Prototypical Policy Impacts
on Multifunctional Activities
in rural municipalities

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prima

WORKING PAPER ON MODEL OUTPUTS COMPARISON AT DIFFERENT LEVELS, BASED ON A REFINEMENT OF THE MODELLING FRAMEWORK AT REGIONAL AND GLOBAL LEVEL

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COOPERATION

PRIMA aims to develop a method for scaling down the analysis of policy impacts on multifunctional land uses and on the economic activities. The scoped policies will include the cohesion policy (ERDF, ESF, CF), the enlargement process (IPA) & the rural development policy (EAFRD) of the European Commission, with a special focus on agriculture, forestry, tourism, and ecosystem services. The approach will: rely on micro-simulation and multi-agents models, designed and validated at municipality level, using input from stakeholders; address the structural evolution of the populations (appearance, disappearance and change of agents) depending on the local conditions for applying the structural policies on a set of municipality case studies. Involving eleven partners, the project is coordinated by *Cemagref*.

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Executive summary

This report provides two different ways to approach the modelling comparison at different levels. The first is applying the MAGNET model with its downscaling scenarios with the four scenarios discussed in WP1. The second is the description of two model settings that could be potentially compared on its results with respect to its outcomes on a NUTS2 regional level: MAGNET with the PRIMA downscaling method, and CAPRI.

We have tested the PRIMA downscaling system with a baseline scenario and three European policy scenarios (chapter 5), where these scenarios were inspired by the scenarios developed in WP1 (chapter 2). The purpose of this exercise was to show how the method functions, detailed further implementation of specific policies is required before the system can be applied for real policy analysis. For example, for the implementation of second pillar CAP policies detailed knowledge about the institutional regulation of distribution of budgets and the empirical knowledge about the projects and its effects is required before the simulation outcomes will get any policy relevance. But the basic mechanisms that are needed for such an analysis are available in the PRIMA regional downscaling method.

This report has presented a brief overview of two modelling tools, i.e. CAPRI (chapter 3) and MAGNET (chapter 4) models with the downscaled results, both enabling to provide the policy assessments at the regional (NUTS2) level. A methodological framework is offered to achieve consistent comparison of the simulation results of different models (chapter 6). The appendices provide information that may be useful when such a comparison would be made in practice.

The current downscaling tool developed in PRIMA is a user friendly tool that can easily adapt new insights and knowledge. Although some econometric research is used as a foundation for some parameters in the models, most parameters are taken by intuition. For this reason, the current results of the simulations must not be taken as an illustration of the potential of the system instead of a solidly founded final results. Further experience with the model and further empirical studies are needed to make from the developed tool a reliable guide for policy analysis.

To finish this report, it is worthwhile to dig into a methodological issue. Originally the idea of the project was to compare upscaled results from local agent based models with the downscaled results from MAGNET. Upscaling of local results to a NUTS2 level was much more difficult than expected, and therefore was not realized. But also from a conceptual point of view, it is questionable if one should target for such a comparison. Because downscaling tackles completely different driving forces than upscaling, the results will be different anyhow. It seems more logical to relate the two approaches in different ways. For example, downscaled results can be used as a scenario environment for local modelling and stakeholder analyses. On the other hand, detailed local studies can be useful to analyse how policies really work out in practice. An abstraction of this information can be used as input for modelling the effects of different policies on regional or national levels. The interaction between upscaling and downscaling should be the focus of future studies on scaling issues. The model developed in this downscaling method provides ample opportunities to develop this in the future.

1 INTRODUCTION

When various (modelling) frameworks are used in a chain to address a policy issue, the value added of using multiple tools usually lies in the extended coverage of the (simulation) results. For example, it could be that an additional sustainability dimension of indicators is made available through such a joint use of tools or that spatial dimension is enlarged. The (modelling) frameworks would often be designed for its stand-alone purposes, serve its envisaged level of details and apply some assumptions regarding the business-as-usual situation.

The primary goal of this document is to assess the results of the downscaling method developed in the project PRIMA. This method uses the results of the scenario projections simulated for the EU Member states and scales these down to the regional level. To do the assessment of the downscaling method, a comparison of selected results at the regional level is proposed to be done with the results originating from the agricultural market model CAPRI.

Before the results are comparable, many issues need to be considered. First, the models operate at different base and projection years and this should be aligned. Second, the assumptions which are valid for future trends on such developments like population and GDP should be the same for both models. Third, the compared results should be of the same resolution (for example, a difference between base year and baseline).

This report attempts to provide clear guidelines on how such a comparison should be done in a methodologically sound way. To build this up, first the report presents brief conceptual descriptions of two modelling tools (CAPRI and MAGNET). Complementary to the report D5.3 (Woltjer et al, 2011) it presents the outcomes of 2 policy simulations (Rural Development and Forestry expansion). Finally, it focuses on providing methodological framework to achieve consistent comparison of selected indicators from CAPRI and MAGNET at NUTS2 level.

2 Policy issues addressed in EU projects PRIMA and SEAMLESS at aggregate level

2.1 Policy issues addressed in PRIMA

Following the Deliverable 1.3 (Kopeva *et al.*, 2010), PRIMA project aims to provide baselines for the design of scenarios on multifunctional land use. Scenarios derived from the review and assessment of EU policies in agriculture, forestry, tourism and environment. The scoped policies will include the cohesion policy (ERDF, ESF, CF), the enlargement process (IPA) & the rural development policy (EAFRD) of the European Commission, with a special focus on agriculture, forestry, tourism, and ecosystem. The scenarios rely on micro-simulation and multi-agents models, designed and validated at municipality level, using input from stakeholders; address the structural evolution of the population (appearance, disappearance and change of agents) depending on the local conditions for applying the structural policies on a set of municipality case studies.

In PRIMA the following scenarios are distinguished (see D1.3, (Kopeva *et al.*, 2010):

- Baseline
- 'Environment' scenario
- 'Rural development' scenario
- 'Infrastructure & Competitiveness' scenario

'Environment' scenario is built on the assumption that measures for landscape, natural and cultural heritage preservation will be leading. Having in mind importance of environment issue in global aspect, it is assumed that environment policy will be more closely linked to rural development and more specifically to multifunctional land use activities. Thus, changes in the policy priorities on EU level are expected. The expectations are that these changes will strengthen and widen priorities and measures of environment policy. This will result in strengthening the impact of internal and external driving forces. New measures will be introduced in the area of environmental infrastructure; environmental "clean-up", water management, energy/efficiency/renewable (CO_2 reduction); biodiversity/NATURA 2000; environmental capacity building, natural risk prevention. In this scenario the focus is environment policy, while the rest of the policies support its implementation. Objectives and measures in other EU policies (Cohesion, Rural Development) are subordinated directly or indirectly to the environment policy. This scenario is also developed on qualitative assessment of possible impact of driving forces (external and internal).

'Rural development' scenario deals with Rural Development Policy that will have a leading role in the next planning period (2014-2020). Sustainable rural development will be achieved through: increasing competitiveness of agriculture and forestry; improving land management; implementing complex measures for environment protection and preservation, wider rural economy through new agricultural and non-agricultural activities; increasing the role of local initiative groups in regional and local decision making process. This scenario takes out rural development as a priority and assumes possible changes in RD Policy. In this scenario economic and environment driving forces will be stimulated for deeper impact.

'Infrastructure & Competitiveness' scenario assumes widened and enriched policy measures in Cohesion Policy. This scenario is developed on the assumption that Cohesion policy will have leading role on national and regional level. New objectives and measures will be elaborated aiming increasing of competitiveness of SMEs, development of favorable business conditions, improving quality of human resources, increasing capacity of local/regional branch organizations, construction of relevant new infrastructure and restoration of the existing. Thus, this Scenario focuses on improvement of business environment, establishment of business opportunities and favorable environment for business initiatives linked to multifunctional land use on regional level.

At the MS and regional level the scenarios are built in line with the descriptions presented above, but are more specific to one of the measures of selected policies. The results of these scenarios derived with the model MAGNET and further downscaled to regional (NUTS2) level are presented in Chapter 5.

2.2 Policy issues addressed in SEAMLESS at MS and regional level

Since the introduction in the European Commission (EC) in 2003 of a mandatory so-called ex-ante impact assessment of new European policies (EC, 2005a), research efforts have been focusing on development of methodologies to evaluate effects of potential policies before their implementation. In its Sixth Framework Programme for Research and Technological Development, the EC funded a range of large research projects to develop methodologies to underpin impact assessment of policies (Van Ittersum and Brouwer, 2009). One of them was the integrated project ‘System for Environmental and Agricultural Modelling; Linking European Science and Society (SEAMLESS)’. The aim of this project (2005–2009) was to assist in overcoming fragmentation in modelling efforts related to agricultural systems and to develop a computerized framework that allows the integrated assessment of agricultural and environmental policies and their consequences on sustainability of agricultural systems and sustainable development at large (van Ittersum *et al.*, 2008; Brouwer and van Ittersum, 2010).

