LUCAS and agri-environmental indicators for EU27

Adrian Leip[1] and Beatrice Eiselt[2]

[1]EC-JRC-IES - [2]EUROSTAT

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Introduction

The Common Agricultural Policy (CAP) has evolved over time and the CAP has been increasingly integrating environmental concerns. Emphasis is placed on reducing the risks of environmental degradation and enhancing the sustainability of agro-ecosystems. Specific agri-environmental indicators have been designed to monitor changes in the environmental quality at EU, national and regional levels. These indicators provide the information necessary to determine the efficiency of agri-environmental policies (1). Examples of agri-environmental indicators are the nitrogen balance, pesticide risk and greenhouse gas emissions.

Quantifying agri-environmental indicators is a challenging task, in particular for large and heterogeneous regions, such as the area covered by EU-Member States and especially when high spatial resolution is required which frequently is the case. Reliable agri-environmental indicators depend on the availability of high-quality input data, but it is often very difficult to find reliable data at such a detailed level.

A sophisticated modelling framework, called the Common Agricultural Policy Regionalised Impact" model (CAPRI), has been developed over time to assist the evaluation of different scenarios for the CAP. CAPRI is a model for the agricultural sector which allows the assessment of the Common Agricultural Policy and trade policies. This model can operate from the global to the regional scale.

The CAPRI core module consists of two main components, a supply module and a market module (2). The market module considers bi-lateral trade flows and attached prices as well as the relevant policy instruments (e.g. bi-lateral tariffs, the Tariff Rate Quota (TRQ) mechanism and, for the EU, intervention stocks and subsidized exports). The supply module maximises regional agricultural income at given prices and subsidies, subject to constraints on land, policy variables and feed und plant nutrient requirements in each region. The supply module is linked to external data bases, such as the EUROSTAT statistical database. The two core modules interact iteratively via prices and quantities for about 50 primary and processed agricultural products to determine an equilibrium.

Major outputs of the core module include crop and livestock activity levels, yields, input use (pesticides and fertilisers), greenhouse gas emissions, nutrient emissions and farm income at regional level.

The CAPRI framework allows to establish a full greenhouse gas accounting system for agriculture (CO2, CH4, N2O), and calculates nitrogen balances and differentiated emissions of reactive nitrogen (N2O, NH3, NOx, NO3). These indicators are provided both on the basis of 'acitivities' (per hectare of cultivated land or per head of livestock) or product-based (per kg of meat, cereals, etc.).

In many cases, however, the calculation of the agri-environmental indicators requires data at a higher spatial resolution as the core CAPRI model can provide. For this purpose, an additional module, the CAPRI land use module, is dedicated to the disaggregation of the outputs obtained from the core model. The CAPRI land use module takes land use and farm input data at regional level, and disaggregates this information with the help of explanatory variables (such as land use related to soil quality, climatic conditions and topographic parameters) to each single grid cell. In order to calibrate the statistical disaggregation model (a local multinominal logit model, see Lamboni et al., 2012 (3)), ground truth data covering the explanatory variables is needed. LUCAS data are essential to provide this observational data that allows to make the link between the agricultural use and the environmental conditions in a certain point (4). Detailed information on the specific algorithm here can be found in Kempen et al. (5, 6) and Lamboni et al. (3).

The CAPRI model allows to simulate different scenarios and to comprehensively assess different agricultural policies (and environmental policies affecting agriculture) and map the likely environmental impact. CAPRI simulations were used to provide input to policy development in the EU, such as the 2003 CAP reform, the 2008 health check, etc.

Examples

The following pictures show two examples, i.e. N-input to agricultural soils and N_2O emissions from all anthropogenic sources. Both examples have been calculated as contribution to the "European Nitrogen Assessment" (7, 8). The first example is a disaggregation of regional data obtained by the core CAPRI model. This disaggregation to grid cells is done through the above-mentioned land use model part calibrated with LUCAS data. The second example uses this spatially disaggregated data to feed into a meta-model for N_2O emissions from agricultural soils and combining this with other agricultural N_2O sources (manure management) which have also been disaggregated and non-agricultural sources (forests, energy, …) obtained from other data bases (INTEGRATOR model, EDGAR). The map shows total N_2O emissions as the sum of these emission sources. The pie diagram shows the contribution of each emission source to the total emissions in EU27. The bar chart finally shows level and contributions re-aggregated to country level.

