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CHAPTER 22

Challenges and Trade-Offs in Environmental and Financial Approaches of the Afforestation of Degraded Lands

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Abstract. Significant areas of unproductive and marginal lands create important economic and environmental imbalances at local, regional and national level, in many Eastern Europe countries. Despite available scientific and technological solutions for their enhancement, existing large degraded areas require major financing. Afforestation of degraded lands is acknowledged as an activity where environmental and financial synergies occur, as it generates a real carbon sequestration potential, besides other associated benefits at local, regional and global level. An opportunity to value carbon sequestration potential is represented by the flexible mechanism of the Kyoto Protocol, Joint Implementation and Clean Development Mechanism (JI/CDM). An afforestation project includes several steps, that should ensure the integration of the project outcomes with social and environmental priorities at local, regional and global level, in the short, medium and long term, such as: preparation, implementation (afforestation technology and plantation maintaining frame), plantation management (administration, planning, management); forest sustainability (local & regional integration); and project's carbon commercial aspects (baseline, carbon projections and validation, monitoring plan, reporting, transfer of carbon units). Carbon accumulation performance of the plantations influences potential revenues. Afforestation projects oriented toward carbon sequestration are exposed to multiple risks due to their long run, like vulnerability to illegal cutting, risks associated with unsustainable management practices or those related to climate change itself, biodiversity loss or social pressure.

22.1 Introduction

In a most common sense *synergy* is taken as "a mutually advantageous conjunction where the whole is greater than the sum of the parts" (www.wikipedia.org). In practice, there is an infinite series of possible arrangements that range from approaches to results, as based on innovative capacity of involved actors. Practical experience shows that a thorough *a priori* analysis is absolutely necessary to assess likely reciprocal positive, neutral or negative impact of each action over actual ecosystem components, as well as on their time evolution and interaction. Actually, synergy refers to innovative approaches and solutions that involve multiple partners, their long term commitment, specific financial contribution and sharing, and multiple environmental benefits, while the ultimate target is the contribution to sustainable development.

Afforestation is acknowledged as an activity where plenty of synergies occur, as it approaches local, regional and global issues and their associated interests. Benefits associated with the afforestation of degraded and marginal lands significantly contribute to improving the integrity of actions targeting the climate change mitigation, conserving and improving biodiversity and restoring the productivity of land. Such lands are found in a large proportion in Eastern Europe countries, under different intensities and types of degradation, out of which some important percentage of lands is abandoned (www.unccd.int/regional/centraleu/meetings/regional).

Abundance of lands available for afforestation may generate a significant positive effect as a global benefit in terms of CO_2 sink establishment.

22.2
Kyoto Protocol's JI/CDM Approach in Afforestation Activities

Degraded and marginal agricultural lands represent a real carbon sequestration potential, besides other several benefits generated by their reclamation through afforestation activities. Innovation regarding the afforestation under the Joint Implementation and Clean Development Mechanism (JI/CDM) is associated with the financial efficiency of the activity itself, according to the rate of carbon sequestrated in the ecosystem components (biomass, soil). Such a financing instrument should substantially stimulate the interest in land use improvement by afforestation of concerned lands. One of the environmental services provided by forest ecosystems, namely the sequestration of atmospheric CO_2, may be satisfactorily quantified, a feature that becomes the core issue in the joint implementation mechanism approaches (in comparison with the difficulties in accurate quantification of other environmental or societal services: soil and water protection, biodiversity conservation, landscape improvement, and protection of communities and crops). Apparent emphasis on carbon sequestration in JI/CDM afforestation projects does not exclude in any way "classical" scope of afforestation, but it additionally strengths targeting of multiple societal and environmental benefits.

Although the global effect on climate of the afforestation activities is still the subject of some debate (caused by age-related carbon sequestration rate, unpredictable late effects, associated uncertainties and large risks of hazards and leakage), it remains one of the most accessible, certain and easy-quantifiable forest activity associated with carbon sequestration.

22.2.1
Afforestation project cycle

A full project cycle includes several steps that should ensure total integration of the project outcomes with social and environmental priorities at local, regional and global level, on short, medium and long term. These steps include:

- preparation (construction of partnership; financial contributions; assessing incentives and compensation; availability, status and actual use of land; type of structure to be created, selection of species to be planted)
- implementation (afforestation technology and plantation maintaining frame)
- plantation management (forest administration, planning, management type)
- forest sustainability (local & regional integration)
- project's carbon commercial aspects (baseline, carbon projections and validation, monitoring plan, reporting, transfer of carbon units).