The software tool SEAMLESS-IF allows to perform two types of impact assessment applications which are distinguished not only by the nature of the policies assessed (impact of Nitrate Directive or impact of trade policies), but also by the focus at different levels of application (at farm-regional or EU level) and geographical coverage (selected member states or whole EU). The two types of applications in SEAMLESS are introduced in further detail in Van Ittersum *et al.* (2008). This section focuses on one of them: a trade liberalization example which illustrates a typical question of relevance to EC policymakers, since trade policy is implemented across the EU (Bezlepkina *et al.*, 2010). This application is in focus since it uses the CAPRI model in its modelling chain. We only briefly introduce this application since primarily the baseline will be of interest for further comparison rather than scenario outcomes.

Policies that distort agricultural trade fall into three major categories: market access, which refers to policies such as tariffs and tariff-rate quotas that regulate the access of imports into a country’s domestic market; domestic support, which refers to various forms of assistance to domestic producers, such as production subsidies and price supports that raise the price of agricultural products; and export subsidies (sometimes called export competition). Countries typically adopt trade-distorting agricultural policies to benefit their domestic agricultural producers. In doing so, however, they generally impose costs on their consumers, who as a result must pay more for agricultural products protected by tariffs; on their taxpayers, who must pay for any subsidies; and on competing foreign producers, who lose market shares (Arnold, 2006). Thus, when analyzing the impact of trade liberalization on European agriculture, the costs to consumers of agricultural goods and the income from agricultural tariffs are to be assessed. The negotiations around trade liberalisation are a political process affecting the trade policies of many countries. The results of an impact assessment of proposals aiming at reducing international barriers to trade by means of a reduction in import tariffs and an elimination of export subsidies by the EU may influence the outcome of the ongoing negotiation round of the WTO.

SEAMLESS-IF is developed for ex-ante policy analysis, i.e. to analyze the future impacts of a policy currently considered by policy makers. This implies that the impacts need to be assessed for some point in the future. The year 2013 is selected since in this year the EU would have to eliminate its export subsidies (one part of the trade policy being considered). Apart from the change in trade policy other policies and autonomous developments will also affect the EU economy in 2013 and these may affect the impact of the trade policy. Thus the effects of the trade policy need to be isolated from other developments until 2013.

3 CAPRI MODEL AT A GLANCE

3.1 Objectives

The description provided in this chapter follows (Woltjer *et al.*, 2011b).

The Common Agricultural Policy Regional Impact model (CAPRI, http://www.capri-model.org/) calculates the effects of EU agricultural and trade policy on European agriculture. The model calculates effects on production, income, markets, trade and the environment from a global to a regional scale. The model has the opportunity to downscale crop shares, yields, stocking densities and fertilizer application rates to 150.000 homogeneous soil mapping units. This can be very useful for environmental impact assessments.

The CAPRI modelling system consists of specific data bases, a methodology, its software implementation and the researchers involved in their development, maintenance and applications.

3.2 Description

CAPRI is a global agricultural partial equilibrium model with a focus on the EU27, plus Norway and the Western Balkans. The CAPRI model consists of two interlinked components: individual regional non-linear programming models per NUTS 2 region covering up to ten farm types, and a global trade model.

The supply module of CAPRI consists of a total of 1,888 independent mathematical supply models for the EU-27; of which 1,823 are farm type models, and 65 are NUTS 2 supply models. These models cover around 50 crop and animal activities for each of the farm types and include around 50 different inputs and outputs (Gocht *et al.*, 2011).

The CAPRI global market model is a comparative static spatial global Multi-Commodity model. It covers 47 primary and secondary agricultural products and models bi-lateral trade between 60 countries grouped in 28 trade blocks. The CAPRI market model is iteratively linked in a transparent and consistent way to the layer of non-linear regional mathematical programming models.

The supply module consists of independent aggregate non-linear programming models representing activities of all farmers of a farm type in a region. The data are based on the Economic Accounts for Agriculture (EAA). The farm models have fixed input-output coefficients for each production activity with respect to land and intermediate inputs. Normally a low and high yield variant for the different production activities are modelled. Requirements regarding NPK balances and feeding requirements of animals are taken into account. A land supply module allows for land leaving and entering the agricultural sector and transformation between arable and grass land in response to relative price changes (Jansson *et al.*, 2010).

Labour and capital costs are captured by a non-linear cost function (the so-called Positive Mathematical Programming (PMP) methodology; see e.g. (Howitt, 1995). These non-linear cost functions are calibrated in such a way that they mimic the base data and capture information about supply elasticities. The models allow for a lot of detail in CAP subsidies. A special component is made to capture the complex sugar quota regime. This component maximizes expected utility from stochastic revenues. Prices are exogenous in the supply module and provided by the market module. Grass, silage and manure are non-tradable and receive accounting prices based on opportunity costs.

The market module consists of a component for marketable agricultural outputs and a specific sub-component that models the feed market. The sub-module for agricultural outputs is a global, spatial multi-commodity model. Bi-lateral trade flows are modelled using the Armington assumptions (Armington, 1969). The behavioural equations for supply, feed, processing and human consumption have flexible functional forms. Calibration algorithms make the coefficients in these functions consistent with micro-economic theory.

Policy instruments in the market module cover Product Support Equivalents and Consumer Support Equivalents (PSE/CSE) from the OECD, (bi-lateral) tariffs, the Tariff Rate Quota (TRQ) mechanism and, for the EU, intervention stocks and subsidized exports. This sub-module delivers prices used in the supply module and allows for market analysis at global, EU and national scale, including a welfare analysis.

As the supply models are solved independently at fixed prices, the link between the supply and market modules is based on an iterative procedure. After each iteration, during which the supply module works with fixed prices, the constant terms of the behavioural functions for supply and feed demand are calibrated to the results of the regional aggregate programming models aggregated to a country level. Solving the market modules then delivers new prices. A weighted average of the prices from past iterations defines the prices used in the next iteration of the supply module. Equally, in between iterations, CAP premiums are re-calculated to ensure compliance with national ceilings.

CAPRI uses templates that are filled with different parameter sets for different regions and products. This reduces maintenance cost and makes results comparable across products, activities and regions. The modular setup allows to use the different components also independently. The model has a lot of flexibility because of its modular approach (see also Figure 1). Regional supply models may be used without the market model, while the market model works also without the explicit farm models. The model can be used both in a comparative dynamic as a static way.

An extensive post-model analysis is provided. Income indicators are calculated consistent with the EAA methodology. A welfare analysis is possible. A detailed account of the first pillar CAP outlays is available. NPK balances are calculated, while climate relevant gases are computed consistent with the guidelines of the Intergovernmental Panel on Climate Change (IPCC). Spatial down-scaling of crop shares and yields, animal stocking densities and fertilizer use to clusters of 1x1 km land grid cells creates the possibility to link CAPRI with the bio-physical model DNDC. Model results are presented as interactive maps and as thematic interactive drill-down tables.

The maintenance of CAPRI is based on the open-source network concept. Databases and model code, including the GUI, are hosted on the software versioning and repository system (SVN) server, from which they can be downloaded and incrementally updated. Selected developers may also commit changes to the server. “The CAPRI modelling system may be defined as a ‘club good’: there are no fees attached to its use but the entry in the network is controlled by the current club members. The members contribute by acquiring new projects, by quality control of data, new methodological approaches, model results and technical solutions, and by organizing events such as project meetings or training sessions. So far, the network approach worked quite successfully but it might need revision if the club exceeds a certain size" (Britz and Witzke, 2008).

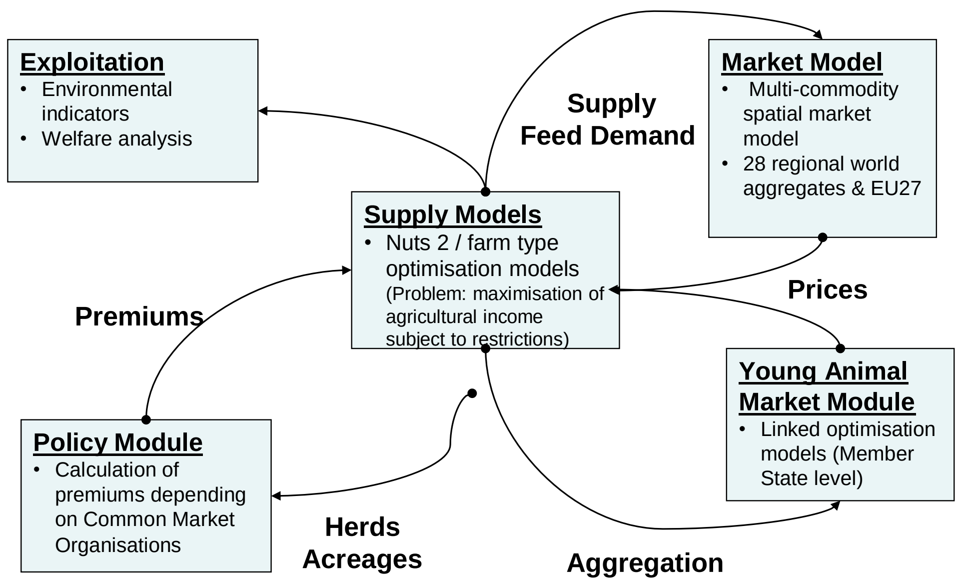

Figure 1: The CAPRI model chain (Britz *et al.*, 2007)

3.3 Required input

The data bases exploit wherever possible well-documented, official and harmonized data sources, especially data from EUROSTAT, FAOSTAT, OECD and extractions from the Farm Accounting Data Network (FADN). Specific modules ensure that the data used in CAPRI are mutually compatible and complete in time and space. They cover about 50 agricultural primary and processed products for the EU, from farm type to global scale including input and output coefficients.

