Mission report for the ULCOS Project – SP 7

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Pre-feasibility survey for the United Republic of Tanzania

Guillaume Lescuyer

CIRAD Forêt, Montpellier, France

Contents

List of tables

List of maps

Executive Summary

Preliminary overall data

Geographically, the United Republic of Tanzania lies between latitudes 1-12° S and longitudes 29-41 E. It covers 945 000km², with 883 600km² of land areas.

According to the 2002 Population & Housing census, the Tanzanian population amounts to 36 millions inhabitants, with 80% live in rural areas. The present population density is 40 pers/km².

Tanzania belongs to the poorest countries in the world. Its estimated per capita GDP amounts to 280$. Agriculture contributes 45% to GDP. From a geopolitical viewpoint, Tanzania is considered a stable country.

Forest contexts and policies

The Tanzanian forest covers 33,5 millions hectares. The annual forest cover change is estimated at -160 000 ha mainly due to clearings for agriculture, that is accentuated by the yearly extraction of fuelwood over another 300 000 ha. Miombos are given as the dominant natural environment in Tanzania. They conceal a very important vegetal and animal biodiversity. To protect its natural environment, Tanzania has signed most environmental international conventions and agreements, notably the Convention on Biodiversity and the United Nations Framework Convention on Climate Change. Likewise, the Tanzanian government adopted new environmental orientations at the end of the 1990s: National Environmental Policy in 1997, National Forest Policy in 1998. New regulations were also instituted: the Forest Act in June 2002 and the Environmental Management Act in 2004.

The forest sector contributes 3,4% to GDP, but this estimate rises to 13% if charcoal activities are included. One axis of the National Forest Programme in Tanzania for 2001-2010 is to enhance economic contribution, employment and foreign exchange earnings through sustainable forest-based industry development and trade of forest products. Today, agriculture and forestry are considered by the Tanzania Investment Centre as lead sectors for investment opportunities.

In April 2000, the industrial forest plantations covered 150 000 hectares and their annual yield harvesting potential amounted to 1 600 000 m^3. They are dominated by softwoods (especially pines and eucalyptus) and constitute the main sources of roundwood in the form of sawlogs, pulpwood and transmission poles.

Most industrial plantations are public ownership that are leased to private companies for 33, 66 or 99 years. Industrial plantations seems to be a profitable investment in Tanzania since the existing companies extend their plantations and (foreign) new comers are currently investigating this opportunity. The average costs of these plantations are summed up in the following table:

Table : Cost estimates for fast-growing plantations in Tanzania

	Eucalyptus grandis	*Pinus patula*	*Acacia mearnsii*
Annual increment	28m^3/ha/yr	18m^3/ha/yr	8m^3/ha/yr
Rotational age (yr)	15	20	10
Initial costs ($/ha)	159	139	186
Recurrent costs	70	59	82
Final costs	82	72	98
Total cost ($/ha)	1222	1393	987
Cost per m^3 ($)	5,09	5,57	18,62

In addition to a forest management plan, the forest industrial plantations are submitted to three main legal constraints in Tanzania: (1) management of industrial plantation must incorporate other land uses like wildlife, eco-tourism, environmental conservation,… through co-ordinated strategic planning; (2) an Environmental Impact Assessment must be conducted; (3) local communities must be encouraged to participate in management of industrial plantations mainly through Joint Forest Management.

Charcoal production and consumption

Biomass accounts for 92% of final energy consumption in Tanzania. The potential annual supply of fuelwood in Tanzania was estimated around 20 millions m^3 whereas the demand is almost triple. The charcoal deficit is compensated with wild fuelwood cuttings mainly on public land. The lack of

fuelwood tends to be concentrated in particular areas, especially in densely populated settlements and those close to rural industries.
Charcoal production is a highly profitable activity: net present value for commercial production of charcoal (using traditional earth kilns) in the miombo woodlands in eastern Tanzania is 511$/ha over a 15-year period. The profit from charcoal production is attributable to very low capital outlays, free own labour, free raw materials, lack of concern about associated external costs and high demand for charcoal.
The wild fuelwood extraction from natural forests is one of the main causes of deforestation in Tanzania. This extraction is accentuated by the very low efficiency of traditional earth kilns used to transform fuelwood into charcoal: the mean kiln efficiency with simple earth kilns varies between 13-23%. A solution to satisfy in a sustainable manner the charcoal needs of the urban populations of Tanzania would be to dedicate some village and/or industrial plantations to fuelwood. Unfortunately, no industrial plantation in Tanzania is nowadays directly or indirectly oriented on fuelwood production. As a consequence, no modern and industrial technique to convert fuelwood into charcoal is presently utilised in Tanzania.

Clean Development Mechanism existing initiatives in Tanzania
Most big planting companies are keenly interested in benefiting from the Clean Development Mechanism (CDM) or from non-compliance agreements on carbon. Still the requirement of additionality is an impediment: as a matter of fact, in order to qualify for carbon credits, plantation projects must be additional to any that would occur in the absence of the certified project activity.
In addition to CDM for large planting initiatives, two recent projects attempt to link community-based forest plantations and CDM.
At the national scale, different scenarios of carbon sequestration with forestation projects (short rotation community plantations, short rotation for softwood plantations, long rotation for hardwood plantations) have been simulated. The net present value of these mitigation benefits vary between –136 and +53$/ha (with a 10% discount rate).

Land tenure and title deed for a one million hectares plantation
Creating a wood plantation over a one million hectares area requires that a land-lease contract be established with the State. This is a major issue as land titling is both a complex and sensitive procedure. To be granted by the Ministry of Land, the land-lease must receive prior villages, districts and regional agreements. For an average size plantation, one should count one year to have the titling procedure completed. The second step is the establishment of the land-lease contract that is based on fixed national standards according to which the company commits itself to using the lands solely for forestry activities.
No doubt that for such a large plantation, the national authorities must also be involved and some form of Joint Forest Management has to be worked out. Furthermore, there is little chance that the Tanzanian government accepts a one-block plantation of this size. One solution is to reduce the dimensions of this plantation (and to combine it with another one in North Mozambique to reach 1 million hectares). Another way out is to break up this extra-large size plantation in several smaller plots.

Potential area for the ULCOS project
In the framework of the ULCOS project, Tanzania was considered as a potential host-country for large size fast-growing wood plantations. These plantations should amount to a minimum of 1 million hectares, located in one or a few forest blocks. Several wood species were a priori selected for this kind of plantation: *Eucalyptus* spp, *Pinus* spp, and some acacias (mainly what are called the "Australian acacias", i.e. *Acacia mangium*, *Acacia auriculiformis* and *Acacia crassicarpa*). Available studies indicate that there are currently between 8-17 Mha available for wood plantations in Tanzania. Thus, land does not appear to be a critical constraint in the immediate future in Tanzania.
The most promising zone for large size fast-growing wood plantations seems to be the southeast part of the country, along the Mozambican border. The estimated surface of this area is around 80 000km² and seems to be extendable westward as many croplands are now deserted there. According to the 2002 census, the target area (that we denominate the Mtwara region) is inhabited by 1 700 000 people. The current demographic density is then around 21 pers/km².
Apart its ecological and demographic suitabilities, the Mtwara region is subjected to an ambitious

development programme, the Mtwara Development Corridor that is funded by the Southern Africa Development Community (SADC). It would provide an excellent framework for the ULCOS plantations. Several "Anchor Projects" are envisaged to cohere around a series of interlocking transport sub-systems that will assist in integrating marginalized regions into several cross-border development zones, noted for their comparative advantages in minerals, agriculture, forestry, fisheries, manufacturing, tourism and trade. However, the demographic growth in the coming decades and the correlated extent of the agricultural areas in southern Tanzania must not be underestimated. If the Mtwara region is today relatively free of any significant agricultural and industrial activities, the competition on land and on natural resources will be sharp in the coming years. It is likely that there will not be many places left for large-size plantations in ten years.