In a practical approach of JI afforestation project, it is important to review and understand the challenges for environmental and financial synergy and as to how to affect trade offs amongst, and create, least environmental and societal adverse effects on different horizons of time. Synergetic and trade off issues would come out easily from pairs (biodiversity *vs.* carbon bioaccumulation, land restoration *vs.* biodiversity alteration, sink reinforcing *vs.* degradation of lands, valued *vs.* not valued environmental services) and a multifactor balance brings more substance in such an approach.

22.2.2 Development of partnership

Crucial in JI afforestation projects is the fact that partners should have different targets in the project, as basis of their association and that there should be a proper balance of their complementary focus. Environmental and/or developmental needs should be balanced, in which the carbon issue plays a major role. Third party involvement is sometimes the key for ensuring the dialog and negotiations and bring on board the innovative issues.

Issues which are commonly raised over this process of negotiation and building up of partnership may be: uncertain land ownership; owner's indecision and long negotiations; weak, or lack of capacity of, forest administration; owner's restrictions or stipulations; and communication problems (technical, vocabulary nature). In case of a large number of owners, their will to associate together, their ability to entrust appropriate representatives, as well as the transparency of negotiations constitute the key factors in the success of the project, where identification of appropriate local "leaders" may play a major positive role, as well as promote a correct understanding of the project approach and the role of all partners.

22.2.3 Financial shares, incentives and compensations

Afforestation activities require significant input of effort in terms of labor, machinery and funds over a short period of time, while the generation of income is significantly delayed (early as secondary and later on as primary wood products). As degraded lands available for afforestation are generally associated with poverty affected area (where financial capacity is usually limited), the transfer of funds to these regions is crucial for achieving of afforestation activities. Public and/or private funding may contribute toward achieving of this goal. To join together several partners and their available funding there is a need for willingness and a capacity for negotiation amongst the partners. Always the afforestation beneficiary must be part of this process, just to ensure proper access to services created and commit his/her role in the project. Experience shows that public funds follow their own legal rules, but private partners may bring in innovative formulae in terms of financing, implementation or sharing of benefits.

Incentives to encourage the afforestation of poor lands range from free seedling offer and technical advice for planting to tax exemption on the land and grants for afforestation works. Incentive systems should be well analyzed and assessed within the economic environment so as to not distort other economical fields or socio-economical player's activities.

Afforestation of lands certainly reduces the areas available for other uses, such as: arable lands for perennial crops or pastures. In fact, an exhaustive impact assessment should warn and advice on negative impacts of land use changes and avoid any afforestation if this activity limits the benefits to the local population. In such cases, the compensation of the population would reduce the dissatisfaction generated by the afforestation of lands and allow time to become aware of the forest and restructure accordingly its own existence.

To address leakages, a relevant question is if the compensation measures, addressing local communities, which are taken to achieve the successful implementation of the afforestation projects are going to be quantified in terms of GHG emission/sequestration. An example of such a compensation measure could be the improvement of the quality of pastures or grazing land for communities, which may include small patches of trees as summer shelters for livestock. Accordingly, an increase of the carbon stock in the soil and biomass, as well as a likely increase of the livestock takes places, if appropriate planning and management apply. In case of a comprehensive green house gases national inventory, side effects of afforestation projects are fully and accurately accounted for.

Afforestation projects have usually a low yield, which may be increased if carbon offset is accounted for. "Afforestation of degraded lands project", developed between National Forests Administration of Romania and Prototype Carbon Fund/ World Bank between 2003-2017, (which includes 6,496 ha of degraded lands), yields a without-carbon Internal Rate of Return (IRR) of 2.04% equivalent to a Net Present Value (NPV) of -\$732 ha^{-1} at a 5% discount rate, and a with-carbon IRR of 3.86% equivalent to a NPV of -\$272 /ha. Estimated IRR values without carbon for pure black locust stands are 6.1%, 4.3% and 1.5% for site classes II, III and IV respectively. Site Class V, the lowest, does not yield an IRR as costs are greater than potential revenues. Still relatively low, the IRR values do not include the social and environmental benefits of the afforestation, which are usually of major significance in dry or drought affected areas (Brown et al. 2002; Abrudan et al. 2002).