3.3.1 Base Period Variables

The database of CAPRI is created in three steps:

1. CoCo — Completeness and consistency. This module creates a complete (no gaps) and consistent (satisfying the CAPRI physical and economic equations) database at member state level from about 20 years back to the most current date. Key sources are EUROSTAT for agricultural production and yields as well as the Economic Accounts for Agriculture (EAA).
2. CAPREG — Regionalization of the CoCo database. Based on the REGIO database on production and yields at a NUTS2 level, the CoCo database is broken down into regions. CAPREG also uses engineering information to estimate fertilization and animal feeding per production activity and region, and manually collected information from EC regulations on direct payments and quotas to calculate gross value added and income. CAPREG uses a three year average around the base year to pre-

vent that temporary differences influence the base data too much. The supply models are calibrated at that point.
3. GLOBAL — Creation of a harmonized global database on bilateral trade flows and trade instruments. GLOBAL processes data from FAOSTAT.

3.3.2 Parameters

CAPRI contains a large number of parameters, especially concerning the biophysical processes involved in animal feeding and fertilization. The core parameters in the simulations are the behavioural parameters for supply and demand

1. Supply elasticities. The behaviour of producers is governed by a quadratic cost function. The parameters are based on regionalized time series produced by CAPREG using a Highest Posterior Density (HPD) estimator that includes the first order conditions of the supply model and weak priors for own-price elasticities.
2. Demand elasticities. The parameters of the Generalized Leontief expenditure system are obtained by a HPD using synthetic elasticities as priors and the demand system equations and economic theory (curvature etc) as estimating equations.
3. Armington substitution elasticities for imports versus domestic products are set manually to synthetic values or to values prescribed by the scenario definition.

3.3.3 Scenario projection variables

For the baseline scenario, the model is recalibrated to a projection that is generated by a combination of the module CAPTRD (for the supply model) and CAPMOD (for the market model).

1. CAPTRD is making a projection of the CAPREG database to a selected future year. The projection is based on, in order of significance, (a) The Agricultural Outlook of the Commission, (b) exponential trends fitted to the CAPREG data (for a regional breakdown), (c) a simulation of the baseline policy in the base year, and (d) expert information, especially where (a) is not present and (b) and (c) fails.
2. CAPMOD contains procedures for projecting the market model base data of GLOBAL to a future year. It is based on (a) Supply utilization accounts from FAO (b) Projection from AT2030 of FAO (c) Trade flows from FAO, (d) COCO/CAPREG data for the market model, (e) population data, (f) growth rates from CAPRI, plus the requirement that the model calibrates in the future point (model equations)
3. Agricultural policies, essentially (a) payment ceilings in physical or economic terms (b) payment amounts (c) eligible activities (d) set-aside rates (e) quotas for milk and sugar, (f) intervention prices (g) WTO limits on intervention and export subsidies, (h) ad-valorem and specific tariffs (i) trigger prices (j) minimum border prices (k) global and bilateral tariff rate quotas with associated volumes and tariff rates.

3.4 Model output

All the components of CAPRI may generate useful output. The supply module generates information about activity levels (hectares, animals), feeding, fertilizer use, and sales. The market model generates trade flows, production, use of agricultural products by the processing industry, animals and humans, bioenergy use, market, producer and consumer prices, profit margins, prices of milk fat and protein, export subsidies, tariffs, and intervention purchases and stocks.

Many additional indicators are computed, including agricultural income, consumer welfare, CAP budget effects (disaggregated into individual payments, intervention and export subsidies), processor profits, nutrient balances at soil level, greenhouse gas inventories, self-sufficiency in agricultural products, labour and energy indicators.

3.5 Strengths and weaknesses

CAPRI has a lot of sectoral and regional detail in the agricultural sector, enabling simulation of agricultural policies in a unified manner for NUTS2 regions in the EU. No other model can do that. The good regional detail is matched by endogenous world trade and prices with a theory-consistent demand system.

The modular setup makes it very suitable for extension, but the way a lot of modules are programmed makes the model not easy to handle and interpret; it requires a lot of expertise to do this.

The model includes very explicit technological assumptions, facilitating implementation of technical constraints on fertilization, feeding or land use. Nevertheless, the model only contains *variable costs* explicitly, whereas fixed costs are subsumed by a quadratic cost function. The quadratic function is estimated based on time series (Jansson and Heckelei, 2009), and ensures perfect calibration on the base year as well as realistic supply responses in the medium term. The quadratic function may also be calibrated on elasticities derived from other models or mechanisms, and thus be used in linking.

The model is in fact a combination of supply models and a market model. This means that the model itself provides an advanced way to link models that may be an example for linkage between other models.

As with the GTAP database the advantage of the CAPRI database is its consistency, the disadvantage that sometimes heroic assumptions are required to make the database consistent and complete.

CAPRI is a club good for technical reasons. A tremendous investment in human capital is required in order to join the club. The club good character makes it difficult to attract new researchers, but also works as a quality control for studies with CAPRI (compare with the dubious reputation of GTAP, which anybody can purchase and run).

4 MAGNET MODEL AT A GLANCE

4.1 Objectives

The description provided in this chapter follows (Woltjer *et al.*, 2011b).

MAGNET, i.e. Modular Applied GeNeral Equilibrium Tool, till 2010 called LEITAP (Woltjer, 2009), analyses the effect of changes in trade and agricultural policies on international trade, production, consumption, prices and use of production factors. The model is mainly used to simulate long-term scenarios and analysing policy options within these scenarios. By coupling MAGNET with biophysical models like IMAGE or CLUE, results about greenhouse gasses or biodiversity may be generated. The model is used for example to analyse the effects of EU-agricultural policy, including second pillar policies, and biofuel policies.

4.2 Description

MAGNET is developed at the Dutch agricultural research institute LEI, part of Wageningen University and Research (WUR). The model is programmed in GEMPACK. Compared with the original version of the GTAP model at LEI it is extended and stylized a lot. Recently it has been reconstructed to make it modular.

The MAGNET model is based on the general equilibrium model GTAP (Hertel and Tsigas, 1997); developed at Purdue University, United States. MAGNET uses the carbon market and the rough characteristics of the production structure of the energy-variant of GTAP, GTAP-E (Burniaux and Truong, 2001). It uses the international capital flow accounting system of the dynamic GTAP model GTAP-DYN (Ianchovichina, 2000), and includes also some parts of the agricultural variant of GTAP, GTAP-AGR (Keeney and Hertel, 2005).

First, a short characterization of the standard GTAP model is provided. GTAP is a global computable general equilibrium model that covers the whole economy, including factor markets. The model uses a consistent database of world trade and production, the GTAP database. The regional aggregation is on a country level, where some countries are aggregated into larger regions (in the GTAP7 database 108 countries and regions available for the year 2004). The database distinguishes 54 sectors and 5 endowment sectors (skilled/unskilled labour, capital, natural resources, land). In order to have a model that can be calculated within a day, sectors and countries have to be aggregated, for example till 36 regions and 25 sectors. A program has been developed to create these aggregations easily from the original database.

The GTAP model is a multi-regional, static, applied general equilibrium model based on neoclassical microeconomic theory. The standard model is characterized by an input-output structure (based on input-output tables of nations and groups of nations) that explicitly links industries in a value added chain from primary goods, over continuously higher stages of intermediate processing, to the final assembling of goods and services for consumption. A representative producer for each sector of a country or region maximizes profits by choosing outputs and inputs of labour, capital, natural resources, land and intermediate goods. Each sector produces one type of output. The producer has a nested CES production function with constant returns to scale, where in the standard GTAP model only endowments have elasticities of substitution that are different from zero. Perfect competition is assumed in all sectors within a country. On an international scale goods from the same sector are not homogenous, which is represented by Armington elasticities for import of goods. Primary production factors land, labour and capital cannot move between sectors. Supply of labour, capital, and natural services is exogenous and these production factors are always fully employed.

The MAGNET model includes a lot of extensions compared with the standard GTAP model, which have been applied in various studies (Hermans *et al.*, 2010; Neumann *et al.*, 2011; Prins *et al.*, 2011). The different extensions of the model can be switched on or off through a simple change in coefficients or through closure swaps:

- an integrated production structure, with energy, feed and fertilizer nesting dynamic international investment. This has for example been applied in the analysis of biofuels (Banse et al., 2008)
- production quota
- EU-policy, including first and second pillar measures
- land supply based on biophysical model outcomes from IMAGE (Bouwman et al., 2006; Eickhout et al., 2007) and Dyna-CLUE (Verburg et al., 2002; Verburg et al., 2006; Verburg et al., 2008). It distinguishes between marginal and average land productivity
- substitution between different types of land (including forestry, see (Walker and Woltjer, 2011) in a dynamic way
- dynamic mobility of capital and labour between agricultural and non-agricultural sectors
- income elasticities of consumption as a function of PPP-corrected real GDP per capita
- the GTAP-E carbon market.