Potential ecological impacts in the target area

Very few updated ecological data are available for the Mtwara region. Obviously, many shrubland areas are actually miombo forests characterised by a high conservation value. On the opposite, especially in the western part of the target area, many cashew nut plantations are being forsaken by villagers, that leaves additional surfaces for future wood plantations.

Another environmental problem in the Mtwara region is the annual distribution of rainfall. This region is characterised by a lengthy dry season that can damage wood plantations, especially during the initial years.

Conclusion : Major advantages and drawbacks of a large-size fuelwood plantations in Tanzania

Major Advantages	Major Drawbacks	Recommendations
♦ A stable political context ♦ An innovative legal and regulation framework, in which industrial forest plantations are promoted ♦ ULCOS requirements regarding rainfall and population density are easily met ♦ Enough surface is presently available in the Mtwara region to consider extra-large size fuelwood plantations ♦ The Mtwara region is the subject of a very ambitious development programme (the Mtwara Development Corridor) supported by the SADC ♦ Privates companies and national administration are willing to support and to participate in the ULCOS project ♦ Tanzania is a signatory country of the Kyoto Protocol and a few CDM initiatives are being tested ♦ An inexpensive financial cost for most fuelwood plantations (but the assessment must be refined)	♦ Land titling and leasing is a complex and expensive procedure ♦ A sharp competition over the natural resources of the Mtwara region is likely in the coming years ♦ The nature and quality of the Mtwara region ecosystems are uncertain ♦ No industrial means for converting fuelwood into charcoal in Tanzania ♦ Fuelwood plantations have to be partly turned to answer domestic consumption ♦ The impacts of such intensive plantations on soil and water quantity/quality may be not positive ♦ Large plantations should be managed together with the local populations and the administration	♦ The Tanzania Investment Centre should be in charge of all negotiations on lands ♦ The ULCOS plantations in the Mtwara region should be decided and implemented in the short term ♦ Further (field) land use studies ♦ Study the conversion techniques used in South Africa ♦ Combine industrial plantations for ULCOS purposes with village plantations for domestic markets ♦ Test and develop mitigation measures through experimental research studies ♦ Apply joint-forest management and/or community-based forestry management ♦ Further socio-economic surveys on industrial plantations

An introduction to Tanzania in the ULCOS context

Some basic data

Geographically, the United Republic of Tanzania lies between latitudes 1-12° S and longitudes 29-41° E. Climatically, the country is hot with an arid central plateau surrounded by the lake region in the west and temperate highlands in the north and south. It covers 945 000km², with 883 600km² of land areas.
According to the 2002 Population & Housing census, the Tanzanian population amounts to 36 millions inhabitants, with 80% live in rural areas. The present population density is 40 pers/km². The average population growth rate is estimated 1.1% per year in rural areas and 2.6% in urban areas. The average fertility rate is of 5. As a consequence, the Tanzanian population should reach 60 millions in 2025 and 82 millions in 2050.

Tanzania belongs to the poorest countries in the world. Its estimated per capita GDP amounts to 280$. Agriculture contributes 45% to GDP. Almost half of the national budget is provided by international aid funds. The annual economic growth rate has varied around 4-5% for the last five years.

From a geopolitical viewpoint, Tanzania is considered a stable country, mainly due to the absence of one dominant ethny and to a national unity policy (the « Ujamaa » policy) conducted by Julius Nyerere from 1963 to 1985 (Hyden, 1980). In 1992, a multiparty democracy system was introduced and successful multiparty elections were held in 1995. The current president, Benjamin Mkapa, was elected in 1995 and re-elected in 2000. New presidential elections are planned in October 2005 but Mpaka's successor (the present Foreign Affairs Minister) is given as the firm favourite.

Forest environments of Tanzania

According to the Ministry of Natural Resources (2000), the Tanzanian forest covers 33,5 millions hectares. The annual forest cover change is estimated at -160 000 ha mainly due to clearings for agriculture, that is accentuated by the yearly extraction of fuelwood over another 300 000 ha. Nevertheless, the assessment of forest surface in Tanzania (as well as the deforestation rate) is controversial as the reliable data sources do not converge. For instance, the Global Land Cover 2000 estimates (*in* Dameron, 2005) are given below:

Table 1 : GLC 2000 forested surfaces assessment

(in hectares)	Dense forest	Mosaic forest/croplands	Woodlands/ shrublands	Grasslands
Tanzania	1 173 000	74 000	48 715 000	14 807 000

Even when excluding grasslands, the forest areas for Tanzania are estimated by GLC 2000 around 50 millions hectares. Such a difference results mainly from the hardship to define and to adequately categorise the miombo ecosystems. Conventionally, miombo is an open forest dominated by *Brachystegia*, *Julbernardia* and *Isoberlinia*. Its tree canopy covers more than 40% of the surface and its canopy exceeds 5 meters high. The miombo woodlands have low stocking, averaging about 50m^3/ha with an annual biomass increase between 2 to 4 m^3/ha. But it is also admitted that the miombo tree layer may vary in density, height and species

composition as an adaptation to environmental circumstances or to human pressures. As a result, some miombo ecosystems will be classified as a forest for some specialists, as a shrubland for others, or as a kind of ecosystems mosaic for some others.
Anyway, miombos are given as the dominant natural environment in Tanzania. They conceal a very important vegetal and animal biodiversity: Tanzania has Africa's largest number of mammals, second largest number of plants (10 000 species), third largest number of birds (1035 species), fourth largest number of amphibians (123 species) and fourth largest number of reptiles (245 species), all harboured by the country's forests.
To conserve this biodiversity, and more broadly to protect its natural environment, Tanzania has signed most environmental international conventions and agreements, notably the Convention on Biodiversity, the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto protocol, and actively attends the United Nations Forum on Forests.