Share of afforestation costs which may be covered from selling carbon could represent in amount a minimum of 20% of the total cost of afforestation work, a lot influenced by gap filling needs in case of low rate of survival. In the case of abandoned agricultural land or low degraded lands (which need less site preparation and maintenance work till canopy closure), the income from carbon sequestration may rise to 40-50% of the total project cost, but *nota bene* this amount is obtained over a period of 15 to 20 years (Blujdea 2003).

Usually, in KP's joint implementation approach there is a need for third party investment, a stable investor who is able to provide an amount of money for plantation establishment, which may be a serious constraint (Abrudan 2003). Alternative solution would be to get an upfront payment from carbon buyer. But in this case there are at least 2 more consequent problems which arise: upfront amount does not cover entirely the amount needed for the establishment of plantations and because of associated risks to afforestation projects (hazards, lower performance) the interest rate applied to upfront payment reduces the carbon revenues of the seller (up to 10%).

Incentives and financial mechanisms are key issues, especially in dry and drought affected areas, because of low incomes and spiraling costs from current activities (agriculture) (Geambasu 2002).

Additional environmental benefits like biodiversity should be reflected in the price of CO_2, as a "biodiversity incentive", even if there is no mechanism in place to accurately value such dimension. Still, buyer may have no interest in this feature as long as its carbon has no "shape" and it is up to national legislation of project's host country to manage biodiversity issues (Blujdea 2003).

22.2.4
Availability, status and actual use of land

Land for afforestation could exceed that for other uses following a regional/local improved planning or in most cases since it is degraded and is no longer suitable or economically efficient for other uses. Legal status and ownership are key things in the initiation of an afforestation project, a crucial issue when partners make their decision.

Land quality is a limiting factor for the afforestation technology, but it mostly could impact the growth of species to be planted (survival rate, stand characteristics, productivity and production). For a successful afforestation work, technology must be adapted to local situations, with focus on existing vegetation, both woody and herbaceous. A soft approach of land use change would allow conservation of carbon in vegetation or/and soils. On the contrary, a hard approach would generate increased emission from current ecosystem pools. Pastures store more carbon than arable soils, so different site preparations must be possibly approached, in order to reduce green house gases emissions (Houghton 2003).

Potential for damaging local diversity depends on how close the existing ecosystem is to natural status. In such situations, pastures, long term abandoned lands (whatever their use) and generally low intensive managed systems are susceptible to host significant biodiversity. In addition, in such cases, the stock and emission of carbon from existing structures is usually significant compared to arable lands.

Lower consumption of fuels and energetic effort in plantation maintenance is required for afforestation achieved on arable lands than on other lands (abandoned arable, pastures, etc). Issues that come out may have negative or positive impact on synergetic approach: land ownership and cadastral situation, land planning and legislation on land use, procedures on land use change, environmental impact assessment legal requests, consolidation of land (total area for afforestation, shape of the contour), capacity of negotiations of the different stakeholders or decision makers, institutional communication and the pressure and will of local populations to change from traditional to new life style. Also, land/soil status (chemical, physical and biological degradation), nature conservation interferences and type and structure of existing vegetation holds the key to understand and approach synergetic projects of afforestation.

22.2.5
Type of forest structure/plantation to be created

Multipurpose forests are generally the target in most cases of afforestation, having as main targets to "heal the poor lands", and further on to offer wood for consumption, protect communities against disasters and contribute to local social security by additional sources of income and alternative bioregenerable energy. Land use change is associated with emissions, which are higher as the current land use is less intensive.

Denomination of tree based structures is firstly driven by its designated spatial pattern (belts, forest like, patches) and purpose (halting erosion, windbreak), while other features remain secondary (management type, wildlife habitats, hydrological role, biodiversity sources, etc). Based on plantation of trees, whatever their purposes, there are several types of key structures to be created: forest, plantations/tree crops, agroforestry and pioneer/ transitory trees plantations. Establishment of any such structure generates different impacts on current ecosystems, in terms of biodiversity depletion and change of carbon stock/CO_2 emissions, as well as on other green house gas emissions (Table 22.1).

Minimizing the impact on biodiversity or carbon pools is associated with decisions on the technologies to be used for land preparation, plantation works or designing spatial pattern of plantations, removal or integration of existing vegetation in the new forest structure, selected species, connectivity and integration with existing forests, and cycle length and management type based on beneficiary needs. For some regions, increased frequency of intense or repeated droughts brings an additional factor in decision making process, namely climatic risks, what could be addressed properly based on specific coping local experience in different phases of the project (i.e autumn plantation, irrigation of plantations or versatile tree species).