Figure 2 presents the circular flow in the MAGNET model.

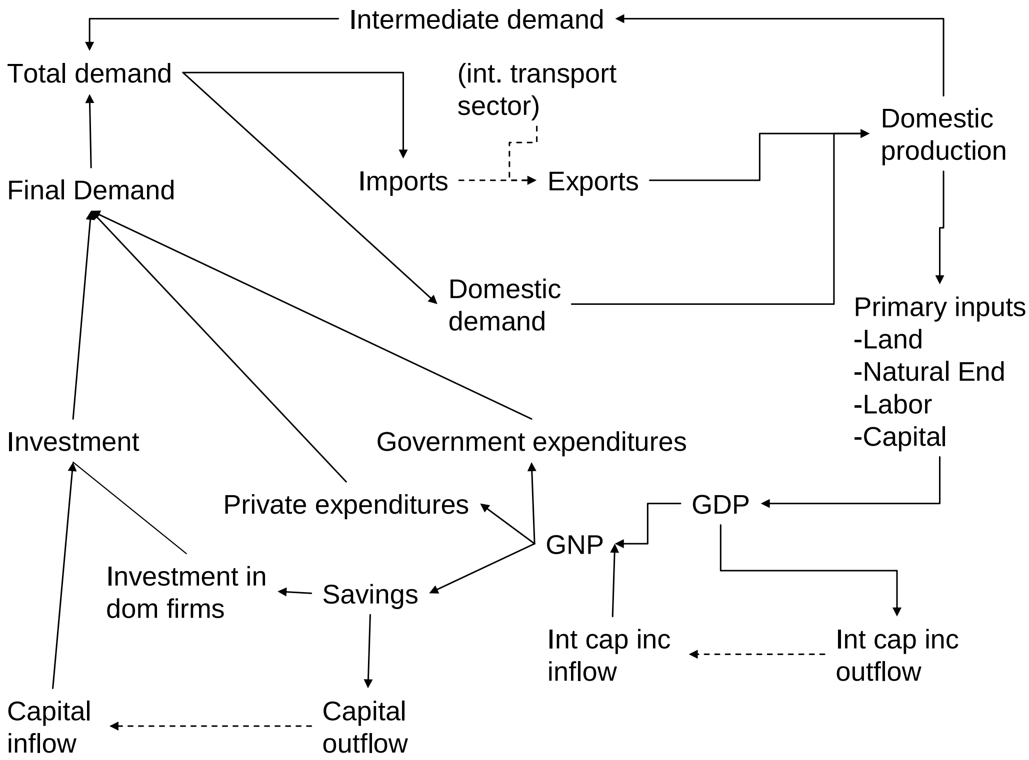

Figure 2: The circular flow in the MAGNET model (Woltjer, 2009) (GDP is gross domestic product and GNP is gross national product).

4.3 Required input

4.3.1 Base period variables

The model uses the GTAP database. This consists of input-output tables that are adapted from tables supplied by countries, product demand by government and private households. All input-output tables and demand tables distinguish between imported and domestically produced products and before and after tax values. For international trade total imported demand for products is allocated to countries, and also these flows are available before and after tax, where the difference between the value of the export of country A to country B and the imports of country B from country A (both at world prices) is the transport margin. This transport margin is allocated to the international transport sectors. We normally model those sectors as part of the service sector. Finally, the value of the capital stock and the value of depreciation is needed, where in the GTAP database it is assumed that the value of depreciation is always 4%.

For MAGNET some extra information is required. This consists of the area of land (km^2) per sector and country (for land supply), the total amount of land that is available and the price elasticity of land supply (for the endogenous land supply module), population and PPP corrected real GDP per capita (to calculate consumption), international capital income flows, and preferably also international capital flows (for the model with international capital flows), and initial rewards in agriculture relative to its equilibrium value (for the dynamic labour/capital mobility module).

4.3.2 Parameters

MAGNET requires a lot of essential coefficients:

- Consumption function parameters
- Armington trade elasticities
- Elasticities and relevant product sets for the input nests
- CET elasticities for land supply, and parameters for the dynamic or static labour/capital flows between agriculture and non-agriculture
- For the land supply module: Parameters for the land supply function and the function that determines the marginal productivity of land
- For the biofuels directive: initial share of petroleum use in the transport sector; and energy content of different energy inputs in the petroleum and/or electricity sector
- For international capital flows: shares of wealth reallocated per year, and the adjustment coefficients in dynamic capital flow equation
- The EU agricultural policy model requires some specific parameters about allocation of second pillar funds and the productivity effect of investments in human and physical capital.

These parameters are sometimes based on econometric research or economic literature, and are sometimes best guesses.

4.3.3 Scenario projection variables

The most important variables needed in scenarios are: Population growth, productivity growth (or GDP growth, where technology is distributed over sectors and inputs according to fixed proportions such as that primary agriculture has four times as much technological change as the service sector; land productivity growth in most cases is exogenously derived from FAO-projections), growth of production factor supply (sometimes simplified by the assumption that skilled and unskilled labour supply grow with population, and capital stock with GDP (not required in model with international capital dynamics).

4.4 Model output

All the variables that are input to the model are also output. MAGNET is flexible in its time periods, but the minimum length of a period is one year. All value changes are decomposed in quantity and price changes. Important outputs are the percentage changes in prices and quantities of land use, employment, capital use, productivity, production, trade, intermediate input use and consumption. There is a tool available (GEMSE_Analist) to generate regional and sectoral aggregates of the outcomes and to define a lot of indicators derived from the data. Examples are farm income, EU agricultural budget, and changes in real exchange rates.

4.5 Strengths and weaknesses

The model uses a consistent database for the whole world and provides a complete and internally consistent description of the world economy. Both price and quantity changes are in, but not the quantities in physical units (tons, etc.), although these can be easily added for the sectors where a useful quantity indicator (like tons of wheat, tons of coal, etc.) is available. For energy inputs there is already a consistent database available with quantity information and also for greenhouse gasses generated by the energy sectors there is a database available.

In order to make the database consistent, the original data have been distorted (changed compared with the originally delivered data) and a lot of information has been filled in. For example, the allocation of agricultural value added over capital, labour and land is done in a very ad hoc way. Most users of the model are not aware of these rules used in creating the database. The differences in quality of the data are not very visible, although most procedures to create the data have been described somewhere. Improvements of the lucidity of the relationship between the GTAP database and the data on which it is based would be beneficial. The MAGNET land supply curve approach provides the opportunity to analyse land use effects of policies over the whole world. The current implementation is very rough, but work is going on for improvement. The energy part provides the opportunity to analyse for example the effect of biofuel policies. The energy nest is very flexible, but the fixed coefficients within this nest as well as the calibration of the coefficients is very ad hoc. The same holds for the feed and fertilizer nests in the agricultural sectors.

The model is very general in character and has a tendency to use constant elasticities as much as possible. For some important parts, like consumption, some improvements have been made in MAGNET, but the empirical foundation remains weak. The Armington approach to international trade allows for bilateral trade, but it simplifies competition a lot and it is not automatically guaranteed that the results are consistent with quantitative supply balances in agriculture, while if Armington elasticities are fixed, small flows will never become very large. For both problems there may be opportunities to improve, but these drawbacks should be taken into account when interpreting of results with the current model version.

In summary, the MAGNET model is very strong in having a consistent accounting system for the whole world and for its ability to incorporate indirect effects of policy measures on land use, income, welfare and production. The drawback is the heroic assumptions that have to be made both in constructing the database and developing a general model. The model helps to think consistently, but the user should be aware that the size of the effects may be influenced by the choice of parameters and functional forms.

The model MAGNET has already a very flexible system of (dis)aggregating spatial units (countries) into groups, as well as sectors and their groups. A downscaling procedure has been developed and applied enabling to disaggregate model output to regions (Woltjer *et al.*, 2011a). In this study the results from the model MAGNET that operates at country level are scaled down to NUTS2 regions of the EU Member States to assess the effects of policy measures at a lower scale. The downscaling method builds up its complexity in a step-wise manner. It starts from a simple but consistent step assuming that regional percentage growth equals national percentage growth. Next, hypotheses are formulated regarding factors that may explain the inequality in the percentage growth and market equations are added to allow for adjustment processes. For example, both migration and allocation of production reacts on changes in wages and employment. Empirical work to quantify differences between regional and national growth developments is carried out. The results of such econometric panel data estimations are integrated into the dynamic equations of the downscaling method, but also information from the literature or experts can be used. The sectoral aggregation on NUTS2 level depends on the available data.

5 Policy scenario's results from MAGNET and the downscaling modelling framework

5.1 Introduction

In this chapter we present results of some scenarios derived from the scenarios discussed in WPO1 (see section 2.2) at different scales, i.e. at a worldwide, European, national and a NUTS2 regional level. The focus is on the latter part, because a downscaling model has been developed specifically for the PRIMA project, while the other parts were already available in the MAGNET model.