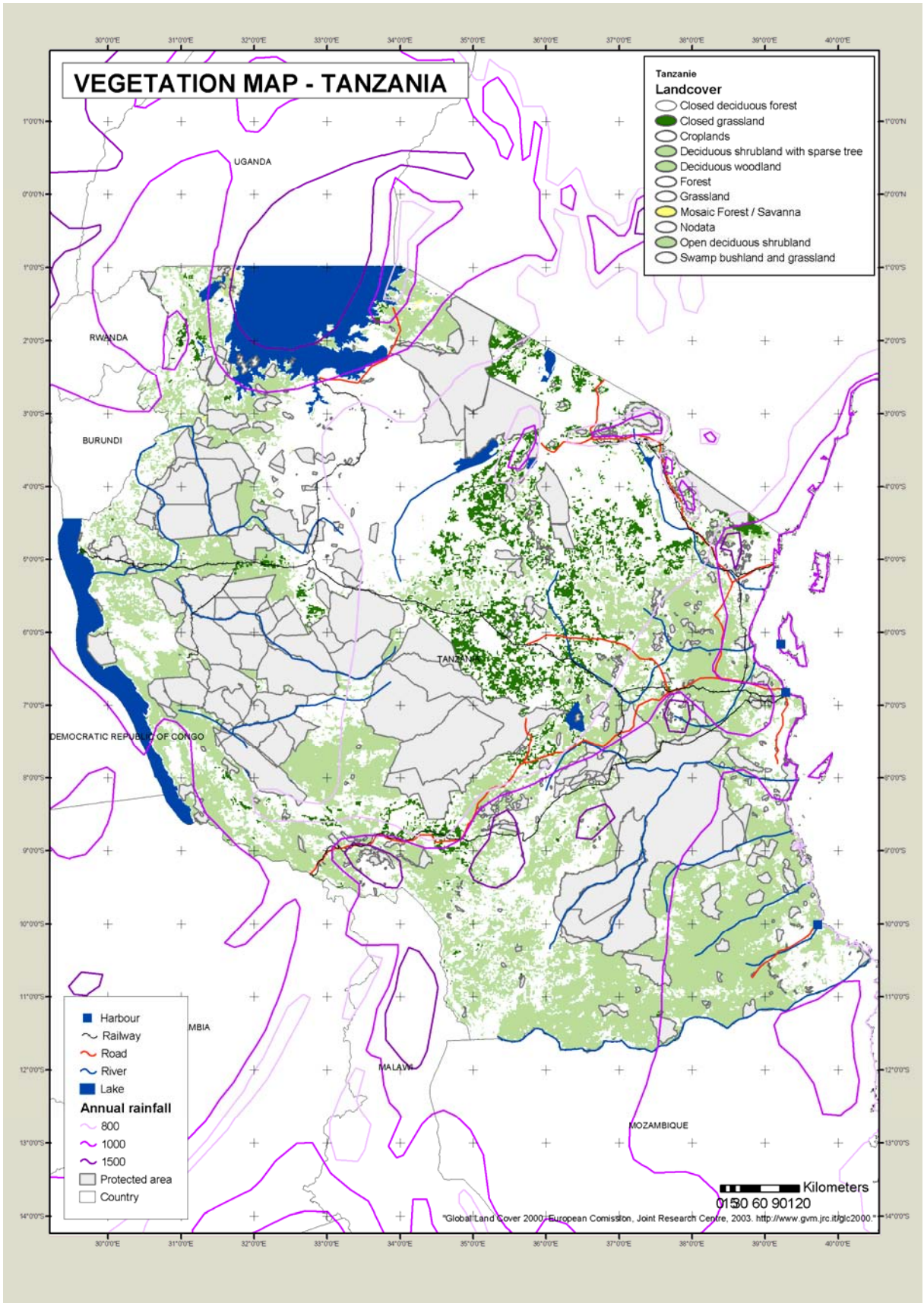
Potential for fast-growing wood plantations

In the framework of the ULCOS project, Tanzania was considered as a potential host-country for large size fast-growing wood plantations. These plantations should amount to a minimum of 1 million hectares, located in one or a few forest blocks. Several wood species were a priori selected for this kind of plantation: *Eucalyptus* spp, *Pinus* spp, and some acacias (mainly what are called the "Australian acacias", i.e. *Acacia mangium*, *Acacia auriculiformis* and *Acacia crassicarpa*).

Several criteria were used by Dameron (2005) to identify the potential areas for such fast-growing species plantations in Tanzania:
- the annual rainfall must be above 800 mm: 84% of Tanzania land territory abide by this criterion, that is to say around 76 millions hectares.
- only a couple of ecosystems are eligible for ecologically sustainable wood plantations:
  - closed grassland (with herbaceous cover greater than 40% and tree and shrub canopy cover under 20%);
  - deciduous shrubland with spare trees (shrub canopy cover between 15-40% and canopy height above 5 meters);
  - deciduous woodland (i.e. common miombo);
  - open deciduous shrubland (with shrub canopy cover over 15% and canopy height under 5 meters with no tree layer).
- the population density must be under 80 inhabitants/km² in 2050. This should concern 58% of the Tanzanian territory in 2050.

The combination of all these criteria produces the present suitability map for fast growing wood plantations in Tanzania. It is illustrated below (Dameron, 2005).

Map 1 : Suitability map for wood plantations in Tanzania



Dameron (2005) indicates that there are currently 17 Mha available for wood plantations in Tanzania. In 2030, this wood plantation potential would drop to 3-6Mha and to 2-7Mha in 2050.
This assessment may be compared to the one of Sathaye et al. (2001) who estimate that 7,5Mha are today suitable for forestation, i.e. 3,5 Mha for short rotation community woodlots, 2,5Mha for industrial reforestation and 1,5Mha for all other reforestation including agroforestry, long rotation plantations, non-forest tree crops,… The difference between the two evaluations comes, on one hand, from the difficulty to gather proper data on miombo ecosystems and, on the other hand, on the methodologies: Dameron puts the emphasis on the required ecological criteria whereas Sathaye et al. focus on the management modes for forest plantations.
However, if the ULCOS objective is to establish a one million hectares plantation, the two studies demonstrate that land does not appear to be a critical constraint in the immediate future in Tanzania. This is confirmed by Angelsen et al. (1999) who determine that only 13% of potentially arable land is presently cultivated in Tanzania. Thus it seems to be enough place for both agricultural and forest activities at the national scale in the medium term.

To meet the constraint of a one block forest plantation (or at least of a few neighbouring blocks), the map n°1 indicates several potential areas. The most promising zone seems to be the southeast part of the country, along the Mozambican border[1]. Before introducing this target area, a general presentation of the forest policy depicts the legal and economic contexts for possible wood plantations in Tanzania.

Tanzanian forest policy: the stake of forest plantations

The legal background

Tanzanian government adopted new environmental orientations at the end of the 1990s: in 1997 a National Environmental Policy was drawn up, which was followed in 1998 by a new National Forest Policy. New regulations were also instituted: the Forest Act in June 2002 and the Environmental Management Act in 2004.
All these texts bring major innovations in how to conceive and conduct forests projects. One new element is the classification of the forest areas (cf. table n°2) that provides substantial room to decentralisation (with the reserved forests for local governments or the village forests), to environmental services (with the catchment forests) and to plantations (both public and private).

Table 2 : Forest classifications in Tanzania

Forest area : 33 500 000 ha						
Reserved Forests : 13 000 000 ha				Public Forests : 20 000 000 ha		
Public plantations 80 000 ha	Catchment forests 1 600 000 ha	Reserved forest for central government 10 720 000 ha	Reserved forest for local governments 600 000ha	Private plantations 70 000 ha	Village forest reserve (no current data)	Public forests

[1] This preliminary choice was confirmed by several discussions with well-informed experts and researchers during my mission. The Annex I lists the main interlocutors I met during my field mission in Tanzania.

This new forest tenure regime allows three broad types of ownership:
- No ownership on the public forests (all unallocated and unclaimed forested lands).
- The reserved forests are set aside for specific purposes but remain the ownership of a (central or local) public entity. They can be managed by the public entity but they can also be leased to private actors. In all cases, the reserved forests are managed on the basis of a forest management plan that must comprise a participatory approach with the concerned population.
- The village forests have their own certificate of occupancy under the management of village councils.