22.2.6
Selection of species to be planted

Indigenous *vs.* exogenous species is the most challenging decision to be made in an afforestation project. This issue is more sensitive in case of private lands when owners have their own needs and have to operate under the restrictions of technical norms/regulations that promote ecological, not necessarily economical, solutions

Table 22.1. Likely impact of different types of forest plantations on biodiversity and carbon stocks and emissions

[illegible]	Impact on local biodiversity		[illegible]	
	Positive	Negative	Positive	Negative
Local/ indigenous species	Self standing on medium / long term	Removal of current biodiversity	Permanent carbon stocks, trigger for biofuel and industrial wood	GHG emission from current structures
Exogenous species	Removal of current effort out of natural forests	Removal of current biodiversity Different degrees of genetic pollution (locally or distance) Soil repeated disturbance	Permanent carbon stocks Downstream fuel substitution	GHG emission from repeated soils disturbance Energy and carbon intensive technologies for (re)planting
Agroforestry	According local *vs.* exogenous species	Diminish natural areas	Allow implementation of neutral GHG emission land use models	Increased GHG emissions form pools and intensive associated activities
Fast growing crops (woody bio energy, pulp, etc)	Removal of current effort out of natural forests	Remove of local species Genetic pollution of local species	Replace classical fuels or supply wood industry	Repeated GHG emissions and additional energy input for activities

for species assortment. Advantages offered by exogenous species (like growth rate, wood quality or market demand) overcome the hidden and diffuse benefits generated by local species promotion (biodiversity conservation, site adapted). Such decisions are assisted by technical norms (normally legally approved), that provide advice on appropriate range of species, their share in composition and technology to be applied so that a high probability of a successful plantation under local circumstances can be assured. Actually, the type and degree of degradation, climatic conditions and management purposes determine the assortment of species to be used, usually from a limited number of options.

In case of carbon oriented business the interest for a high rate of annual carbon storage brings additional stakes in decision making on the selection of afforestation species. Generally speaking, from carbon sequestration point of view, the tree species may be categorized as: fast growing and high wood density; fast growing and

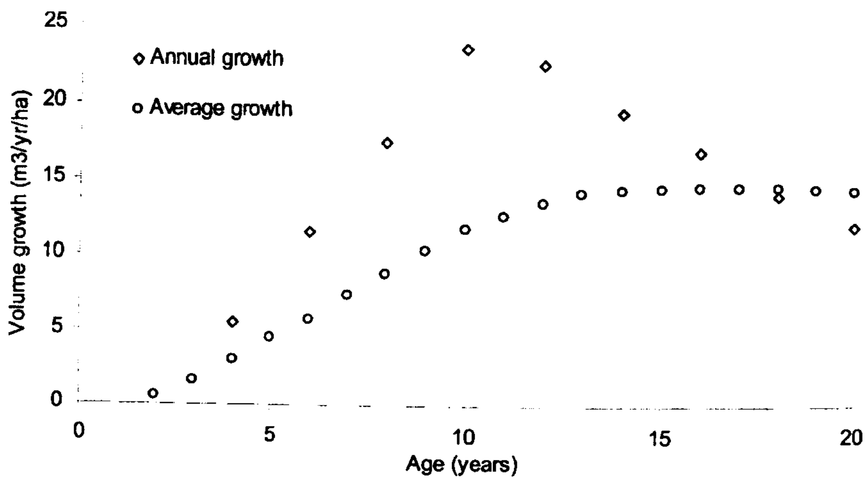

Fig. 22.1. Volume growth pattern in an exogenous poplar (*Populus hybride, I 214*)

low wood density; slow growing and low wood density. Classic forestry is "wood volume based" that allows cutting stands only after the age when rate of current annual growth in volume equals the average growth in volume (Figure 22.1).

Compared to this traditional approach, in the case of carbon sequestration interest, production cycle may be set shorter based on maximal value of annual current growth of the stand. Such decisions should involve a thorough analysis of subsequent benefits (wood, market need and supply for short cycles plantation products, i.e. pulp for fuel or cellulose, etc) and based on carbon or energy balance of whole production cycle of final wood products. In terms of green house gases emissions the effect of repeated irrigation and fertilization must be accounted for.

