INSEA - Project objective(s)

The ***project's goal*** is to develop an analytical tool to assess economic and environmental effects for enhancing carbon sinks on agricultural and forest lands. Scientists and practitioners around the globe are searching for options to stabilize increasing carbon dioxide concentrations in the atmosphere, which are seen as the main cause of global warming. Approximately 85% of primary power consumption today is fossil-fuel based, thus alternative production and efficiency of energy use are seen as a solution to the problem. Recent studies however, illustrate that in spite of revolutionary technological advancements in carbon (C) emission-free energy, the goal of CO_2 stabilization will be difficult to achieve (Hoffert *et al.*, 2002). Therefore, supplementary actions should be undertaken. One such option is the manipulation of biogenic carbon sinks and sources, possibly in countries where land resources are available.

Land use, land-use changes and forestry (LULUCF) activities are eligible in Articles 3.3 and 3.4 of the Kyoto Protocol for stabilizing the greenhouse gas concentration in the atmosphere. The focus is allocated to verifiable changes in biogenic C stocks in biomass and soils. Detailed studies show that changes of C pools in terrestrial ecosystems follow the basic law of conservation of matter and that C accumulation in one element of the component of an ecosystem is balanced by losses in other components (e.g., Nilsson *et al.*, 2000). This is in line with the basic principles for C cycling (Vernadski, 1965; Bolin *et al.*, 1977). The practical implication of this is that the net C-sink enhancement can be verified if all C fluxes are accounted and the overall C exchange picture is clear. In turn the C cycle is a part of other essential nutrients turnover. The insufficient supply of the latter might constrain the biomass production and limit the C-sink potential. This is why we consider the option to account for the entire basket of biogenic GHGs (CO_2, CH_4, N_2O and NO_x). The C-sink enhancement is a goal that should be accomplished by cost competitive analysis in which other social and environmental targets and consequences are introduced.

Both in the EU as well as internationally there is a lack of analytical tools to quantify reliably and in an integrated manner economic and environmental effects of C-sink enhancement and other greenhouse gas emissions originating from the use of land for agriculture and forestry purposes. Therefore, the ***impact*** of this project on both long- and short-term planning of climate mitigation policies can be considered substantial. It is thus the prime objective of the proposed research to develop an operational model to support the international negotiation process. The application and the development of the model should directly lead to robust policy conclusions pertinent to measures, in particular their implementation schedule, in the agriculture and forestry sector vis-à-vis all other climate mitigation measures.

Cost estimates for C-sinks can vary substantially with the choice of method and the respective assumptions made within each method. Three different model categories are currently in use by a number of expert groups to estimate the costs of sequestering atmospheric C with LULUCF:

- Engineering approach (ENG);

- Partial economic approach with exogenous output prices (PE); and
- Full economic approach with endogenous prices (FE).

The US is currently the most researched geographic area with respect to cost curves. *Figure 1* compiles the derived marginal cost curves (or C sequestration supply curves) for eight major studies, we selected from a larger survey, of estimating costs for, e.g. forest C sequestration in the US. Since each study differs in various aspects such as the assumptions on harvest rotation time span of projection and the discount rate, the results are not completely comparable. However, it does give an idea of the consequence of the selection of each approach on the cost estimates. From the survey we also observed that authors would provide, within a period of five years, cost estimates of the same geographical object that differ by a factor of up to 1000%. We can conclude that for the US, and even more so for the EU, a consistent picture of supply of C-sink enhancement is still lacking.

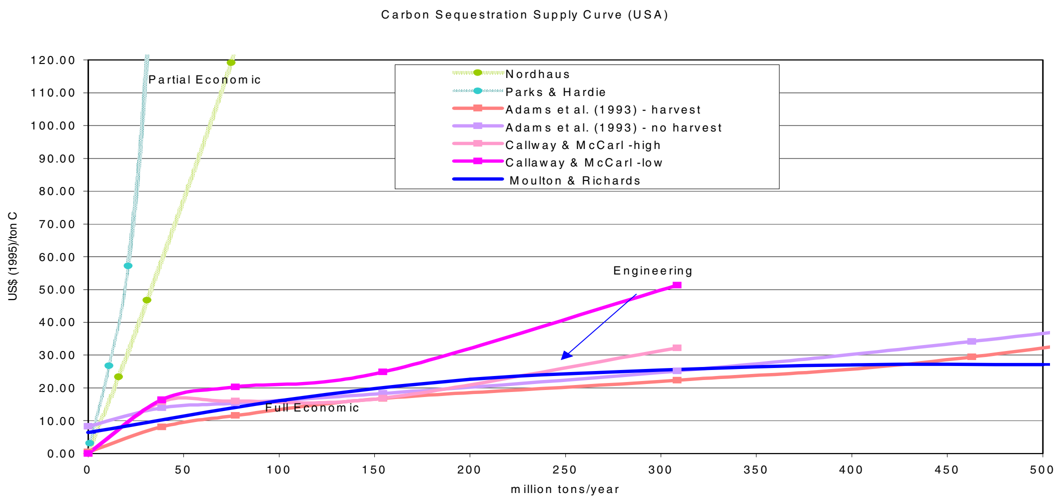

Figure 1. Survey of forest carbon sequestration curves for the US.