All public and private stakeholders are urged to construct partnerships under two main forms:
- community-based forestry management where a partnership is set up between a local government and one or several villages: in 2004, 2 000 villages were concerned, covering 1 200 000 hectares;
- joint forest management where partnership is established between the central government and one or several villages: 525 villages are currently involved for 1 800 000 hectares;

An emphasis on forest plantations

The forest sector contributes 3,4% to GDP, but this estimate rises to 13% if charcoal activities are included. Though it remains small, this contribution has increased considerably during the past 10 years (around +35%) thanks to trade liberalisation policies introduced in 1987. The economic reform programmes have converted the command-based economy into a market-oriented economy. In 1998, the new forest policy has encouraged private sector involvement with a view to increase trade of forest products. One axis of the National Forest Programme in Tanzania for 2001-2010 is to enhance economic contribution, employment and foreign exchange earnings through sustainable forest-based industry development and trade of forest products. Likewise, the National Environmental Policy states that « *rational exploitation of forest resources accompanied with reforestation and afforestation programmes shall be promoted and enforced to meet requirements of domestic consumption and exports earnings in a sustainable manner* ». Today, agriculture and forestry are considered by the Tanzania Investment Centre as lead sectors for investment opportunities.

In April 2000, the industrial forest plantations covered 150 000 hectares and their annual yield harvesting potential amounted to 1 600 000 m^3. They are dominated by softwoods (especially pines and eucalyptus) and constitute the main sources of roundwood in the form of sawlogs, pulpwood and transmission poles.

Most industrial plantations are public ownership that are leased to private companies for 33, 66 or 99 years. Private plantations have been created during the last decade but they still remain a complement to the leased public plantations. For instance, the largest operating sawmill in the country, the Sao Hill company (belonging to the Tree Farms group) in Iringa, uses 50 000 hectares from which 40 000ha are state plantations[2]. In order to export 90% of its production of sawnwood (but of poor quality), the company has concentrated on the water-intensive and fast-growing species *Pinus patula* and *Eucalyptus saligna*.

[2] Globally, the Tree Farms group has the use of 90 000ha of plantations in Tanzania. It is worth noting that this leading company settled down in Tanzania only in the middle of the 1990s.

Industrial plantations seems to be a profitable investment in Tanzania since the existing companies extend their plantations and (foreign) new comers are currently investigating this opportunity[3]. The scope of this study is not to proceed a cost-benefit analysis of an industrial fast-growing plantation in Tanzania but only to collect data on the cost side. Specific interviews were carried out on this topic with the administration and two important plantation companies. These informations are complemented by the data provided by Makundi (2001). Average estimates are summed up in the table n°3 and displayed with more details in the Annex II:

Table 3 : Cost estimates for fast-growing plantations in Tanzania

	Eucalyptus spp (Makundi, 2001)	*Pinus* spp (Makundi, 2001)	*Eucalyptus grandis* (interv.)	*Pinus patula* (interviews)	*Acacia mearnsii* (interviews)
Annual increment	36m^3/ha/yr	25m^3/ha/yr	28m^3/ha/yr	18m^3/ha/yr	8m^3/ha/yr
Rotational age (yr)	8	25	15	20	10
Initial costs ($/ha)	217	204	159	139	186
Recurrent costs	47	24	70	59	82
Final costs	69	48	82	72	98
Total cost ($/ha)	590	876	1222	1393	987
Cost per m^3 ($)	3,31	2,50	5,09	5,57	18,62

In addition to the forest management plan, the forest industrial plantations are submitted to three main legal constraints in Tanzania.

First, management of industrial plantation must incorporate other land uses like wildlife, eco-tourism, environmental conservation,… through co-ordinated strategic planning. A particular importance is put on biodiversity conservation. As quoted in the National Environmental Policy, « *account will be taken of the danger of monoculture and to the extent possible natural forests will not be replaced by exotic species* ». The establishment of monoculture plantations is to be minimised by introducing stands of mixed species.

Second, an Environmental Impact Assessment (EIA) must be conducted for any kind of project dealing with (1) timber logging and processing or (2) forest plantation and afforestation and introduction of new species. Even if they are mentioned in the Forest and Environmental Acts, official EIA regulations do not exist yet but guidelines are available. Moreover, the National Environmental Policy speaks of Strategic Environmental Impact Assessment for policy or development programmes that may apply for the ULCOS potential investment.

Lastly, local communities must be encouraged to participate in management of industrial plantations mainly through Joint Forest Management.

The charcoal question

Biomass accounts for 92% of final energy consumption in Tanzania and will continue to dominate the national energy balance. The average national consumption of fuelwood is estimated 1.2m^3/capita/year. Availability, reliability of supply and cheaper prices render fuelwood more preferable than alternative sources of energy. The potential annual supply of fuelwood in Tanzania was estimated around 20 millions m^3 whereas the demand is almost triple (Sheya & Mushi, 2000). The charcoal deficit is compensated with wild fuelwood cuttings mainly on public land, especially from the miombo forests.

[3] cf. the examples in the target area.

The problem of fuelwood tends to be concentrated in particular areas, especially in densely populated settlements and those close to rural industries. For instance, in 1991, the average total consumption of charcoal in Dar es Salaam amounted 1,5 millions bags (of 30kg). Dar es Salaam's charcoal supplies come from within a radius of 100-150 km. Within this radius, a large percent of villagers are engaged in charcoal business to supplement farm income from agriculture. This is a highly profitable activity: net present value for commercial production of charcoal (using traditional earth kilns) in the miombo woodlands in eastern Tanzania is 511$/ha over a 15-year period. The profit from charcoal production is attributable to very low capital outlays, free own labour, free raw materials, lack of concern about associated external costs and high demand for charcoal (Luoga et al., 2000). Most of charcoal production is sold to city traders who make gainful business from this activity: between the village (1000-1500Tsh) and the final markets (4000-5000Tsh) in Dar es Salaam, the charcoal bag price is tripled. No official tax and fee is applied in the rural areas.

The wild fuelwood extraction from natural forests is one of the main causes of deforestation in Tanzania. This extraction is accentuated by the very low efficiency of traditional earth kilns used to transform fuelwood into charcoal: simple earth kilns make charcoal at a conversion rate of 2-3 bags of charcoal from 1 m^3 of fuelwood. The mean kiln efficiency varies between 13-23% (Monela et al., 2001). The fixed part of carbon amounts 70-80% of the total volume, with a linear relationship between the wood basic density and the density of charcoal (Kimaryo, 1982).
Similarly, although the communal woodlands are locally governed by a fairly well-defined group of villages, the motive of profit maximisation from charcoal encourages individuals to overuse common resources. The common property regime seeks to be weak in enforcing control mechanisms to check overuse of fuelwood resources.

A solution to satisfy in a sustainable manner the charcoal needs of the urban populations of Tanzania would be to dedicate some village and/or industrial plantations to fuelwood. Unfortunately, no industrial plantation in Tanzania is nowadays directly or indirectly oriented on fuelwood production. For instance, the Tanganyika Wattle company stopped producing charcoal a decade ago, as its price did not recover the production and transportation costs. On another hand, the Sao Hill company is presently considering the building of a small fuelwood transformation plant in order to valorise the plantation wastes but this investment does not seem to have priority.
As a consequence, no modern and industrial technique to convert fuelwood into charcoal is presently utilised in Tanzania. Any significant fuelwood plantation project would have to deal with this matter and would also be expected to contribute to reduce the quantity of illegal cuttings of fuelwood for domestic consumption.

