INSEA

Integrated Sink Enhancement Assessment

Deliverable D9

Report on First Supply Functions

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(Overview)

EC Project

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Web: http://www.iiasa.ac.at/Research/FOR/INSEA/

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Report on First Supply Functions

Overview of papers submitted

Introduction and Future Steps

Section I

Paper 1: Biophysical Process Modelling for EU25: Concept, Data, and Methods

The report introduces concept, data, and methods for the delineation of homogenous Hydrologic Response Units (HRU) in EU25. The Environmental Policy Integrated Climate model (EPIC) is employed to simulate all HRU. Each HRU is described by dominant weather, soil, topography, and management practice. A large data pool is processed in order to fulfil a minimum of input data requirement necessary for biophysical process modelling at large scale.

Paper 2: A Two-Model Comparison of GHG Emission and Abatement Costs in Baden-Württemberg

This text addresses the issue of greenhouse gas emissions from agriculture and the assessment of marginal abatement costs. The results from AROPA-GHG and EFEM, two linear-programming, farm-type based models are compared. First, the modelling approaches are reviewed and discussed, focusing specifically on parameters estimation, farm-type characterization and aggregation. Secondly, the modelling of management practices particularly relevant to GHG are discussed, namely fertilization, animal feeding and manure management. The results indicate that, for a carbon value of 20 EUR/tCO_2eq, the estimated reduction in emissions ranges between 2.4% and 5.3% of the baseline BW agricultural emissions.

Paper 3: Comparison of the Stand Level Model PICUS and the Grid Based Forest Model TsuBiMo

This manuscript gives an overview of the state of biophysical part of forestry modelling in the INSEA project at micro (plot) and meso (grid) level. Special focus is put on the existing link between those two models and levels. First, a common data base for the two models is described. Both the models, PICUS v1.3 and TsuBiMo, are presented. Thirdly, results on the comparison between the models are provided and discussed. This assessment leads then to proposed improvements to be made as future steps in the project on the forestry modelling part. (A detailed description of PICUS v1.3 is attached as an appendix which has been submitted for publication in *Tree Physiology*.)

Section II

Paper 4: The European Forest and Agricultural Sector Optimization Model

The paper describes the European Forest and Agricultural Sector Optimization Model (EUFASOM) as a partial equilibrium model of the European Agricultural and Forestry sectors, which has been developed to aid the European government in analyzing the consequences of new, environmentally oriented policies. Various policy designs and their consequences can be tested before implementation. In addition, the model is well suited to examine the impact of new agricultural and forest technologies, which have not been used on a large scale outside experimental plots. The scientific value of the model also includes its linkability to other models. Particularly, EUFASOM can provide input to the AROPAJ model from INRA, the AGRIPOL model from CIRAD, and land use models at IIASA. Through these models, EUFASOM results can be "processed" to obtain a higher spatial resolution or to increase the scope of the results.
(*The EUFASOM code is available from the author on request*)

Paper 5: Land Use Decision Modeling with Dynamically Updated Soil Carbon Emission Rates

This article proposes a computationally feasible mathematical programming method for integration of soil status dependent sequestration rates in land use decision optimization models. The soil status is represented by an array of adjacent status classes. For each combination of soil management and initial soil status class, transition probabilities of moving into a new or staying in the same status class are computed. Subsequently, these probabilities are used in dynamic equations to update the soil status level before and after each new soil management period. To illustrate the impacts of the proposed method, a simple hypothetical land use decision model is solved for alternative specifications.

Paper 6: Dynamic Integrated Model of Forestry and Alternative Land Use (DIMA)

The paper presents a description and first results of DIMA. The model uses marginal land as a first option for potential afforestation although other not protected lands are considered as well. The focus is put on the economic joint production potential of biomass from afforestation activities and its associated carbon sink. The DIMA model, produced within the framework of INSEA, is one tool that tracks the dynamics of carbon fluxes, both sinks and sources, resulting from a range of activities related to various forestry practices such as afforestation, deforestation, reforestation, forest under different management regimes, unmanaged forest, biomass for bioenergy production, carbon storage in long lived products, etc..