Different efficiencies in carbon sequestration of indigenous compared to exogenous tree species is shown in a particular case of afforestation of degraded lands in south west of Romania (Figure 22.2). Over 100 years analysis span, the total carbon accumulation in stands of exogenous tree is almost 6 times higher than in indigenous one (simulated with CO_2fix, v2.1; Nabuurs 2001; Masera 2003).

Under likely climate change, the key in afforestation is to approach species of trees that are versatile both in terms of different structures or management and the projected change in climate (droughts, shifts in vegetative seasons). Practically, tree species already tested in neighboring existing plantation may be used or species that allow both coppicing and old forests stands management (just to offer flexible option for management in case of climate change) (Blujdea 2002).

22.2.7
Afforestation technology and plantation maintaining frame

Land use change from current to forest plantation often requires high input of energy and intensive carbon emission. Usually, the afforestation technology refers

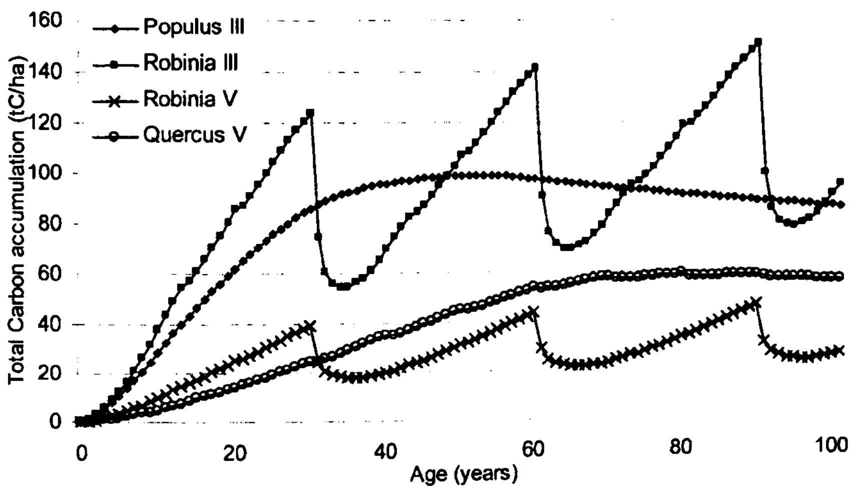

Fig. 22.2. Whole cycle carbon accumulation in different productivity stands of indigenous *(Quercus peducluliflora, Populus alba)* and exoge-nous (*Robinia pseudoacacia*) species

to a specific range of activities that would ensure successful establishment of the plantation. Currently, these technologies are energy and carbon intensive, with emissions both from machinery and ecosystem pools that additionally generate a heavy impact on existing biodiversity which is proportional to the intensity of management. Such intensity is actually caused by imposed activities set both by legal norms (standardized technologies) and the risk of unsuccessful plantations, especially in areas under drought. A full sequence of a standard afforestation technology comprises of site and soil preparation, seedling plantation, gap filling and maintenance/tending operations until the stage of canopy closure.

Plantation maintenance is intensive as well, not so much in terms of carbon emissions, as in terms of biodiversity reduction and replacement of species belonging to current structure to occasional associations in a transient structure. Stable flora of new forests may come in 2 to 3 decades, but its richness depends on seed sources. In cases of plantations established for ecological rehabilitation purposes, ground vegetation becomes closer to natural stands if there are available seed sources in the area (a management measure could be to transfer litter from natural forests to plantation to ensure the transfer of seeds and microflora). Forest ground vegetation has specific abilities to loosen upper soil layers and improve soil physical status, compared to other non forest species. Compared to arable lands, the forest plantation may host and ensure propagation of invasive species, both herbaceous and woody.

Specific management of plantations on sandy dunes, over the very early stages of development (First, and likely the second growing season of plantations) may have side effects on GHG balance of the soils due to fertilization and irrigation of associated crops (e.g. water melons) established between planted tree rows. The use of ammonium nitrate is followed by nitrous oxide release in the atmosphere, an effect that has to be quantified. Irrigation is not expected to create additional release of carbon from such soils due to low carbon content under continuous use for long period.

22.2.8
Forest administration and planning, management type

A key question is if the created forest is permanent or not. There are cases when community or owner enthusiasm of owning forests decreased in a short time and the young trees have been cut or plantations are heavily grazed. Forests administration, planning and management types are key issues under consideration when approaching an afforestation project. Over the forest cycle, the management objectives may change according evolution of ecological and societal needs, but the shift needs to be maintained within the framework of sustainable development. Management standards and human pressures (illegal cutting, grazing, accidental fires, deforestation, poverty) are issues that should be taken into consideration when planning an afforestation project.