Land tenure and title deed for a one million hectares plantation

Creating a wood plantation over a one million hectares area requires that a land-lease contract be established with the State. This is a major issue as land titling is both a complex and sensitive procedure. To be granted by the Ministry of Land, the land-lease must receive prior villages, districts and regional agreements. The first step is thus to identify the plantation area and to negotiate with the village authorities. This is the most difficult step as land tenure systems result from a mix of "traditional" rights (for the native populations) and modern rights established by the Ujamaa policy (for the displaced populations). Plantation boundaries, compensations to local populations and other local obligations are discussed under the control

of the administration. This first round of discussion is repeated at the district and at the regional levels. As an example, for an average size plantation, one should count one year to have the titling procedure completed. It is generally useful and cost-effective to turn to the Tanzania Investment Centre to conduct the land negotiations with the legitimate owners and local authorities.
The second step is the establishment of the land-lease contract that is based on fixed national standards according to which the company commits itself to using the lands solely for forestry activities. All details of implementation, like the length of the lease and the annual land rent, are made explicit. For instance, the Sao Hill contract is signed for a 99-year period and throughout this period the company must pay an annual land rent of 1.9$ per hectare to the government.

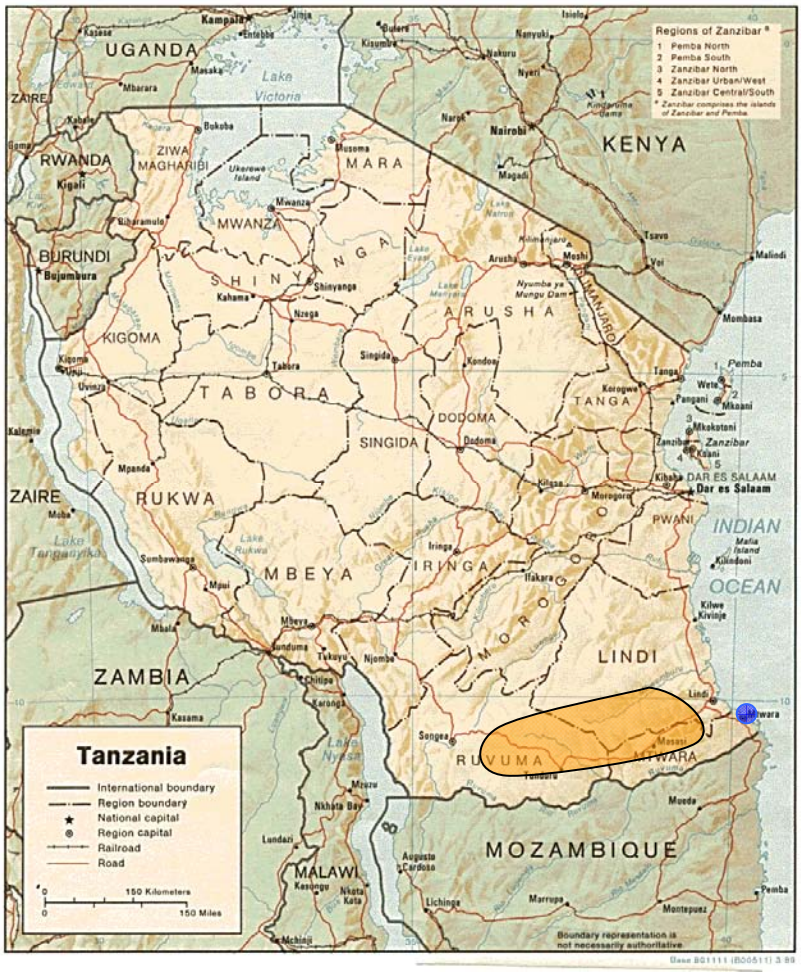
No doubt that for such a large plantation, the national authorities must also be involved and some form of Joint Forest Management has to be worked out. Furthermore, there is little chance that the Tanzanian government accepts a one-block plantation of this size. One solution is to reduce the dimensions of this plantation (and to combine it with another one in North Mozambique to reach 1 million hectares). Another way out is to break up this extra-large size plantation in several smaller plots.

Opportunities and economic constraints in the target area

Introduction to the Mtwara region

The study of the suitability map as well as discussions with national experts point out one specific area where a ULCOS fast-growing plantation may be considered. The area is roughly delineated in orange colour on the map n°2.

Map 2 : The target area for an ULCOS plantation



The estimated surface of this area is around 80 000km² and seems to be extendable westward as many croplands are now deserted there. According to the 2002 census, the target area (that we denominate the Mtwara region) is inhabited by 1 700 000 people. The current demographic density is then around 21 pers/km². It overlaps three regions (Mtwara, Ruvuma and Lindi) and covers 8 districts.
Apart its ecological and demographic suitabilities, the Mtwara region is subjected to an ambitious development programme that would provide an excellent framework for the ULCOS plantations.

Developing the Mtwara region: the anchor projects

In relation to the Southern Africa Development Community (SADC) Protocol, the Governments of Malawi, Mozambique, Tanzania and Zambia signed a letter of intent in 2002, in which they committed themselves to the preparation and establishment of the Mtwara Development Corridor (MtDC). This was followed up by the establishment of a multi-lateral agreement with Malawi, Mozambique and Tanzania on the MtDC, which was signed by the respective Heads of State in Lilongwe, Malawi on the 15th December 2004.

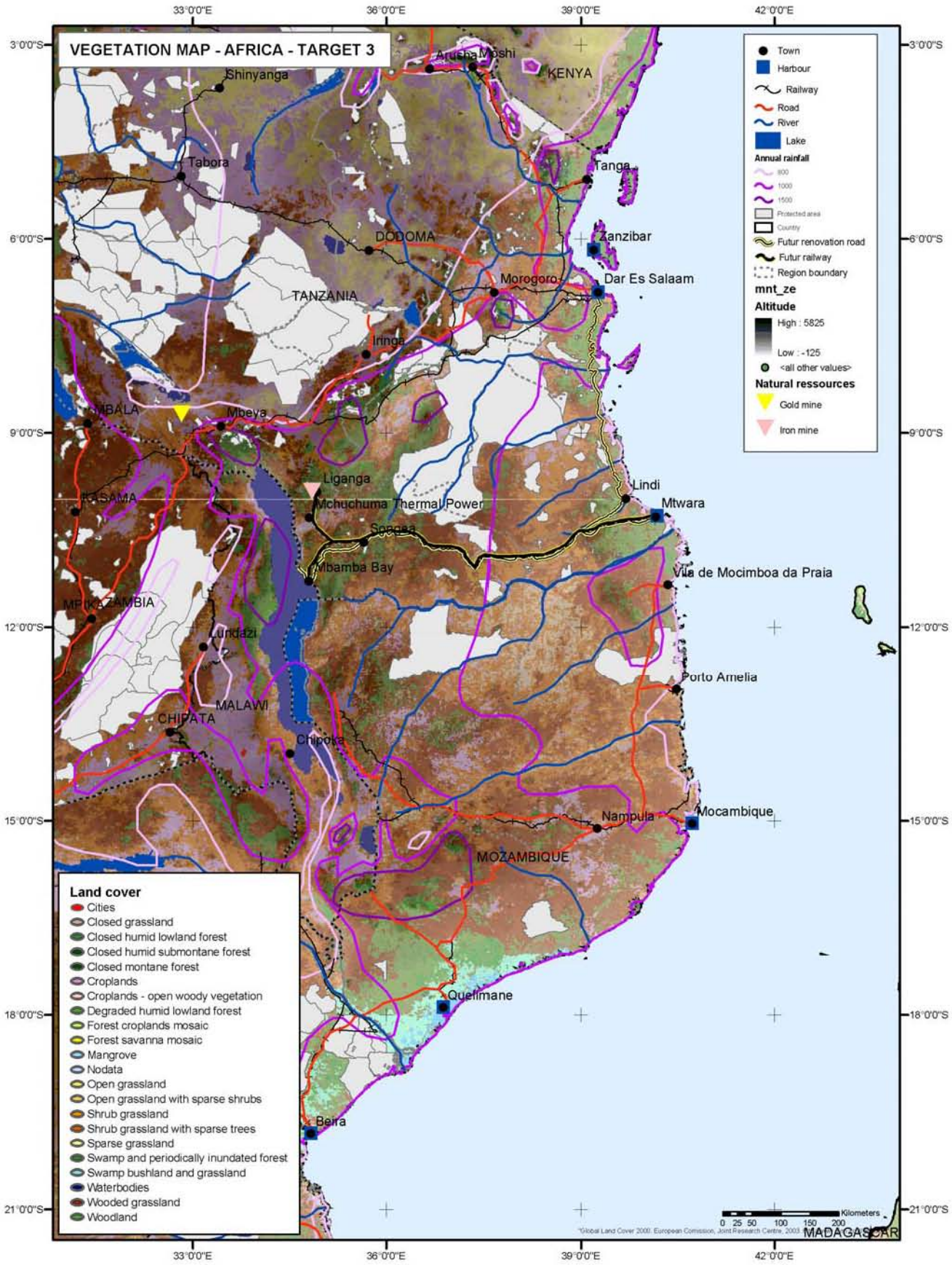
Several “Anchor Projects” are envisaged to cohere around a series of interlocking transport