Paper 7: Global Supply of Biomass for Energy and Carbon Sequestration from Afforestation Activities

This paper provides estimates of global biomass supply from afforestation activities and its implicit carbon sequestration in the forest and the consumption sector. The analysis is based on geographical explicit information on a half degree resolution. A global vegetation model is used to estimate forest growth patterns for each grid cell and derived forest management rules. For each grid land prices, cost of forest production and harvesting are derived as a function of site productivity, population density and estimates of economic wealth. Only marginal agricultural lands were selected for the analysis in order to guarantee global food security. (The paper has been submitted for publication in *Mitigation and Adoption Strategies* as well as at *CASFOR II Conference*, *Palenque, Mexico, November 2004*)

Paper 8: Efficient Energy Systems with CO_2 Capture and Storage from Renewable Biomass in Pulp and Paper Mills

This paper investigates the impact of combining CO2 capture and storage with alternative systems for biomass-based combined heat and power production (CHP) in Kraft pulp and paper mills. We compare heat, power, and CO2 balances of systems with alternative configurations of the CHP and CO2-capture systems. Because the captured CO2 comes from renewable biomass, the studied systems yield negative CO2 emissions. It is shown that pulp mills and integrated pulp and paper mills have the potential to become net exporters of biomass-based electricity while at the same time removing CO2 from the atmosphere on a net basis. (The paper has been published in *Renewable Energy, 29, 2004*)

Paper 9: Black Liquor Gasification with Borate Autocausticizing
A Feasibility Study of Black Liquor Booster Gasification with Borate Autocausticizing

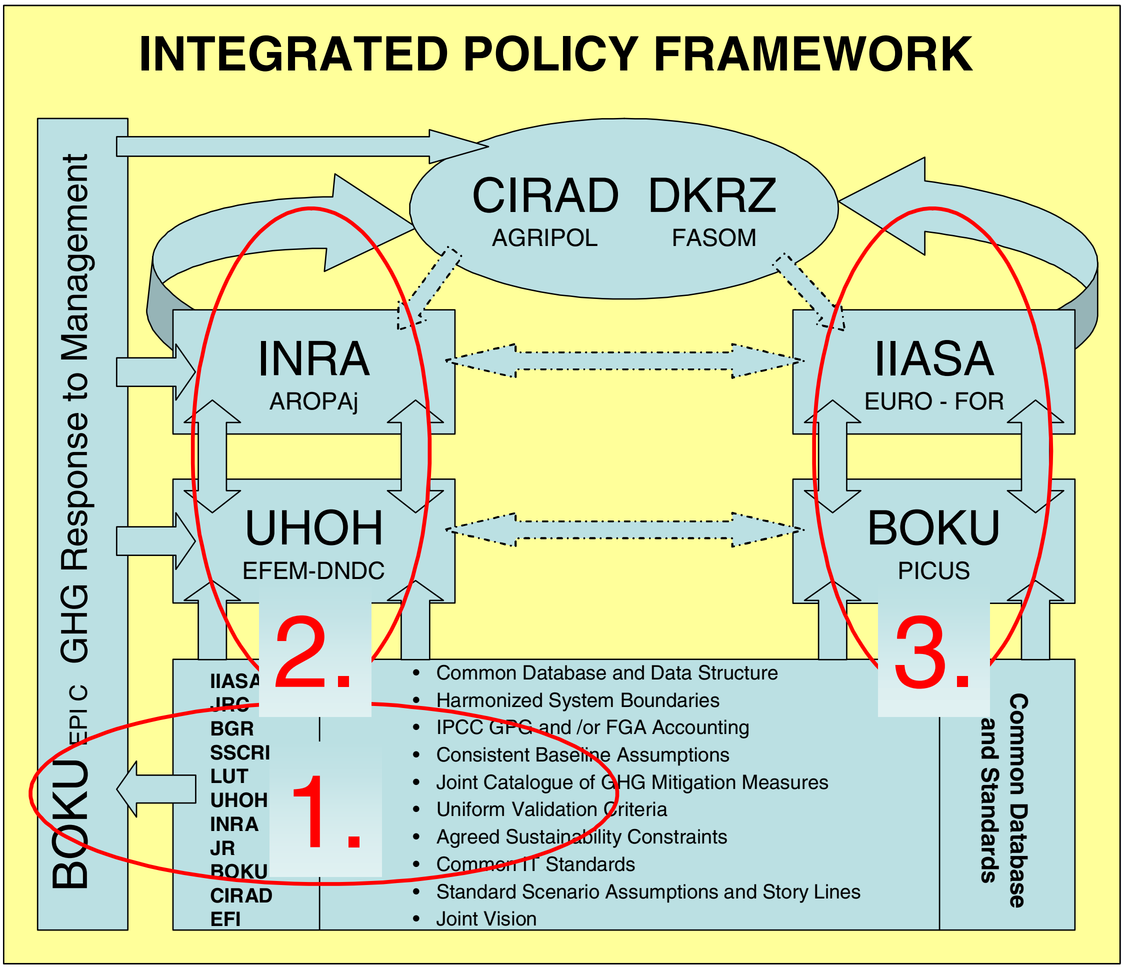
This paper is to investigate a new technology for biomass (black liquor) gasification, which is key equipment for efficient recovery of both energy and chemicals in the pulp and paper mills, a large bioenergy system. The gasification technology also plays an important role for the future negative CO_2 emission systems. The process studied in the paper has a real advantage regarding the earlier borate autocausticizing process; it can theoretically be lead either in full scale or as a part of the process to a usual causticizing and with moderate borate setting. Simulation of the new black liquor gasification has been modelled in this paper. (The paper has been submitted for publication at *International Electric Power Conference*, *Chicago, USA, 2005*)