Future developments: Example - Pilot project on regional Nitrogen Budgets

The pilot project on regional nitrogen budgets is a good example of the key agri-environmental indicators that can be derived using CAPRI. Current reporting of nitrogen budgets from Member States occurs at the national level. For policy making, a higher resolution, matching with legislative and environmental boundaries (nitrate vulnerable zones, watershed) rather than administrative boundaries (country) is required. Nitrogen budgets are calculated using the mass-flow approach, IPCC emission equations, and endogenous estimations of feed intake and nitrogen excretion based on available feed and product statistics (9, 10). During the pilot project (year 2013), nitrogen budget estimates from CAPRI are compared with those obtained from official national entities at country- and regional level (where available) to assess the feasibility of using CAPRI for the estimation of regional N-budget. If successful, the data can be further disaggregated to obtain N-budget maps in consistency with national estimates. These maps will be linked to the land use maps obtained through the disaggregation based on LUCAS data.

Conclusions

CAPRI is a complex modelling environment that allows to simulate different scenarios and to comprehensively assess different agricultural policies. It provides fundamental input to policy developments in the EU. Ground-truth land use observations, such as LUCAS, are indispensable and represent a *sine-qua-non* for such a modelling framework. The estimation of many agri-environmental indicators which require information on crop species and farm management depends on the availability of such data. This is particularly true as long as the access to other detailed data sets (e.g. Forest Structure Survey micro data, Integrated Administration and Control System) is restricted.