sub-systems that will assist in integrating marginalized regions into several cross-border development zones, noted for their comparative advantages in minerals, agriculture, forestry, fisheries, manufacturing, tourism and trade (Smith, 2005). These key projects for Tanzania are detailed below and located on the map XXX:

- The construction of a mineral-based railway line from the Mchuchuma coal/power complex to the Mtwara port in southern Tanzania[4]. Two spurs will support this rail line, the first from Mbamba Bay on the shores of Lake Nyasa and the second from the Liganga Iron Ore/Vanadium/Titanium deposits.
- This railway line will be supported by the construction of the Dar es Salaam to Mingoyo Road covering a distance of 480 km down the southern coast and of the Mtwara to Mbamba Bay Road covering a distance of. 600 km inland of the Mtwara port. The Chinese cooperation is currently building the Dar es Salaam – Mtwara road (2*2 lanes) and is interested in the building of the Mtwara – Mbamba Bay road.
- The upgrading of the Mtwara harbour, port facilities and operations. Presently, the Mtwara port can annually deal with 400 000 metric tons. It is a deep-water port that can receive 174m long vessels. It provides adequate equipment for storage and handling.
- The Mchuchuma Coal to Electricity Project near the lake port of Manda on the shores of Lake Nyasa.
- The development of the Nguka, Njuga and Mbamba Bay coalfields as an extension of the Mchuchuma-Kateweka complex to underpin the case for the Mchuchuma-Mtwara railway line.
- Additional large-scale forestry projects relate to bio-diesel production as a substitute for or blended with diesel oil, use of charcoal as a substitute to coke in minerals benefaction, and sustainable harvesting of and value adding to indigenous hardwoods.
- The Liganga Vanadium-Titanium-Magnetite Ore Project approx. 100 km north east of the Mchuchuma Project.
- Titanium Dioxide Pigment Plant at the port of Mtwara.
- The establishment of a Special Economic Zone, centred on an iron and steel smelter, TiO2 pigment plant, natural gas terminal, coal/charcoal export terminal, chemicals industrial cluster, ship-breaking yard, fish, forestry products and agro-processing, fuel depot, container (import-export), motor vehicles and parts (imports) and dry-bulk (cement, fertiliser, lime, gypsum, caustic soda etc) terminals, proximate to the Mtwara port.

[4] The port of Mtwara is indicated by a blue circle on map 2.

Map 3: Key projects of the Mtwara Development Corridor



The overall cost of these development projects in Tanzania exceeds USD 4 billion. Part of it is already born by aid agencies (cf. building of roads by China). Private companies may also commit themselves in this MtDC project: two South-African pulp companies, Sappi and Mondi, are prospecting in South-Tanzania for pines and eucalyptus plantations. But the most massive investments (railway, industrial plants,…) are still to be funded in the SADC context.

In addition to this, the demographic growth in the coming decades and the correlated extent of the agricultural areas in southern Tanzania must not be underestimated. If the Mtwara region is today relatively free of any significant agricultural and industrial activities, the competition on land and on natural resources will be sharp in the coming years. It is likely that there will not be many places left for large-size plantations in ten years.

Potential ecological impacts

Very few updated ecological data are available for the target area. Discussions with Tanzanian experts/researchers bring new information that deserves attention.
Obviously, many shrubland areas on the suitability map are actually miombo forests characterised by a high conservation value. Groundtruthing studies have to be carried out to identify these natural ecosystems and to exclude them from the potential plantation areas.
On the opposite, especially in the western part of the target area, many cashew nut plantations are being forsaken by villagers, that leaves additional surfaces for future wood plantations.

Another environmental problem in the Mtwara region is the annual distribution of rainfall. This region is characterised by a lengthy dry season that can hardly damage wood plantations, especially during the initial years. This is particularly true for the Australian acacia species (*acacia auriculiformis, crassicarpa*, *mangium*) which cultivation has been experimental in Tanzania so far.

Lastly, all MtDC projects will be submitted to an EIA procedure and, at a larger scale, to a Strategic Environmental Assessment (SEA). As the guidelines for SEA are not yet defined in Tanzania, this requirement may slow down the implementation of these projects. More specifically, the impacts of ULCOS large-size forestation project on hydrology and on soil quality might rise some concerns.

Clean Development Mechanism existing initiatives in Tanzania

On the way to carbon credits

Several instruments exist to claim funding from international financial sources for sequestering carbon in wood plantations. The main opportunities are the Clean Development Mechanism (CDM) and Adaptation Funds, although there are other smaller funds such as the BioCarbon Fund (under the supervision of the World Bank). In addition, there is some “non-compliance” financing, that is to say direct finance through private organisations looking for “green” projects but not necessarily for carbon reduction certified by the UNFCCC. This various mechanisms are being tested in Tanzania for both industrial and village forest plantations.

Most big planting companies are keenly interested in benefiting from CDM or from non-compliance agreements on carbon[5]. For instance, the two companies I visited are already involved in getting a Forest Stewardship Council certificate for their plantations and they would like to combine this certification with a carbon offset[6]. Still the requirement of additionality is an impediment: as a matter of fact, in order to qualify for carbon credits, plantation projects must be additional to any that would occur in the absence of the certified project activity. This means that tree planting operations would not have been conducted if the option of trading CDM-based credits had not existed. However, most industrial plantation companies set up in Tanzania several years before the Kyoto protocol was signed, revealing that, for these companies, any trade in carbon credits is an opportunity for additional earnings: conventional forestry remain their main purpose and source of income.