INSEA addresses this crucial gap. The ***overall objective*** is to support the formulation and implementation of the European Community policies, by providing a timely scientific contribution to policies that are targeted on the prevailing needs from the policy side, coherent across the various regions, and sensitive to changes in policies as they take place. Its ***specific objectives*** are **to develop an analytical tool to assess in a geographic explicit fashion the economic and environmental effects of LULUCF measures in the short and long-term in a transparent and consistent way. In parallel we will derive options for policy that allow cost-efficient and practical implementation mechanisms** for LULUCF[1] activities, taking into account other international conventions[2]. This will

[1] Land Use, Land Use Change and Forestry
[2] Conventions on Biological Diversity and to Combat Desertification, Helsinki Process, FAO Global Forest Resource Assessment, etc.

drive and shape practices in the LULUCF sector. Five critical issues pertinent to the design of this project are:

- **Quality assessment (QA)**: to improve the quality of the LULUCF assessment and reveal dubious figures;
- **Sustainability**: to assure compliance with other international conventions;
- **Validation and Uncertainty**: to assess the confidence levels of computed figures and the sensitivity of parameters;
- **Comprehensiveness in terms of assessment of all GHG Fluxes**: to aim the sink assessment at the effect of LULUCF activities upon the total GHG balance (i.e. including also livestock activity)[3].
- **Timeliness, Simplicity and Implementability**: to assure that results can be readily integrated with cost estimates of other sectors and that measures are realistically implementable.

In order to achieve the operational goals of the objective the following means have to be considered. A comprehensive and consistent C-sink assessment has to be built on a solid scientific concept embracing appropriate **knowledge** and independent observations from **field experiments and national studies** and **high quality auxiliary spatial data**. System and data integrity is an important requirement, together with the efficient application of data such as **GIS** data related to topography, soil, vegetation, forest inventory, region boundaries, other land and landscape information all the way to spatially explicit socio-economic data. By making extensive use of spatial data we hope to be able to reap the benefits from the huge investment on the part of the EU in Earth observation (EO) systems and networks of collection of consistent spatial explicit data. The subsequent and parallel steps to massive database work is the construction of consistent **baselines** for all spatial units in order to provide a solid basis for assessment of additionality in both environmental and financial terms. A **comprehensive inventory of C-sink enhancement option** shall be built based on the achievements of WG 7 (Agriculture) of the European Climate Change Programme. Each option will be appraised according to its cost competitiveness using engineering cost models and environmental management criteria that were created in a number of different international agreements. After the application of a carbon cost and accounting algorithm to each geographic unit **cost landscapes** are computed that are visualised by means of Geographic Information Systems (GIS). These landscapes will be scrutinized by a user community that will have access to cost landscape information and tested with real data from a number of other carbon programs in a **validation phase**. In addition to 'classical' sinks we will also provide integrated assessment of biomass based **negative emission technologies**, which according to our current scenario work seems to be crucial with respect to achieving stabilization of atmospheric concentrations in particular of low emission scenarios. The long-term assessment of C-sinks and negative emission technologies will be performed in a specially targeted **scenario package** that will be integrated with a number of existing energy scenario models and integrated assessment models of climate change.

[3] Hereafter, sink enhancement assessment shall be synonymously be understood as GHG mitigation in the broad sense in the forestry and agricultural sector. This explicitly includes the analysis on non-CO2 emissions from the LULUCF sector like livestock activity.

This project will conclude with a **Summary for Policy Makers type of report** explaining the scientific concept, technological requirements, simulation results and implications for policy making of the most crucial issues.

Scientific Objectives[4]

1. Theoretical backgrounds, assessment strategies and uncertainty assessments for full greenhouse gas accounting and economic valuation of sink enhancement measures of terrestrial biota at the grid (polygon) and national levels using a systematic approach;
2. Elaboration of direct linkages between full cost accounting and "Kyoto deliverables";
3. Synergetic use of all relevant sources of information, including a multitude of competing assessment models, with geographically explicit land information as a nucleus of the approach;
4. Design of the structure of an integrated information system directed towards ecological and environmental assessment under global change, which would meet UNFCCC requirements.

Technical Objectives

1. Selection and integration of available and the most suitable existing spatial and technical data;
2. Design of static-dynamic, single-multiple output, deterministic-stochastic cost models and application of reduced form models to the geographic area of the enlarged EU and globally. The first cut cost model to be integrated with other sectors should be deliverable by middle of 2004;
3. Construction of a flexible and consistent scenario model;
4. Structuring the relevant GIS systems and defining potential technological links to other European programmes such as INSPIRE[5], CORINE[6], MARS[7] and a potential user community that would allow self-organized quality improvement.

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[4] Note that both scientific and technical objectives include notions of vision statements rather than the definitions of practical objectives and goals, which could be used of assessing project progress.
[5] INfrastructure for SPatial InfoRmation in Europe
[6] Coordination of Information on the Environment
[7] Monitoring Agriculture with Remote Sensing