammenarbeit* (GIZ) for assistance with energy supplies for Antsiranana, the capital city of Diana Region. The task was to restore, enhance and maintain productive landscapes for the provision of wood fuel and other broad public benefits.

In 1996, GIZ initiated the German-Malagasy Environmental Programme. Its immediate target was to increase the percentage of sustainably produced charcoal through wood energy plantations to supply Antsiranana. Benefits for the rural poor were essential: 92% of Madagascans live below the poverty line (World Bank 2013), and only 11% of households have food security (FAO and WFP 2013). A heavy dependence on natural resources and an annual population growth rate of about 3% contrast with an average farm size of only 1.2 hectares (ha) per household and traditional production methods. Few farmers' yields allow them to sustain their family throughout the year (Üllenberg 2009).



A LANDSCAPE APPROACH IS NEEDED TO ENHANCE THE SUSTAINABLE MANAGEMENT AND REHABILITATION OF PRODUCTION CAPACITIES.

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Increasing the productivity of landscapes through sustainable wood energy

Productive landscapes in Madagascar are characterized by a mosaic of land uses, mainly comprising agriculture (rice, manioc, maize), extensive cattle ranching and forests. Households in rural areas mostly use fuelwood for their domestic needs. In urban centres, fuelwood has been replaced by charcoal. To reduce the pressure on natural forests the sustainable capacity of landscapes to produce wood fuel needs to increase.

In order to identify and retain production capacity in both energy wood plantations and natural forests, the programme applied the best practices of sustainable forest management (SFM). The elementary requirement was that extraction rates, including woody biomass, must not exceed present growth rates. The programme proceeded in an integrated way:

- creation of new forest resources through reforestation of degraded landscapes with secure tenure rights;
- improvement of the entire wood fuel value chain; and
- establishing the conditions for an enabling framework.

The programme combined land rehabilitation with local economic development. It established interconnected socio-economic impacts (diversification of income and increase of the landscape's production capacity); and environmental impacts (fire reduction, rehabilitation of degraded land, reduction of pressure on natural forests). All activities were embedded in land-use planning at the regional and local level to support implementation at the landscape level.

Turning users to owners

One main focus was afforestation through allocating degraded land to individual households and granting long-term user rights. Patches of degraded communal land that are eligible for afforestation are converted into private property. A prerequisite was that the barren land, which is usually owned by communities, must not be suitable for other uses, such as farming. Since the approach requires the voluntary and proactive participation of communities it is called village-based individual reforestation (*Reboisement Villageois Individuel*, or RVI). It involves allocating land title to an individual person, combined with collective administration and capacity building, usually by a village afforestation body designed for this purpose. Management tasks such as preparatory steps (planning and management of the nursery, transportation of plants, etc.) are the responsibility of the afforestation body. This structure was perceived as an advantage by user groups.

The planned reforestation was subject to a consultation process involving the community council, community members and foresters in order to avoid land disputes and support consensus-based decisions. Individual reforestation sites are endorsed by a community council decision through a communal decree and allocated to interested households, along with defined user rights and obligations. Each plot is demarcated, mapped and documented. Technical assistance was provided by local NGOs throughout the process.

The reforestation sites are registered with the topographical services of the respective land office. Registration involves official verification of the site based on the sketch plan, communal decree and tenure plan. This provides an unprecedented level of tenure security in the country.

In addition to institutional and technical support, the substantial external input is mechanized soil preparation along contour lines, including breaking up compacted soil layers. Nursery operations are collectively organized; planting and maintenance are the land-owners' responsibility. Almost all plot owners (98%) reforested with *Eucalyptus camaldulensis*, although other species such as *Acacia auriculiformis* and *Acacia mangium* were available.

The investment cost for one ha of eucalyptus plantation amounts to €207, 66% of which is provided by technical assistance. The remainder comes in the form of labour by the land-owners.

On average, smallholder households involved in the scheme own three ha of wood fuel forest. It increases their income by about 40%. For many people the increase will be significantly higher, since about 30% of farming households are in the poorest and landless segment of the population.

The programme has also strengthened the economic position of women. By enrolling in the afforestation schemes women had more opportunities to own resources.

Value chain development

Most kilns used in Madagascar had a low rate of effectiveness (10–12%) and a high rate of waste. The programme's fast-growing plantations, managed with short rotation cycles, yield large quantities of wood. This supported the development of technologically advanced kilns that are more efficient and produce fewer emissions. Kilns developed by the project, such as the stationary GreenMad Dome Retort, have an efficiency rate of more than 30%, triple that of the old kilns. New kilns with methane recycling cut the carbonization time from 7 days to 72 hours and recycle flue gases that would be normally be emitted into the atmosphere. The internal rate of return of such an investment (€4,500/unit) exceeds 40%. And since the global warming potential of methane is 21 times that of CO₂, the technology yields significant CO₂e reductions.

Modernizing the value chain in an integrated manner meant assisting both plantation owners and charcoal burners to organize themselves as groups of shareholders. Groups averaged 40 to 50 members. They gained market access by creating registered micro-enterprises to invest in and run the retort (microcredit services) and commercialize the product, including certified proof of origin. Each company's business plan is based on the exploitation plan of the respective plantation area (in general, about 300 to 400 ha per company). Companies pay duties to the commune and taxes to the region. In order to create a "green" value chain, some of the rural companies joined forces and established an

urban charcoal market in Antsiranana, thus facilitating the product's traceability and increasing transportation efficiency. This increased shareholders' economic returns by 30%.