Improvement of degraded lands by afforestation is associated with a trade off between the management purposes and the limited available site resources for forest establishment and growth. Traditionally, on heavy and medium eroded soils some exotic species are recommended, while low degraded soils are suitable for local indigenous species (specific to the natural type of forests in that area). Sustainability of forests in such areas is related to a certain management type adapted to the local environment, which actually contributes to the selection of the most suitable species (e.g. sprouting species are preferred to non-sprouting ones or those yielding other economic advantages than wood). In this respect some exotic species naturalized in Romania, like *Robinia pseudoacacia*, are the only viable solution for extreme types of sites (i.e. sandy dunes), where none of the local indigenous species has any chance to reach a minimum level of productivity or even to survive. In such situations, exogenous species present themselves as an optimal solution in providing convenient carbon sequestration compared to any local tree, and thus contributing significantly to the afforestation cost coverage, in addition to ecological and societal services.

22.2.9
Forest sustainability and regional/local integration

Behavior of local people against the forests created is crucial in ensuring their sustainability, and a range of question must be answered already when planning to establish a new forest: How does it integrate into local/regional land uses? Do people perceive the forest as wood supplier or acknowledge that the forests offer multiple benefits? Are they able to restructure their daily life and enjoy long term benefits of forests? Do they accept that forests have tight limits in offering goods (wood, etc) and services (protection, etc)? Is there adequate communication between planners and administrators? Are decisions in project steps taken with the participation of relevant local communities?

A high rate of internalization of benefits of the forests, in terms of a significant contribution to local economy and income patterns, is usually a strong driver to ensure long term sustainable management of the forests. Awareness of this issue versus a poor understanding of man-forest relation, is an issue to ponder on. As a general rule, the poorer the area, the higher the risk for forests sustainability, to which local interests (i.e. corruption and groups interests), real ownership of forest or capacity of owners to organize themselves, and implementation of transparent and equitable benefits sharing mechanisms should be added.

22.2.10
Project's carbon commercial aspects

Financing of carbon sequestration may act as an incentive for triggering afforestation programs or projects. Based on negotiations under UNFCCC and Kyoto Protocol, Annex I countries may use activities under Art 3.3 of the Kyoto Protocol to prove their emission reduction, namely ARD (afforestation, reforestation and deforestation) and may select optional activities under Art. 3.4, like revegetation (all definitions according FCCC/CP /13/Add1), for the same purpose. These arrangements open stronger discussions on the relations between financing of mentioned activities and emission reduction targets.

22.2.10.1
Project baseline – carbon approach

In a project approach, the key is to develop sound carbon accounting system, which means to establish a carbon reference stock against which the project generated accumulation may be assessed as accurately as practically possible. Accumulation of carbon in biomass may be satisfactorily estimated and verified, but in case of soils (especially for soil organic matter component) associated costs are high since credible statistical sampling in the form of large number of samples is required, caused by the large variability of SOM. Soil issue is generally complicated as it is necessary to address both scientific issues (in terms of replicable techniques, laboratory, statistical framework and quality assurance) and practical approaches (field sampling, appropriate equipment, achievable targets, etc.). Consequently, a decision needs to be made as to whether soil carbon is to be considered in the transaction deal or not. A full environmental integrity approach would be to prove that the soil is not a source, at least in the long term. This maybe true in case of afforestation of arable marginal land where soil organic matter is low, but in case of other less intensive current use (pastures, hayfields etc.), increased emissions associated with land use change are likely to occur and hence a concern for calculations of real net absorption from atmosphere.

In case the soil is taken into account the actual carbon stock in the soils of the area to be afforested should be determined just before the afforestation work starts, to ensure that short term emissions associated with land use change are offset by medium and long term sequestration.

A certain baseline survey implies the stratification of the land to be afforested in homogenous strata from the point of view of carbon in the soil, largely variable with the soil type and land uses. Recent history of lands in terms of tillage carried out is also important, and the same type of soil preparation over a long period creates a certain carbon balance with the atmosphere. In this respect, soils under agricultural crops may be considered to have a steady carbon balance with the atmosphere and tillage of soils as part of the site preparation for the afforestation is not associated with an increase of carbon release from soils. In the case of pasture lands, an increase of carbon release from soils is expected during the site/soil preparation work and consequent soil maintenance operations, for a short span (Liski 2002; Smith 2005).

