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IRSES Mid-Term Report

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IRSES MID-TERM REPORT

A summary of two year research within the EU 7th Framework Programme Marie Curie action IRSES "Geoinformation Technologies, Spatio-Temporal Approaches, and Full Carbon Account for Improving Accuracy of GHG Inventories"

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ANNEX 1: MID-TERM REPORT

Marie Curie Actions – International Fellowships

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Project Acronym: GESAPU

Project Full Name: Geoinformation Technologies, Spatio-Temporal Approaches, and Full Carbon Account for Improving Accuracy of GHG Inventories

Marie Curie Actions

IRSES Mid-Term Report

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GESAPU, 1st Periodic Report

Publishable Summary

Greenhouse gases (GHG) inventories involve uncertainties. A main reason is the problem that, some data might be unavailable, imprecise, and/or inaccurate. These uncertainties are ineluctable, but one should notice that many of them are significant and have important scientific, and policy implications. At present, Parties to the UNFCCC are encouraged, but not obliged, to report estimates of the uncertainty associated with estimates of GHG emissions and removals, consistent with the IPCC good practice guidance reports. In addition, inventory uncertainty is monitored under the Kyoto Protocol, it is however not regulated.

There are serious difficulties, linked up directly or indirectly with the issue of the uncertainty in the inventoried emissions of GHGs:

(1) The issue of compliance with commitments to reduce GHG emissions is not yet solved. For most countries the emission changes (emission signals) agreed on under the Kyoto Protocol are of the same order of magnitude that the uncertainty in their estimates of CO_2-equivalent emissions.

(2) The emission trading systems of, e.g, the European Union (and its planned amendment and expansion) also do not deal with the uncertainty of emissions estimates.

The more then ten-year period, after the Kyoto Protocol was signed, clearly demonstrated that the schemes introduced by the Protocol have a number of principal gaps that substantially hinder the possibility of reaching the eventual goals of the UN FCCC:

- a distortion of the real picture of the role of individual countries in climate change mitigation efforts, because a substantial part of emissions and removals of greenhouse gases are not included in the accounting regime; for large regions of the Earth the omitted part can provide emissions that exceed those from industry and "managed" part of the biosphere;
- the exclusion of "climate friendly" investments in perspective fields of the biosphere [or–using the language of the Kyoto Protocol–in the LULUCF (Land Use Land Cover Change and Forestry) sector];
- a threat to the protection of some categories of "unmanaged" ecosystems, e.g., old growth forests;
- an unsatisfactory consideration of large sources of emissions (e.g., wild fires);
- the restriction of opportunities to participate in the international processes of climate change mitigation.

More precisely, partial accounts do not allow any comprehensive analysis of uncertainties due to the fact that, considering the impacts on part of a system are not sufficient for assessing the responses and feedbacks of the entire system in any complete form. Substantial problems also arise from the large difficulties (and often – impossibility) of strict definitions and unambiguous implementation of some key terms of the post Kyoto language like managed land, anthropogenic impacts, base-lines, etc., that raises doubt concerning some incentives and results. Possible full inclusion of the terrestrial biosphere in the post Kyoto process seems to be crucial after the first commitment period.

Overall, decreasing inventory uncertainty is of paramount importance to its credibility, quality of compliance, and proper functioning of trading systems. This project aim is to improve accuracy of the inventories in big countries, with differentiated regions, and/or high coverage by forests i.e. in the case when standard inventory procedures fail in producing high accuracy inventories. The proposed solution is to apply spatially distributed inventories and more detailed forest modelling.

Various mathematical models can be involved in building GHG emissions cadastres depending on how fuels are processed and consumed in the residential sector, by industry, and in the transport sector. These models were available and were used to spatially resolve the emissions of the individual Kyoto GHGs in the Western region of Ukraine, and to derive their aggregates for administrative units and cities in this region. The GIS is used to visualize results as digital maps that can include several layers. Finally, a Monte-Carlo approach can be used to assess the uncertainties of the multilevel GHG inventory at any level.

One of the objectives of the project is to develop similar spatial inventory of GHG emissions for Poland. As far as possible, the inventory is intended to follow the Ukrainian geo-information technique. However, crucial activity data in Poland are unavailable with a required spatial resolution. Therefore, the proposed method relies on statistical scaling models. These methodologies will be novel in preparing GHG inventories.

Another crucial issue of GHG inventories is an assessment of emissions from the terrestrial biosphere, particularly from forests. In essence, the FCA is a large dynamic fuzzy system that comprises a sophisticated interplay of many stochastic elements/processes. In any practical implementation, such systems cannot be directly validated or verified in any strict formal way. It requires assessing the uncertainties, including a number of obligatory prerequisites and requirements to the approach. An appropriate methodology is based on system integration of methods and models of a different nature, and multiple constraints. Forests are considered as an informative case study due to highly complicated and poorly understood role of forests in global carbon cycle, as well as a complicated structure of forest ecosystems.