The purpose of this chapter is to show that the modelling framework functions, not to develop the scenarios in detail. For reliable outcomes we need more empirical foundation, of which the econometric estimates discussed in D5.3 are only a starting point. Therefore, we have decided to implement the basic idea of the four scenarios in a very simple way.

The four scenarios described are:

- Baseline
- 'Environment' scenario
- 'Rural development' scenario
- 'Infrastructure & Competitiveness' scenario

The baseline discussed in D5.1 has been adapted based on the new MAGNET model and the availability of a more recent database, but the basic approach remains the same. For the environment scenario we have chosen to use simple reforestation program for the EU. For the rural development scenario we have assumed that investment in human and physical capital of the agricultural sector in the regions is increased by increasing CAP expenditures with 15% of the first pillar budget in a country, where these expenditures are in regions with a relatively low value added per worker in agriculture. Finally, for the infrastructure and competitiveness scenario it is assumed that the 15% of the first pillar CAP budget is used to enhance general productivity in a region, where the subsidies are focused on regions with a low GDP per worker. We finish this chapter focused on the applicability of the modelling tool in the future and its relationship with local research as developed in other work packages of PRIMA.

During the discussion of the results we present tables that are only a selection of all the information that can be retrieved out of the modelling system. The purpose of this chapter is not a completely analysis of the baseline and some scenario's, but to provide a glimpse of the possibilities the modelling system provides for analysing scenario's and policies.

Before we turnto the analysis of the simulated scenario's , a short digression on an extra element that has been added to the MAGNET modelling tool and that was partly inspired by the downscaling problem of land use in PRIMA will be presented.

5.2 A new land supply approach

Compared with the model discussed in D5.1 and D5.2 an important improvement has been made. One of the focuses of PRIMA was land use, and land use outside agriculture was not covered in MAGNET very well. For this reason, we have decided to create a more general and land-cover based approach to land use. For this purpose we use the land cover statistics from FAO and EU as a starting point (more details can be found in D5.3, Woltjer et al, 2011). Instead of modelling agricultural land supply based on the total amount of potential agricultural land available for agricultural, we model the opportunities to transform different land cover types into agricultural land. So, there is a transformation elasticity of forest land, shrubland, savanah grassland and builded land that depend on the price of agricultural land. Furthermore, the demand for builded area was modelled directly based on developments in population and welfare. The advantage of this approach is that it could be applied directly also at a NUTS2 level, creating a possibility to downscale land cover in the modelling system.

We have decided to use the new land supply modelling approach in the PRIMA project because it extends the opportunities to analyse land cover changes a lot. Nevertheless, we have to be careful with the interpretation of the results, because the size of the coefficients is not determined by empirical research. Transformation eleasticity is set at 0.1 for most regions of the world, at zero for some countries like The Netherlands and India, and at one for some regions where we assume ample opportunities to expand land use (like in Southern America and Africa). The results are partly determined by these elasticities. To investigate the size of the elasticities it is important to increase the reliability of the model results.

5.3 The baseline

The baseline projects a development of the world economy and land use based on population and GDP projections from USDA (see D5.1). Tale 1 shows the development of agricultural land use in the period 2004-2030.It shows a global 9% increase in agricultural land use, but a 2% decrease of land use at a European level. This is caused by the fact that the increase in population and welfare happens in other parts of the world than Europe, while agriculture production tends to be in the neighbourhood of these developments. But it is also caused by comparative advantages in the world: while in Europe land is relatively scarce, in some parts of the world, especially Southern America, Africa and some parts of South East Asia have opportunities of agricultural land use, although this may be at the cost of valuable forests.

Table 1 Percentage change in land demand (2004-2030)

	Agriculture	Crops	Livestock	rice	wheat	coarse grains	vegetable oils	sugar
World	9	1	13	-38	-7	2	20	6
EU	-2	-1	-5	9	3	2	-19	4
Belgium/Lux	-1	-3	4	0	-8	-20	-53	66
Denmark	-5	-3	-22	0	10	-10	-32	-10
Germany	5	16	-21	0	49	5	7	-20
Spain	2	2	2	-20	29	25	-39	49
France	-4	-4	-2	-25	-12	-6	-13	3
Ireland	0	-7	3	0	-39	10	45	0
Italy	-11	-10	-11	35	-66	7	-20	6
Netherlands	-1	-31	23	0	-61	-25	-20	-1

This is illustrated in table 2. Half of the increase in Agricultural land in South and Central America comes from forest land, and the other half from Savanah grassland and shrubland.

In Africa only 1/6 is coming from forest land. But if we transfer this information into percentage changes (table 3), the large effects of this default development become very visible. 20% or more of South American and African forests will be lost. It is obvious that an anti-deforestation policy will be very important for these regions.

Table 2 Land cover change (1000 km² between 2004 and 2030)

	Agriculture	Forest	Savannah Grassland	Shrub land	Built-up land	Other land
World	3830	-962	-1781	-469	93	-710
EU	-40	38	-1	-1	2	1
South/Central America	1125	-560	-356	-193	16	-31
Mid and South Africa	3392	-504	-1495	-329	13	-1076
South East Asia	135	-124	-16	0	5	0

Table 3 Percentage land cover change (2004-2030)

	Agriculture	Forest	Savannah Grassland	Shrub land	Built-up land	Other land
World	9	-6	-13	-5	15	-3
EU	-2	3	-1	-1	2	4
South/Central America	19	-20	-14	-17	20	-4
Mid and South Africa	36	-27	-27	-27	43	-27
South East Asia	10	-9	-9	-9	21	-9

On a regional scale, population dynamics is important, especially because a lot of regional policy is focused on the prevention of depopulation and the agent-based models of PRIMA had a focus on population, too. Figure 3 shows the development of population between 2004 and 2030 for the twelve provinces of the Netherlands. As expected, it shows clearly the depopulation problems in north and south of the Netherlands. Table 4 shows how this depopulation is accompanied with an aging population; in 2030 in Limburg (NL42) and Zeeland (NL34) about 30% of the population is above 65 years old.

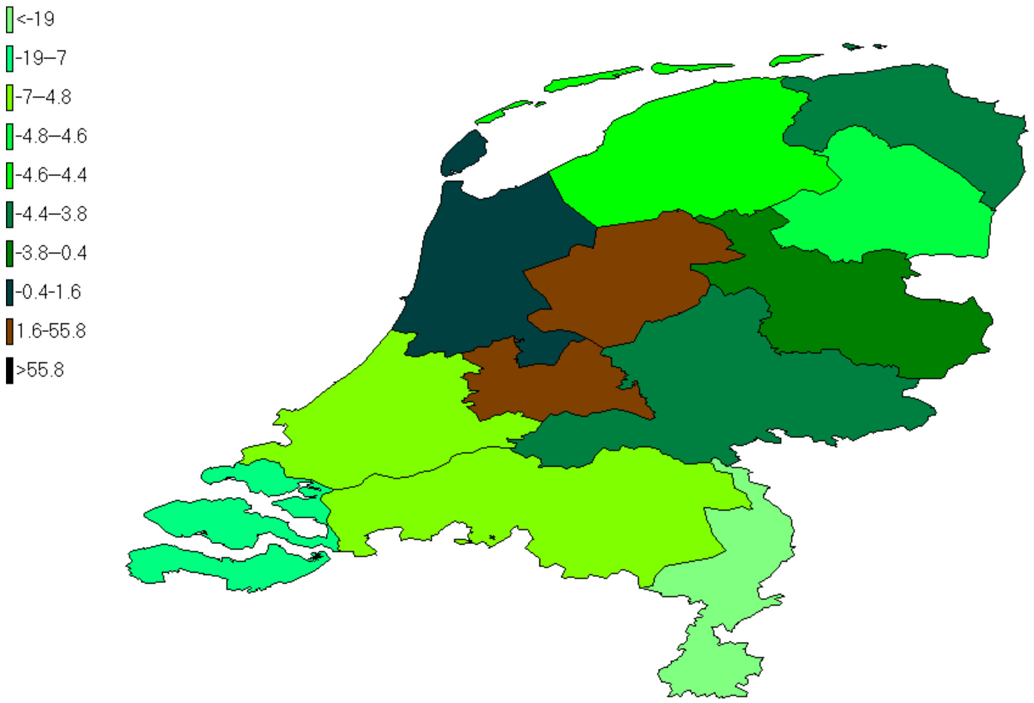

Figure 3 Percentage population change in each of the Dutch provinces (NUTS2) between 2004 and 2030