22.2.10.2
Projection and validation of carbon accumulation

Patterns of biomass and carbon accumulation, respectively, largely depend on tree species, site conditions, as well as on afforestation schedule, considering that early plantations will produce earlier carbon accumulation and that there could be global and local environmental associated effects. Several projections regarding carbon accumulation in the project may be considered and accordingly several options would be available for the project negotiation culminating in one option for the final purchase agreement among the partners. When simulating carbon accumulation in tree plantation, entry data are generally provided based on yield tables used in forestry, which include wood volume which is late age oriented and can induce large uncertainties in early stages of projections. Presumed and simulated plantation productivity and production are validated as much as possible in the early stage of project (by assessing existing other plantation) or by field measurement (Figs. 22.3 and 22.4).

According to the recent developments regarding the afforestation activities based on scientific achievements, there is a statistical evidence of carbon sequestration in the biomass (foliage, stems and branches, roots) and soil (litter and organic matter in the soils) over short time periods.

Projections should represent "*bona fide*" estimates of the accumulation of carbon in the afforested area, as each approach must be based on certain requested input data and computation pattern, but it involves often much expert judgment or field measurements in similar plantations/stands in the neighborhood, if available. Consequently large uncertainties are associated with simulation of carbon accumulation in afforested areas, which is actually a continuous challenge for the scientists. One available option is to choose the minimum projection accumulation in the project, which allows both partners to be pretty sure about the achievability of the carbon target of the project. This would also allow the seller to get the market price at the moment of delivering the extra carbon sequestered in case of better performance of the project, if initial purchase contract did not state otherwise.

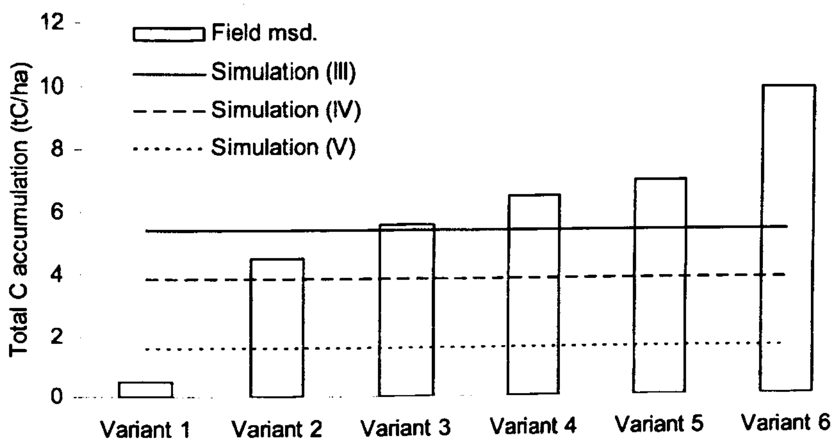

Fig. 22.3. Early accumulation of carbon in total biomass compared to simulated (*Robinia pseudo-acacia, 3 years old plantations*)

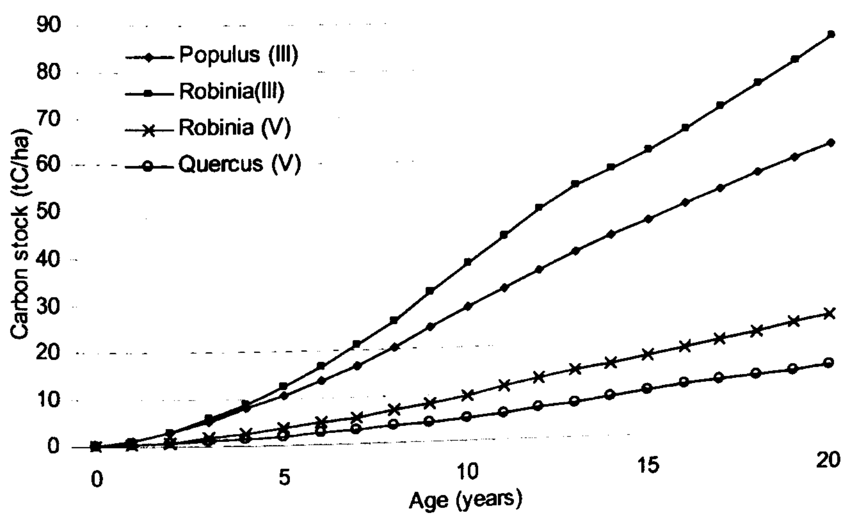

Fig. 22.4. Total carbon sequestration in 20 year-old plantations of different species (pure stands, first rotation) (generated by CO2fix, v2.1; Nabuurs 2001; Masera 2003, based on Romanian forest yield tables)