Introduction

According to the deliverable plan of the INSEA project at T9 Deliverable D9 *First Cut deterministic supply functions for the enlarged EU* is due. At the Kick-Off meeting it was decided to alter the objective for T9 and narrow down the geographic scope of the analysis in the agricultural sector. Baden-Württemberg (Ba-Wue) was selected as a pilot region to assess consistency between the EFEM and AROPAj model. In the first section of D9 we illustrate model results and data links which are currently operational (see also Figure 1). These are,

1. Common Databases for biophysical modeling and linkage to the EPIC model.
2. Consistency analysis between the farm level model EFEM and the regional farm model AROPAj.
3. Comparison of the stand level model PICUS and the grid based forest model TsuBiMo.

Figure: Overview of the three major currently working links of INSEA components illustrated in D9.



In addition to the description of the basic linkages between INSEA components, D9 provided an update on the state of the art of modeling that is not included in the above mentioned linkage exercise. Section 2 includes descriptions of:

1. State of the art of EUFASOM
2. The current state of and first results from the global forest scenario model DIMA (EURO-FOR) on the *Implications of Deforestation, Afforestation and Forest management on global carbon and biomass supply*.
3. Papers illustrating the state of modeling energy conversion technologies and negative emission technologies.

Future Steps to be performed by the INSEA consortium as identified at the T9 project meeting (20, 21 September 2004)

A. Agriculture

- Review, compare and expand on emissions from the life-stock
- Try to fully automize input file creation for EPIC runs from the joint database
- Define crop rotations from economic databases, agronomic knowledge and optimization calculations.
- Create a joint database of technical packages for cropping systems and perform subsequent engineering cost calculations.
- Aim for consistency and acquire database with MARS Crop Calendar
- Acquire and fully use Multiple Data sources
    - LUCAS
    - EUROSTAT
    - FADN
    - Climate Change Scenarios combined with weather data
- Incorporate EPIC runs in all economic models
- Harmonize Scenario assumptions within INSEA

B. Combined Agriculture-Forestry – Bio-Energy Modeling

- Perform model linkage between EPIC plantation results and forestry model with agricultural models
- Define energy supply chains and include in economic models or link with large scale energy models

C. Forestry

- Create new input data for climate, soil etc…
- Repeat Scaling Exercise and perform Cross Validation
- Compute a global Forest Biomass map
- Incorporate more management and define eventually the economic calculus as an Optimal Control Problem
- Substitute the currently existing Cost indexing with a Cost Engineering Model
- Incorporate Risks such as fire and insect diseases