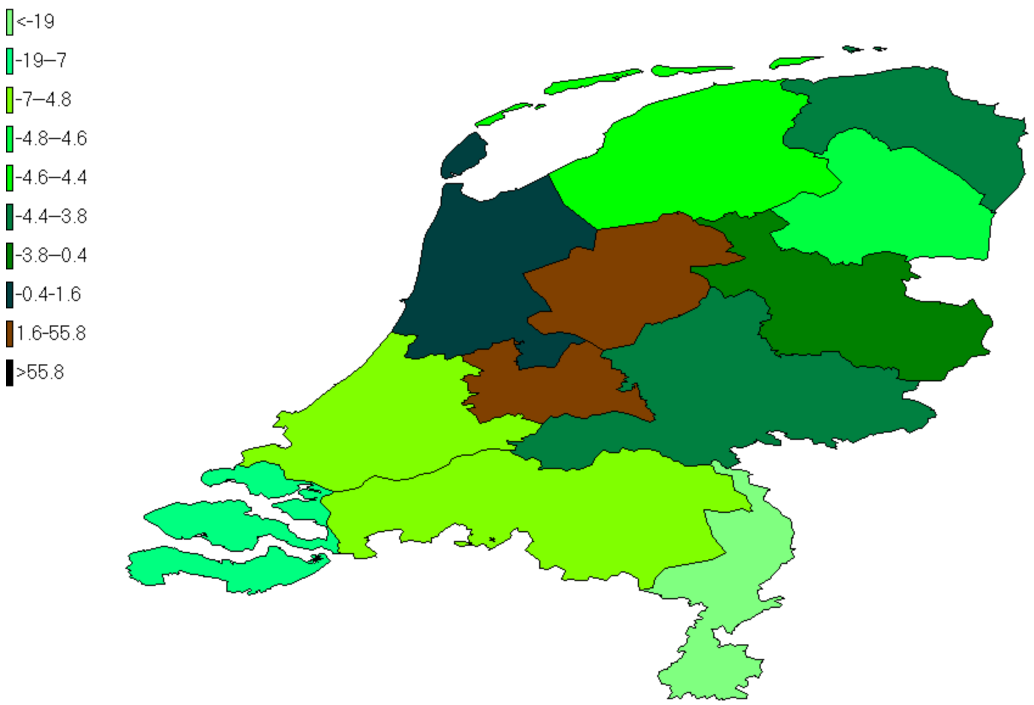

Table 4Fraction of population above 65 in 2004 and 230

Year	NL11	NL12	NL13	NL32	NL33	NL34	NL41	NL42
2004	0.15	0.15	0.16	0.14	0.14	0.17	0.14	0.16
2030	0.23	0.25	0.28	0.22	0.22	0.28	0.24	0.30

5.4 Effects of three European policies

In this section we compare the effects of three European policies on Europe, the rest of the world and the NUTS2 regions in the Netherlands. The rural development scenario, called Base_PRIMA3_AGRINV below, was implemented as a change in productivity in creating all output in primary agriculture, both on a national level in MAGNET as on a regional level in the PRIMA downscaling model. Both investment in physical and investment in human capital could be used for it, and empirical coefficients about the average effects in this type of investment were applied in the MAGNET model.

The Infrastructure and Competitiveness scenario, called Base_PRIMA3_REGDEV below, was implemented as a change in general productivity in all sectors. It is implicitly assumed that the improved infrastructure and other general regional policies influence all sectors more or less in the same way.

The Environment scenario is implemented as a target increase of forest area of 5%. For some countries like the Netherlands this implies an increase of 5% in forest area, but in countries with less clearly defined forest areas the increase may be less. This increase inforest area is mainly at the cost of agricultural area, implying that agricultural land rents will increase.

The policies were implemented for the period 2010-2015, so we present the consequences of the policies policy at the end of this period, i.e. the year 2015.

Table 5 shows the European and worldwide effects of the three policy experiments. A shift of funds towards a regional development policy has only small changes towards both land use in the EU and the Rest of the World (ROW). As expected, investment in agricultural development has much more important consequences, generating a small reduction in EU land use, implying that the influence of improved land productivity is higher than the influence of the attraction of extra agricultural activities because of a lower cost price. The influence on the rest of the world is the effect the attraction of activities towards Europe because of the (subsidized) investment in increase in agricultural productivity. Finally, the only partially successful attempt to increase forest land in the EU generates a large reduction in agricultural area in Europe, half of which is transferred to other parts of the world.

Table 5 Change in agricultural land use (Km²) in 2015 as a consequence of three EU-policies

Scenario	Region	Crops	Livestock
Base_PRIMA3_REGDEV	EU	-4	-15
	ROW	-89	-113
Base_PRIMA3_5percforestinc	EU	-21873	-10122
	ROW	9164	7139
Base_PRIMA3_AGRINV	EU	-121	-530
	ROW	-7393	-8546

What are the regional land use effects of these policies? We take the Netherlands as an example. Figure 4 shows that the agri-investment policy generates a reduction in crop land use in the Netherlands, and an increase in land use for livestock. So, animal production comes more productive, and this holds for most parts of the country. Be aware that the change in livestock area is extremely small, a fraction of a percent!

The regional development policy gives as a general tendency a reduction in cropland use, but again the changes in total agricultural land use are negligible. The reduction in cropland use is caused by an increase in land productivity without generating much extra production.

Finally, the increase in forestry has a large influence on land use, both for crops and for livestock. There is a clear difference between different provinces, determined by the amount of forestry in the regions, and the relative profitability of different agricultural activities.

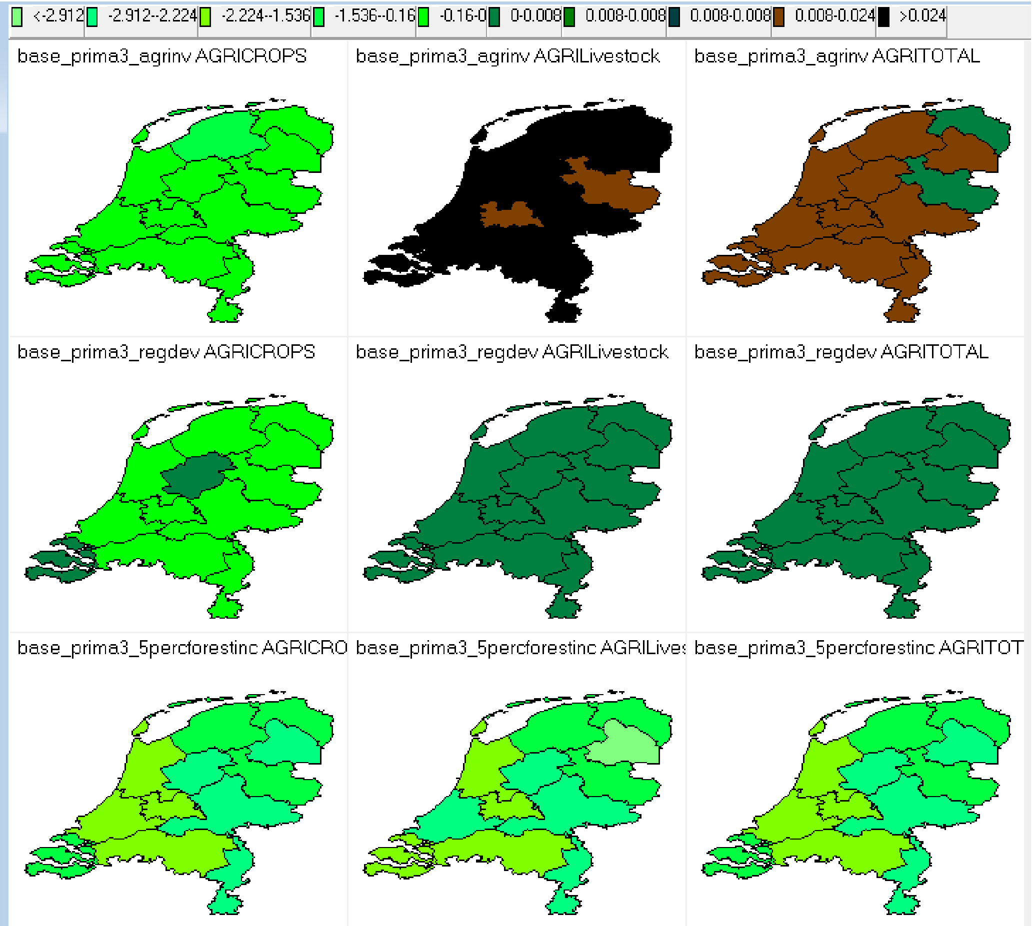

Figure 4 Percentage change in 2015 as a consequences of three policies

We may also illustrate the effect of the different policies with the effect on value added generation. Figure 5 shows that the policy focused on agricultural productivity has a negative effect on the value added in the agricultural sector. The increased efficiency shows itself in a higher value added per employee (figure 6), but implies that less farmers are needed. It is good for industry, because the increased agricultural production requires more processing, and because farmers tend to go to the industrial sectors. The regional development policy has also a positive influence on the service sector, although the influence is bigger on industry. Finally, the increase in forest area has a slight negative effect on total value added in agriculture, but a positive influence on earnings in the agricultural sector.

Be aware that almost all changes are very small when formulated as percentage changes, but so are the expenditures in the Netherlands of the policies analysed.