Two recent projects attempt to link community-based forest plantations and CDM:

- The research project "*Kyoto: Think Global, Act Local. Bringing community forest management under CDM*"[7] tries to enable community based forest management projects to access funds under the Kyoto protocol regime. In the short term, the objective is the identification of potential methods to enable cost effective monitoring and evaluation of carbon and development impacts of community-based forest management. These techniques must be partially carried out by the communities themselves. To this purpose, local NGOs train the community members to make standard biomass estimates using specially programmed handled computers with GIS and GPS facilities. The project started in June 2003 and is planned as a five-year study.
- "*The International Small Group and Tree Planting Program*"[8] is elected at the BioCarbon Fund. This project refers to a present network of 863 independent small groups spread out across four regions in Tanzania (Dodoma, Kigoma, Morogoro, Tanga). Each small group is made up of 6 to 12 smallholder subsistent farmers who plant trees and own those trees and the rights to the carbon sequestered by them. Most of the planted groves are less than one hectare in size. In June 2005, these small groups planted 1,169,561. The program is developed to ensure the participation of over 20 000 Tanzanian subsistence farmers.

In addition to these existing initiatives, carbon permits appear to be a lucrative trade as some European brokers are currently investigating in Tanzania the opportunities for wood plantations firstly dedicated to CO_2 sequestration.

Simulation of carbon sequestration by Tanzanian forestation projects

It may be interesting to complete the CDM state of the art in Tanzania with some data on the overall Tanzanian capacity to sequester carbon with forestation projects. Makundi (2001) proposes this analysis for three wood plantations options at the Tanzanian scale. The principal

[5] Tree Farms is already in touch with a Norvegian electricity company, Industrikraft Midt-Norge, for a carbon credit price of slightly less than 4,5$ per ton CO_2.
[6] In this twofold purpose, the Société Générale de Surveillance, that both grants FSC certificates and monitors CDM application in Tanzania, will be visiting Sao Hill and Tanganyka Wattle companies in July and August 2005.
[7] This project is conducted by the University of Twente in the Netherlands with several research institutions in South countries, notably the University of Dar es Salaam in Tanzania. For more information: http://www.communitycarbonforestry.org
[8] http://www.tist.org

results of his research are displayed in table n°4:

Table 4 : Tanzanian capacity to sequester carbon with forestation projects

	short rotation community plantations	short rotation for softwood plantations	long rotation for hardwood plantations
Species	*Eucalyptus* spp, *Leucena leucocephala*, *Melia* spp	*Pinus* spp, *Cupressus lusitanica*	*Tectona grandis*, *Grevillea robusta*, *Acacia* spp
Surface (ha)	1 689 000	25 000	90 000
Rotation age (yr)	8	25	60
Vegetation biomass (m3/ha)	32.5	15	39
Carbon Sequestration (2000-2030)	197 402 000 Mg	5 622 000Mg	11 755 000Mg
NPV of mitigation benefits ($/ha) [9]	53	-136	-81
NPV of mitigation benefits ($/MgC)	0.46	-0.60	-0.32

With a discount rate of 10%, only the community project remains profitable but all scenarios are very profitable when the wood is sold as poles instead of fuelwood. Besides, the profitability of these fuelwood projects is highly increased when agroforestry measures are introduced, like a mix of eucalyptus and maize or an intercropping of *Gravellia* and maize (Makundi & Okiting'Ati, 1995). In this case, all agroforestry plantation options give a negative cost of avoiding carbon emissions.

Conclusion and recommendations

This pre-feasibility study investigates the capacity of the United Republic of Tanzania to become a host-country for large size fast-growing wood plantations. These plantations should amount to a minimum of 1 million hectares, located in one or a few forest blocks. Several wood species were a priori selected for this kind of plantation: *Eucalyptus* spp, *Pinus* spp, and some acacias (mainly what are called the "Australian acacias", i.e. *Acacia mangium*, *Acacia auriculiformis* and *Acacia crassicarpa*).

On the bases of the consulted literature and of my mission in this country, it seems to me that Tanzania gathers most conditions for such plantations are successful. Several obstacles must of course be addressed. Similarly, further studies should be carried out to refine this preliminary analysis. The respective advantages and drawbacks of Tanzania as a ULCOS host-country are synthesised in table 5 and some recommendations are proposed.

[9] The net present value calculations use a 10% discount rate.

Table 5 : Large-size fuelwood plantations in Tanzania : advantages, drawbacks, recommendations (from the ULCOS viewpoint)

Major Advantages	Major Drawbacks	Recommendations
♦ A stable political context	♦ Land titling and leasing is a complex and expensive procedure	♦ The Tanzania Investment Centre should be in charge of all negotiations on lands
♦ An innovative legal and regulation framework, in which industrial forest plantations are promoted	♦ A sharp competition over the natural resources of the Mtwara region is likely in the coming years	♦ The ULCOS plantations in the Mtwara region should be decided and implemented in the short term
♦ ULCOS requirements regarding rainfall and population density are easily met	♦ The nature and quality of the Mtwara region ecosystems are uncertain	♦ Further (field) land use studies
♦ Enough surface is presently available in the Mtwara region to consider extra-large size fuelwood plantations	♦ No industrial means for converting fuelwood into charcoal in Tanzania	♦ Study the conversion techniques used in South Africa
♦ The Mtwara region is the subject of a very ambitious development programme (the Mtwara Development Corridor) supported by the SADC	♦ Fuelwood plantations have to be partly turned to answer domestic consumption	♦ Combine industrial plantations for ULCOS purposes with village plantations for domestic markets
♦ Privates companies and national administration are willing to support and to participate in the ULCOS project	♦ The impacts of such intensive plantations on soil and water quantity/quality may be not positive	♦ Test and develop mitigation measures through experimental research studies
♦ Tanzania is a signatory country of the Kyoto Protocol and a few CDM initiatives are being tested	♦ Large plantations should be managed together with the local populations and the administration	♦ Apply joint-forest management and/or community-based forestry management
♦ An inexpensive financial cost for most fuelwood plantations (but the assessment must be refined)		♦ Further socio-economic surveys on industrial plantations

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ANNEX I - Main interlocutors in Tanzania

Chris Bekker, Manager, African Forests, Njombe

David Parkhill, Financial Controller, African Forests, Njombe

George Jambiya, Policy Officer, WWF Tanzania Programme Office

Godlove Mwamsojo, Senior Environmental Management Officer, National Environment Management Council

Graham Anderson, former manager of the Commonwealth Development Corporation

Graham Smith, Project manager of the Mtwara Development Corridor

Humphrey Mwaniki Ngibuini, Managing Director, Tree Farms, Mafinga

Olivier Hamerlynck, former leader of the Rufiji Environment Management Project, UICN

Peter A. Oduol, Agroforestry Consultant, World Agroforestry Centre, Tabora

Simbang'Ulile Kivinge, Principal Land Officer, Tanzania Investment Center

Stéphanie Duvail, researcher at the Institut de Recherche pour le Développement

Yonika Ngaga, Professor, Sokoine University of Agriculture, Forest Economics Department, Morogoro

ANNEX II – Economic assessments of fast-growing plantations

II.1. An example of a short rotation softwood plantation (Makundi, 2001)

Species	Eucalyptus spp
Rotation Age	8 years
Average mean annual increment	36m^3/ha/yr

	Costs ($/ha)	Volume (m^3/ha)
Year 1- initial costs	217	10
Year 2 – recurrent cost	47	20
Year 3 – recurrent cost	47	30
Year 4 – recurrent cost	47	45
Year 5 – recurrent cost	47	70
Year 6 – recurrent cost	47	106
Year 7 – recurrent cost	69	142
Year 8 – recurrent & logging costs	69	178
Total cost	**590**	
Costs per cubic meter	**3,31**	