Only 15,7% of the total territory of Ukraine (9.5 million ha) is covered with forest. In spite of this relatively low percentage, Ukraine is considered to be an important European forested country, taking eighth place with respect to forest area. Forests in Ukraine play an extremely important role: (1) as a protective component of the environment (more than 50% of Ukrainian forests are strictly protected areas); and (2) as a crucial element of agroforestry landscapes. Within this context a verified FCA means that uncertainties are defined reliably and comprehensively, and are below a preliminary defined level. Thus, the works are conducted on developing advanced approaches to assess the biospheric role of forests in countries with low forest cover, and assessing major components of the forest FCA.

Linkages between sustainable forest/land use management practices and carbon management, particularly, the use of forest biomass for energy production are a substantial part of the problem, to reach a better understanding of the Ukrainian forest sector, its uncertainty, and its role in the global carbon cycle.

One of the crucial negative factors, which ruin forest structure, burn biomass, and release carbon to the atmosphere, is wildfire. In order to develop better wildfire policy and management, it is important to make assessment of the losses in the total GHG budget.

To address above problems, in the first part of the project the main effort has been put to gathering data and forming databases. The following works have been performed.

Specificity and availability of national spatially resolved statistical data in Poland have been studied. Final results are presented in maps, figures and tables included in the deliverable 3.1. This information has been collected to conduct greenhouse gases inventory for each subcategory of the general sectors: energy, industry and agriculture, all for 17 territorial regions (voivodeships) in Poland. The results are presented in the form of digital maps and corresponding georeferenced databases, with the temporal resolution of 1 year, for the years 2009 and 2010. The point data are associated with their geographical coordinates, and for the linear and areal data the basic space resolution is 2 km. The resulting emission data are presented in a graphical form on maps in the Deliverable 1.1.

The emissions introduced to the GIS database were used to analyze emissions' territorial distribution for individual subcategories of greenhouse gases, and produce emission summaries of various profiles, like economy sectors and administrative units. The results are presented in 31 figures and 12 tables in the Deliverable 1.2.

A research has been conducted on improving accuracy of inventories by means of spatio-temporal statistical methods. A novel disaggregation model for the regional activity data has been designed, taking advantage of the gridded information on land use and line emission sources. The relevant statistical tool is based on a conditionally autoregressive structure. Estimates of values in a fine grid are obtained by a model based prediction. The formulae for the predictions and their errors were derived. The method has been validated on ammonia inventory in Poland (agriculture sector). Preliminary steps were also taken for application of the method to the developed GHG inventory in Poland. The plausible sectors include agriculture, and fossil fuel consumption in the residential sector.

Intensive works have been carried on methodology and modeling of verified full carbon account of forest ecosystems with adaptation for Ukraine. The most representative database on live biomass measurements in Ukraine and neighbor countries have been collected. The database contains results of measurements on 541 sample plots in Ukrainian forests that completely reflect all main type of forests and 212 more sample plots in surrounding countries. This database is used for (1) modeling of fractional structure of forest phytomass in Ukraine based on data of forest inventory (State Forest Account), and (2) development of models and tables of dynamics of biological productivity of forests. Spatially distributed set of model for assessing dynamics of live forest biomass and net primary production have been developed. The models cover whole territory of Ukraine and all main forest types. The major results are presented in Deliverable 2.2. Qualitative indicators of progress and success are as follows. Analysis of available spatial datasets covering Ukraine (remote sensing datasets, GIS datasets) has been done. As a basis for development of Ukrainian forests digital map the next remote sensing products were chosen: Global Land Cover (GLC2000) with resolution 1km; GlobCover 2009 with resolution 300m; MODIS Land Cover with resolution 500m; MODIS vegetation continuous field (VCF) with resolution 500m; ENVISAT ASAR with resolution 150m. The remote sensing products GLC2000, GlobCover 2009, MODIS Land Cover were compared using fuzzy logic methodology and experts knowledge. The GIS-based forest enterprise map (polygons) for 2002 and 2010 years has been created that covers the entire territory of the Ukraine. A forest/non forest map for Ukraine based on global land cover products has been developed. The achieved results show that three products exactly identified 50 % of the forest land of Ukraine. Developed forest/non forest map has been compared with regional data on the State Forest Account, and auxiliary information by natural zones (forest zone, forest-steppe zone, steppe zone, Carpathians, Mountain Crimea). Analysis of the validation points to determine the land cover type where the remote sensing products (GLC2000, GlobCover 2009, MODIS) disagree, and the cross-check of forest land areas in the developed map has been done (this map was put online: regional.geo-wiki.org).