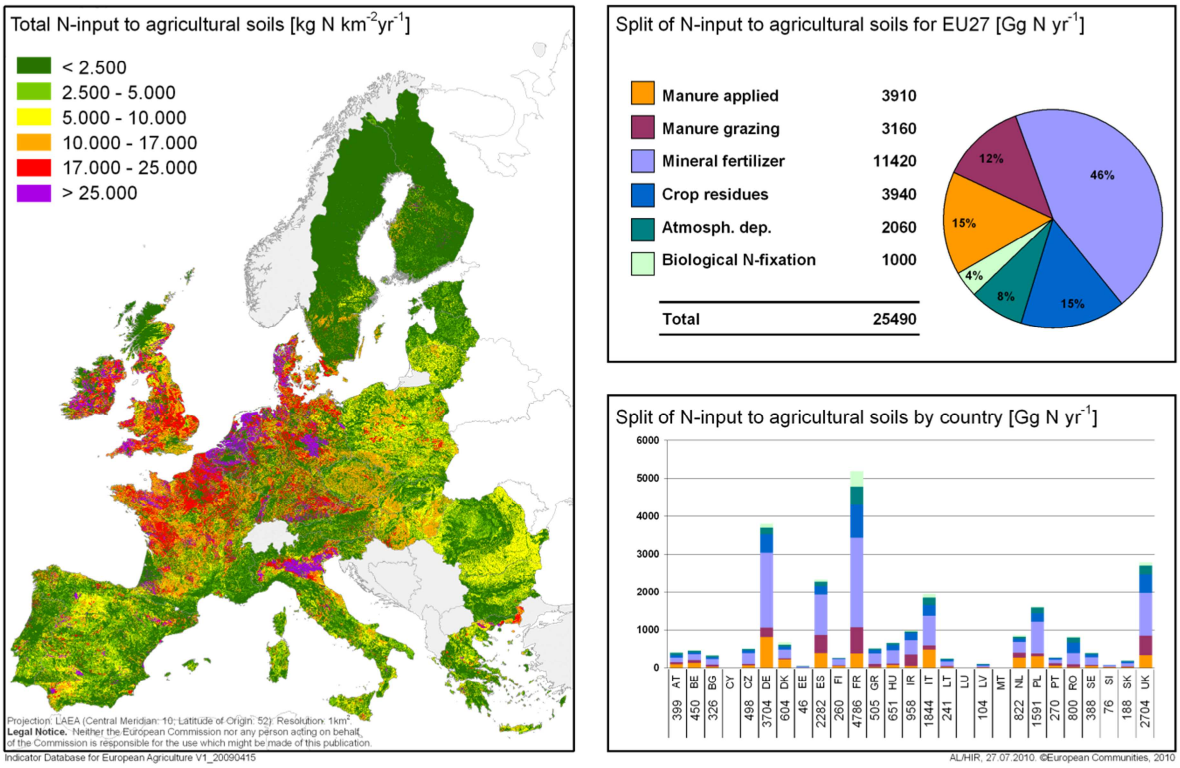

Figure 1. Nitrogen input to agricultural soils in EU-27 for the year 2002.

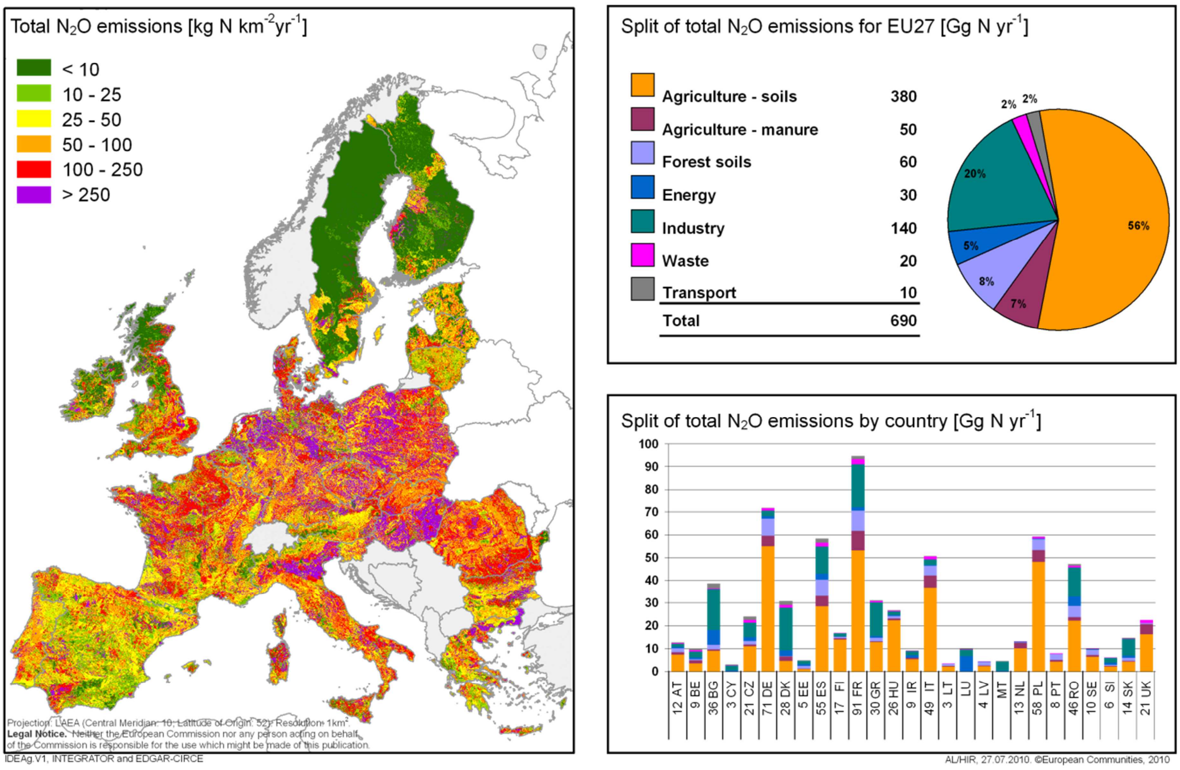

Figure 2. Total N_2O emissions in EU-27 around the year 2000.

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