Use of improved cook-stoves (ICSs) is also curbing wood fuel consumption in the city, which is the primary market for the RVI plantations. The challenge is to design an ICS that can be manufactured locally and be compatible with established cooking habits. The project intervened at all levels of the ICS value chain — from production to commercialization — by supporting private entrepreneurship and public relations activities. Today, a women's association promotes the use of improved stoves in local households. The association makes households aware of the environmental and health hazards associated with traditional stoves and the benefits of ICSs. Most of the ICS production sites and sales locations are run by women. To date, around 4,500 urban families (about 20% of all Antsirananan households) use ICSs with reduced charcoal consumption (89 kg/year instead of 125 kg/year).

Enabling framework conditions

The management of landscapes must be broad enough for far-reaching management visions but narrow enough to ensure the participation of all relevant stakeholders in decision making and planning (FAO 2012). A landscape approach should strive for a consensus on general development goals and challenges and on options and opportunities (Sayer et al. 2013).

GIZ facilitated an adapted Regional Modernization Strategy (Jorez, Richter and Sepp 2009) for the Diana Region by means of a multi-stakeholder process. It defines an approach for the wood fuel sector, including proposals for urgently needed regulatory measures by the forest service to curb the widespread and unregulated production of wood fuel from natural forests. An environmental coordination platform (*Organisation de la Société Civile pour l'Environnement dans la Région Diana*, or OSC-E/Diana), coordinates all stakeholders in the region. The members of the platform gather regularly to discuss progress and negotiate ways to overcome barriers.

GIZ also supported the elaboration of regional land-use plans (*Schéma Régional d'Aménagement du Territoire*, or SRAT) with a horizon of 20 years. A product of the multi-stakeholder process, these plans have a coherent vision for regional development (Republic of Madagascar 2012). They also assure the spatial coherence of plans of the various sectors involved (forestry, agriculture, nature conservation, infrastructure, urban planning, etc.) and thus guide the development of the landscape. The regional land-use plans acknowledge wood as an important future energy source, one that can decrease dependency on energy imports as long as livelihoods are sustained and environmental effects are managed. It is hoped that municipalities will take over and integrate wood



energy production in their plans at the local level. This is a key element for assuring long-term production perspectives for local land users.

Impacts on the forest landscape

Overall, 2,900 households afforested 8,000 ha of degraded land around 68 villages.

Table 1 compares the traditional (business-as-usual) approach with the modernized value chain.¹

Table 1. Efficiency gains through plantations and an improved value chain

Interventions	Metric	Traditional value chain (natural forests)	Modernized value chain (plantations)	Improvement coefficient
production	annual increment (m ³ /ha)	2	6.5	3.25
conversion	efficiency	12%	30%	2.50
combustion	efficiency	19%	21.3%*	1.12
energy produced	megajoule (MJ)	958	8,722	Leverage factor: 9.11
sustainable supply	no. of persons	1.5	13.9	

Note: Assumptions: wood density: 700 kg/m³; energy content: wood 16 MJ, charcoal 30 MJ, * weighted average, as only 20% of the urban population use ICSs with a 28% efficiency rate. Source: authors' fieldwork.

Based on the annual increment and the efficiency gains, sustainable wood fuel production at a scale of 8,000 ha offsets the previously unregulated exploitation of more than 72,000 ha of natural forests under traditional production, both within and adjacent to protected areas.

Local biodiversity conservation in state-owned natural forests is an additional benefit. Another benefit is the prevention of bush fires in and around the afforestation zones, since the owners of the forest plots have a strong interest in protecting their property.

Within newly created energy forests many native and even endemic species were able to establish themselves on previously denuded surfaces under eucalyptus trees (Edmond 2013). The understory vegetation — which includes grasses and bushes as well as the shallow root system of *Eucalyptus camaldulensis* — is very important in protecting the soil from erosion. This is important, since the plantations are situated on degraded and marginal land areas that are at risk of soil erosion.

Conclusions

Integrating the requirements of the ecosystem into development and land-use planning processes can deliver benefits to an extensive range of stakeholders. Afforestation and restoration of formerly degraded areas have for the time being reduced the pressure on neighbouring protected areas. By participating in a formalized value chain, rural wood fuel producers gained tangible benefits, such as increased income and diversification of livelihoods.

In addition to securing sustainable energy supplies, afforestation was reported to reduce resource conflict and therefore build social capital, which contributes to the success of resource management (Ostrom 1999; Ostrom, Gardner and Walker 2006) and climate change adaptation (Adger 2003). Local and regional authorities have based their land-use planning on the needs of the local land users, and support these social synergies. This is especially important in regions that are vulnerable to environmental threats and have ineffective legal frameworks (Economic Commission for Africa 2011).

The RVI approach is limited to barren land. It can supplement but not replace measures to promote transition towards SFM of all types of forests. With a growing demand for energy resources from growing populations, natural forests will eventually have to be included in SFM schemes.

The rehabilitation activities described here have the potential to be scaled up to other areas. They address the three pillars of sustainability: ecological suitability is ensured by rehabilitating formerly degraded land; and sustainable management has been proved to be economically viable and adapted to the social system as it diversifies local livelihoods and provides important income to reduce rural poverty.

Endnote

1. The relative improvement achieved at three principal stages (production, conversion and combustion) is shown as an improvement coefficient, resulting in an overall leverage factor of 9.1. With an average energy requirement of 625 MJ/pers./a, the traditional system can supply 1.5 persons sustainably; the modernized value chain can supply 13.9 persons.

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