In the case of a Romanian afforestation project, the field measurements done in adjacent plantations to the project area showed a higher amount of carbon than predicted with CO_2Fix ver 2.1 (Nabuurs, 2001; Masera, 2003), mainly due to specific ecosystem processes (low rate of decomposition of necromasis) and higher growth rate of the stand than the initially projected one. Field estimation of accumulated carbon requests an appropriate approach for ecosystem components (stems, branches, foliage, DOM, SOM) both in terms of the method and the statistical framework adopted. Maximum yield approach as a basis for a carbon purchase agreement could be risky as based on project performance, except in the case where additional guarantees as "hot air" compensation for non-performance projects could backup the transaction amount initially planned and agreed.

22.2.10.3
Carbon estimation

Vegetation establishment on poor lands is associated, in many cases, with low productivity of the established forests due to the site conditions, and this creates difficulties in predicting and quantifying the carbon accumulation. Commercial afforestation projects are assessed by monitoring and reporting.

Annual reporting may refer mainly to an overview of the implementation stage: annual afforestation pace, composition of plantation, survival rate, records on fuels and fertilizers used.

Once the project implementation starts, every 5-7 years the amount of carbon sequestered has to be accurately estimated, with the purpose of assessing the project performance and to balance the cash flow between partners (in case of annual payment started at the beginning of the project). Such monitoring activities are supposed to identify any change of the size of the afforested area included in the project, any major damage that may disturb significantly the carbon accumulation process and to actually quantify the carbon stocks. Monitoring activity should be carefully considered in terms of costs and desired objectives, since an increase in precision would imply a larger number of permanent monitoring plots, which leads to an increase in the cost. Carbon estimation through monitoring must consider the Marakesh pools, as previously concluded by project parties, i.e soil organic matter, dead organic matter, trees stem, branches, foliage and roots. In the monitoring year, the right moment for biometrical and soil measurement should be the one showing stable accumulation of carbon in the ecosystem parts, which is the end of the summer, just before the leaves fall (15 July to 1 September in temperate regions).

Annual or periodic reporting manifests itself as a tool to assess the performance of a project, and it has a strong component of communication amongst project partners. Also, it includes avoiding double accounting and transfer of carbon offsets to relevant partners.

22.2.10.4
Biodiversity assessment

There is no baseline for biodiversity, but it is assumed that it correlates to land use. Still an Environmental Impact Assessment (EIA) is performed before the start of the project and sensitive areas are identified and excluded or mitigation impact strategies must be approached. Biodiversity change generated by afforestation should be also assessed over the monitoring. Simple and economically key parameters should be considered for assessment over the project period; the biodiversity gains generated by land use change from degraded land to forest plantation, would likely require an in depth multilateral research and assessment, beyond the pragmatic monitoring purposes in order to fulfill the Kyoto requirements. A key for biodiversity monitoring would be end-of-food chain species in the ecosystem (e.g. raptors, birds). Measures to mitigate the impact on local species and associations could include connecting existing forest patches; partially preparing the site in order to allow existing vegetation to continue living; soft site preparation technologies and reliance on existing vegetation as nucleus for further improvement of stand structure; implementing management plans for wildlife; forbidding and guarding against grazing or illegal cuts; and assessing traditional knowledge in order to balance the needs of local populations in certain species or a specific product.

22.3 Conclusions

Afforestation is accepted as a key solution for "healing" the degraded lands that occur almost all over the world, but with a higher occurrence in dry and drought affected areas. Afforestation projects or programs suppose a range of actions and arrangements that imply institutions, legal and technical expertise and adequate funding that assume associated and relevant risks, as well. One way to ensure financial support is via carbon transactions that may cover a good share of total project cost, under the relevant articles of the Kyoto Protocol (3.3, 3.4, 6 or 12) which may act as an incentive for national resource mobilization. Direct and synergetic benefits of the afforestation toward local population and local environment remain key objectives, to which global benefits of carbon sequestration could be added. Improvement of land use by afforestation contributes substantially to the environmental integrity of the Kyoto Protocol and the mitigation of the climate change effects.

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