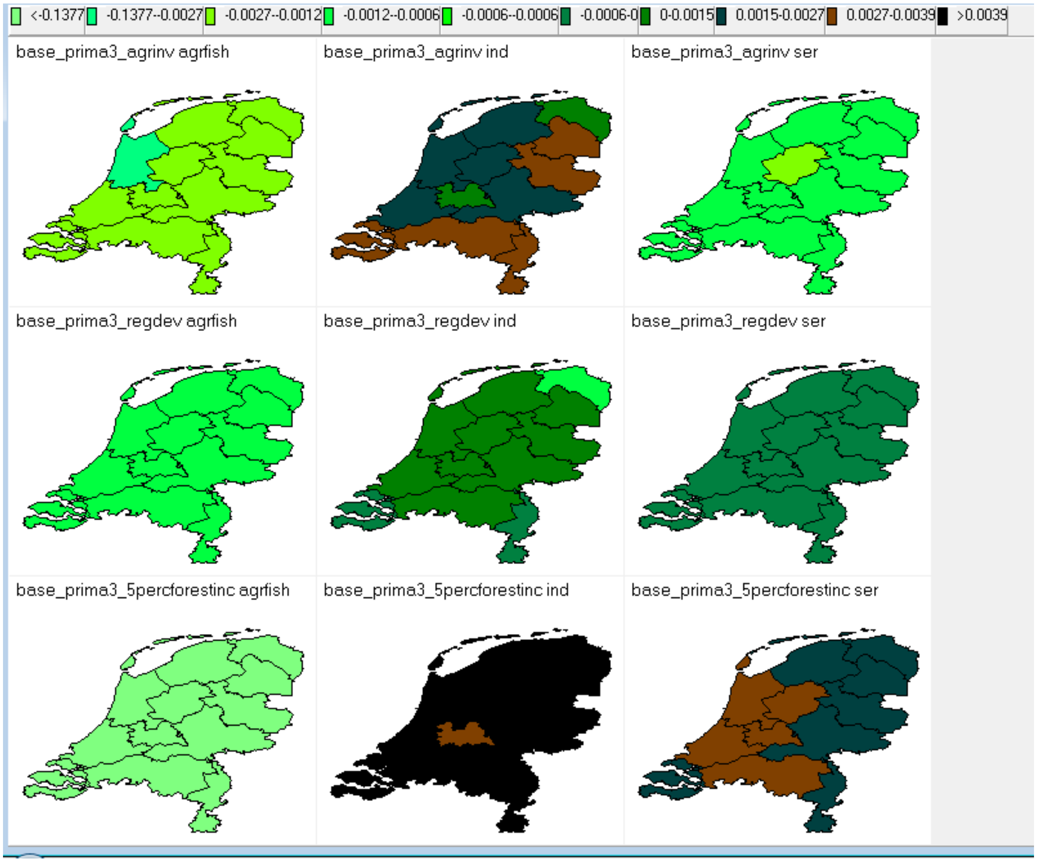

Figure 5 Effect of different policies on value added in three sectors in 2015

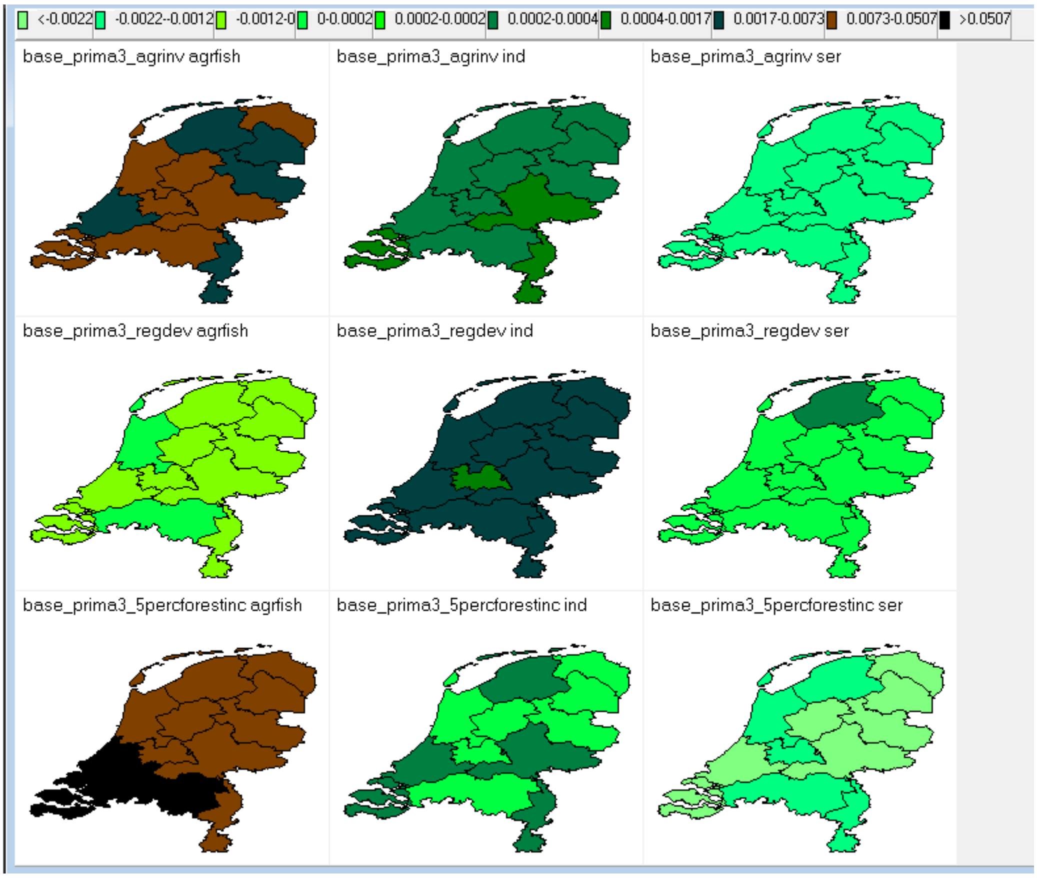

Figure 6 Effect of different policies in 2015 on value added per worker

This ends our illustration of the possibilities for policy analysis in the framework for European, worldwide, national and regional analysis of European policies.

5.5 Concluding remarks

The scenarios discussed in this chapter show that the modelling tool can be applied on a whole range of scales, from a worldwide level towards a NUTS2 level. Potentially, when the data are made available, the downscaling can also be applied to a NUTS3 level, but there are limits towards the level of downscaling through the method developed here because locality specific information like specific location of roads becomes more and more needed additionally to the general forces.

The illustration in sections 5.3 and 5.4 show that there are ample opportunities to present the results in different ways. Creating these tables, graphs and maps, both in percentage changes, absolute changes or values, is very fast, and helps to get a quick inside into results and also creates opportunities for instant answers on causalities when for this other steps are required.

6 Methodological framework to achieve consistent comparison of selected indicators from CAPRI and MAGNET at NUTS2 level

6.1 Complementarities between two established modelling systems CAPRI and MAGNET

Work of Britz and Keeney (2010) analyses complementarities between two established modelling systems like CAPRI and GTAP (also applicable to MAGNET). The methodological comparison is done regarding the technology representation and supply behaviour; representation of demand and the modelling of commodity markets; databases, and the overall design (including the software).

The authors conclude that although the systems are closely based on optimisation behaviour rooting in micro-theory and experience continuous improvements, equally obvious they have distinct differences. CAPRI is linked to a much smaller and more focused market: the complex Common Agricultural Policy and its impact on farm income and management, food prices, land use and environmental impacts. That focus asks for a high dis-aggregation in sectors/products and space, while coverage of land use/management and environmental aspects introduces a lot of physical data in the system. Especially the latter two features render a link between GTAP & CAPRI interesting for specific applications.

Despite the differences in these systems, several key steps have been made in SEAMLESS project (www.seamlessassociation.org) to advance the linkage of CAPRI model and GTAP model (Jansson et al., 2009) with the following created concordances that are relevant in making the MAGNET and CAPRI outcomes compatible and thus comparable:

- Between CAPRI and GTAP regions
- Between CAPRI and GTAP outputs or sectors
- Between CAPRI intermediate inputs and GTAP outputs
- Between CAPRI macro-economic drivers and GTAP variables

Table 1: Comparison between CAPRI and GTAP from a methodological / coverage perspective

	CAPRI	GTAP
Coverage	Only agricultural sector and some important first processing stages (oil & cakes, dairy, bio-fuels) Global, but focus on and detailed representation of Europe	All sectors No specific regional focus
Agricultural Supply	Europe: Explicit optimisation under constraints, sub-national resolution Mostly Leontief demand for intermediates (as far as possible in physical quantities, expressed per ha/head); exceptions: feed & fertilizer Capital & labour shadowed in dual cost function, land as physical balance Non-Europe: dual; normalized non symmetric quadractic profit function	Implicit optimisation (FOC in MCP), nation & group of nations Leontief demand for intermediate (constant values, expressed per unit of output) CES GVA nest
Final demand	Generalized Leontief; expressed in raw product equivalent	Different functional forms; directly linked to sectors/commodities
Feed demand	Based on explicit nutrient requirements (energy, crude protein, dry matter corridor ..) of herds –supply model; composition of bulks such as cereals based on CES - handled in market model	Leontief as other intermediates
Fertilizers	Substitutions between mineral & organic fertilizers; based on N,P,K nutrient requirements of crops, farming practise and location factors	Leontief as other intermediates
Processing demand	Dual; normalized not symmetric quadratic profit function; only for cakes, oils, dairy, bio-fuels	Same structure as all other sectors (Leontief + GVA nest via CES)

Trade	Armington; physical quantities; ad valorem & specific tariffs separated; explicit TRQs and some trade instruments of EU; no CET	Armington; constant values; ad valorem equivalents (encompassing TRQs); CET
Consumer prices	Linked to raw products prices with fixed margin	Linked to producer prices of relating sectors (food industry etc.)
Spatial resolution	280 regional units in Europe; 59 countries / country blocks worldwide	~180 nations world wide (maximal, typically aggregated in applications)
Commodity resolution	ca. 40 products (agriculture and first stage processing of agriculture)	Ca. ? products covering all economic activities
Sectors	Multiple outputs per sector (= production activity), 35 crop and 13 animal activities	Typically symmetric to one commodities

Source: Britz and Keeney, 2010

6.2 Concordance of regions

Following Jansson et al. (2009), there are 47 countries that are distinguished in both models, 15 regions distinguished in CAPRI which do not exist as such in GTAP although a same name may be used and 49 regions distinguished in GTAP which are not distinguished as such in CAPRI. Given the focus of PRIMA the main interest is in the 27 EU member states that are individual countries in both MAGNET and CAPRI.