II.2. An example of a long rotation softwood plantation (Makundi, 2001)

Species	Pinus spp
Rotation Age	25
Average mean annual increment	30m^3/ha/yr

	Costs ($)	Volume (m^3)
Year 1- initial costs	204	10
Year 2 - recurrent cost	24	20
Year 3 - recurrent cost	24	30
Year 4 - recurrent cost	24	40
Year 5 - recurrent cost	24	60
Year 6 - recurrent cost	24	80
Year 7 - recurrent cost	24	100
Year 8 - recurrent cost	24	125
Year 9 - recurrent cost	24	150
Year 10 - recurrent cost	24	180
Year 11 - recurrent cost	24	210
Year 12 - recurrent cost	24	240
Year 13 - recurrent cost	24	265
Year 14 - recurrent cost	24	280
Year 15 - recurrent cost	24	295
Year 16 - recurrent cost	24	305
Year 17 - recurrent cost	24	315
Year 18 - recurrent cost	24	325
Year 19 - recurrent cost	24	330
Year 20 - recurrent cost	48	335
Year 21 - recurrent cost	48	340
Year 22 - recurrent cost	48	345
Year 23 - recurrent cost	48	350
Year 24 - recurrent & logging costs	48	350
Total cost	**876**	
Costs per cubic meter	**2,50**	

II.3. An example of a Eucalyptus plantation (personal interviews, 2005)

Species	Eucalyptus Grandis
Mean annual increment (m3/ha/yr)	28
Rotational period	15jrs
Distance to the tarmac road	3km
Distance to the processing factory	15km

	Costs ($/ha)	Volume (m3/ha)
Year 1	*158,20*	5
Preplant weed	12,00	
Nursery	24,50	
Planting	70,00	
Fertilising	4,20	
Chemical and manual weeding	40,00	
Rates and levies	0,2	
Management costs	2	
Financing costs	5,3	
Year 2	*82,20*	10
Beat up / Blanking	3,50	
Fertilising	4,20	
Chemical and manual weeding	40,00	
Slashing	6,00	
Prunning	3,00	
Thinning	6,00	
Regrowth removal	8,00	
Fire & wild animals control	4,00	
Rates and levies	0,20	
Management costs	2,00	
Financing costs	5,30	
Year 3	*82,2*	15
Year 4	*82,2*	25
Year 5	*69,70*	40
Fertilising	4,20	
Chemical and manual weeding	40,00	
Thinning	6,00	
Regrowth removal	8,00	
Fire & wild animals control	4,00	
Rates and levies	0,20	
Management costs	2,00	
Financing costs	5,30	
Year 6	*69,70*	60
Year 7	*69,70*	88
Year 8	*69,70*	116
Year 9	*69,70*	142
Year 10	*69,70*	170
Year 11	*69,70*	198

Year 12	*82,20*	220
Fertilising	4,20	
Chemical and manual weeding	40,00	
Thinning	6,00	
Regrowth removal	8,00	
Fire & wild animals control	4,00	
Timber logging	9,50	
Transportation to factory	3,00	
Rates and levies	0,20	
Management costs	2,00	
Financing costs	5,30	
Year 13	*82,20*	230
Year 14	*82,20*	235
Year 15	*82,20*	240
Total cost	***1221,50***	
Cost per cubic meter ($)	**5,09**	

II.4. An example of a Pinus plantation (personal interviews, 2005)

Species	Pinus patula
Mean annual increment (m3/ha/yr)	18
Rotational period	20 yrs
Distance to the tarmac road	3km
Distance to the processing factory	15km

	Costs ($/ha)	**Volume (m3/ha)**
Year 1	*139,20*	5
Preplant weed	12,00	
Nursery	21,90	
Planting	70,00	
Fertilising	3,80	
Chemical and manual weeding	24,00	
Rates and levies	0,20	
Management costs	2,00	
Financing costs	5,30	
Year 2	*80,80*	10
Beat up / Blanking	3,50	
Fertilising	3,80	
Chemical and manual weeding	24,00	
Slashing	6,00	
Prunning	12,00	
Thinning	8,00	
Regrowth removal	8,00	
Fire & wild animals control	8,00	
Rates and levies	0,20	
Management costs	2,00	
Financing costs	5,30	

Year 3	*80,80*	15
Year 4	*80,80*	25
Year 5	*59,30*	35
Fertilising	3,80	
Chemical and manual weeding	24,00	
Thinning	8,00	
Regrowth removal	8,00	
Fire & wild animals control	8,00	
Rates and levies	0,20	
Management costs	2,00	
Financing costs	5,30	
Year 6	*59,30*	50
Year 7	*59,30*	68
Year 8	*59,30*	86
Year 9	*59,30*	104
Year 10	*59,30*	122
Year 11	*59,30*	140
Year 12	*59,30*	158
Year 13	*59,30*	176
Year 14	*59,30*	194
Year 15	*59,30*	
Year 16	*71,80*	212
Fertilising	3,80	
Chemical and manual weeding	24,00	
Thinning	8,00	
Regrowth removal	8,00	
Fire & wild animals control	8,00	
Timber logging	9,50	
Transportation to factory	3,00	
Rates and levies	0,20	
Management costs	2,00	
Financing costs	5,30	
Year 17	*71,80*	230
Year 18	*71,80*	240
Year 19	*71,80*	245
Year 20	*71,80*	250
Total cost	***1392,90***	
Cost per cubic meter ($)	**5,57**	

II.5. An example of a Acacia plantation (personal interviews, 2005)

Species	Acacia mearnsii
Mean annual increment (m3/ha/yr)	8
Rotational period	10jrs
Distance to the tarmac road	3km
Distance to the processing factory	15km

	Costs ($/ha)	Volume (m3/ha)
Year 1	*186,00*	2
Preplant weed	12,00	
Nursery	47,50	
Planting	72,00	
Fertilising	7,00	
Chemical and manual weeding	40,00	
Rates and levies	0,2	
Management costs	2	
Financing costs	5,3	
Year 2	*97,00*	4
Beat up / Blanking	3,50	
Fertilising	7,00	
Chemical and manual weeding	40,00	
Slashing	6,00	
Prunning	5,00	
Thinning	12,00	
Regrowth removal	10,00	
Fire & wild animals control	6,00	
Rates and levies	0,20	
Management costs	2,00	
Financing costs	5,30	
Year 3	*97,00*	8
Year 4	*97,00*	12
Year 5	*82,50*	20
Fertilising	7,00	
Chemical and manual weeding	40,00	
Thinning	12,00	
Regrowth removal	10,00	
Fire & wild animals control	6,00	
Rates and levies	0,20	
Management costs	2,00	
Financing costs	5,30	
Year 6	*82,50*	28
Year 7	*82,50*	36
Year 8	*97,50*	44
Fertilising	7,00	
Chemical and manual weeding	40,00	

Thinning	12,00	
Regrowth removal	10,00	
Fire & wild animals control	6,00	
Timber logging	9,50	
Transportation to factory	5,50	
Rates and levies	0,20	
Management costs	2,00	
Financing costs	5,30	
Year 9	*97,50*	50
Year 10	*97,50*	53
Total cost	***987,00***	
Cost per cubic meter ($)	**18,62**	