Table 6: Matching regions in CAPRI and MAGNET

CAPRI		*MAGNET*	
Code	*Description*	*Code*	*Description*
DE000000	Germany	DEU	Germany
SE000000	Sweden	SWE	Sweden
FR000000	France	FRA	France
IR000000	Ireland	IRL	Ireland
DK000000	Denmark	DNK	Denmark
ES000000	Spain	ESP	Spain
EL000000	Greece	GRC	Greece
AT000000	Austria	AUT	Austria
FI000000	Finland	FIN	Finland
IT000000	Italy	ITA	Italy
UK000000	United Kingdom	GBR	United Kingdom
BL000000	Belgium	BEL	Belgium

		LUX	Luxembourg
NL000000	Netherlands	NLD	Netherlands
PT000000	Portugal	PRT	Portugal
CY000000	Cyprus	CYP	Cyprus
CZ000000	Czech Republic	CZE	Czech Republic
EE000000	Estonia	EST	Estonia
HU000000	Hungary	HUN	Hungary
LT000000	Lithuania	LTU	Lithuania
LV000000	Latvia	LVA	Latvia
MT000000	Malta	MLT	Malta
PL000000	Poland	POL	Poland
SI000000	Slovenia	SVN	Slovenia
SK000000	Slovak Republic	SVK	Slovakia
BG000000	Bulgaria	BGR	Bulgaria
RO000000	Romania	ROM	Romania
AL000000	Albania	ALB	Albania
HR000000	Croatia	HRV	Croatia
NO000000	Norway	NOR	Norway

Source: Jansson et al. (2009)

6.3 Concordance between agricultural sectors

There is only one sector (paddy rice) where both models use the same sector definition in terms of product codes used in MAGNET (6-digit HS 1996 concordance). In all other cases CAPRI sectors appear with several MAGNET sectors. To indicate the extent to which an aggregate representation in MAGNET would be covered by CAPRI Figure 7 presents the share of HS codes in GTAP covered by CAPRI sectors. Of the 19 GTAP sectors five are completely covered by the CAPRI sectors: paddy rice, wheat, cereals, vegetables, fruits & nuts, processed rice. On the opposite extreme there are two MAGNET sectors that are not covered by the CAPRI sectors: plant-based fibers, wool and silk-worm cocoons.

For the purpose of PRIMA downscaling routine, there is no need to achieve the full concordance between all products since the downscaling can be demonstrated for selected agricultural products for which the concordance is available (see right most column in Table 7).

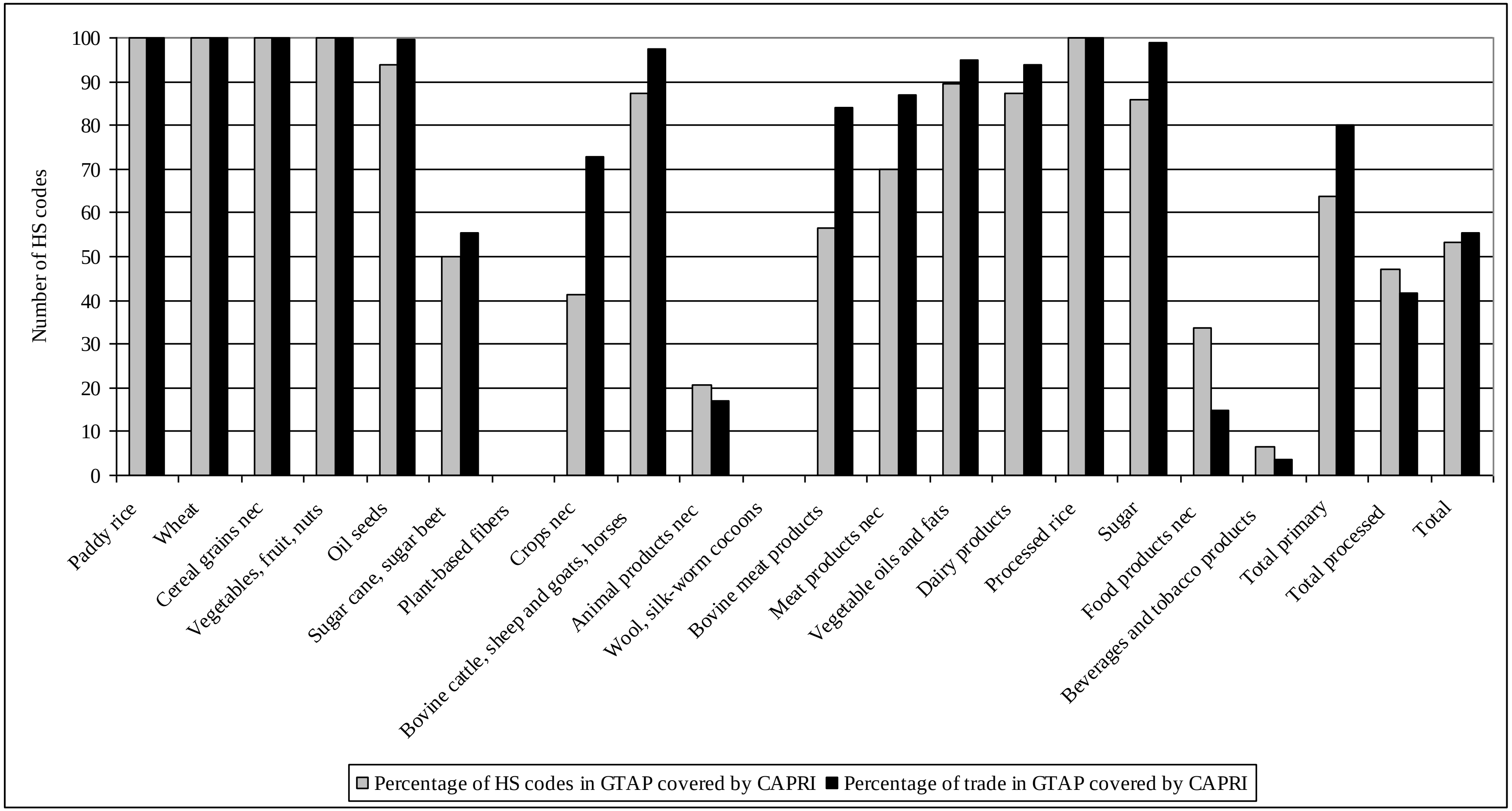

Figure 7: Coverage of agricultural HS codes in MAGNET/GTAP by CAPRI (number of HS lines by MAGNET/GTAP sector covered by CAPRI)

Table 7: Disaggregated mapping of CAPRI products to GTAP sectors (for codes, please refer to Annex 0)

CAPRI activity or commodity	MAGNET tradable commodity	MAGNET tradable commodity code
pari	Paddy rice	pdr
swhe,dwhe	Wheat	wht
ryem,barl,oats,maiz,ocer	Cereal grains nec	gro
toma,oveg,appl,ofru,citr,tagr,tabo,twin,owin	Vegetables, fruit, nuts	v_f
rape,sunf,soya,oliv,ooil	Oil seeds	osd
sugb	Sugar cane, sugar beet	c_b
text	Plant-based fibers	(not mapped)
puls,pota,toba,oind,nurs,flow,ocro,maif,roof,ofar	Crops nec	ocr
ycow,ybul,yhei,ycam,ycaf	Cattle,sheep,goats,horses	ctl
ypig,ylam,ychi	Animal products nec	oap
comi	Raw milk	rmk
beef,sgmt	Meat: cattle,sheep,goats,horse	cmt
pork,poum,eggs	Meat products nec	omt
rapo,suno,soyo,olio,ooil	Vegetable oils and fats	vol
butt,smip,ches,frmi,crem,cocm,wmip	Dairy products	mil
rice	Processed rice	pcr
suga	sugar	sgr

Source: Jansson et al. (2009)

6.4 Concordance between macro-economic assumptions

To account for autonomous development, the following trends of the eight main exogenous drivers are to be considered for the baseline construction of MAGNET as implemented in the market model CAPRI. The projections listed here are obtained from the EUROSTAT data unless specified otherwise. *Demographic changes* are based on the EUROSTAT projections for Europe and UN projections for the rest of countries in the world and are presented in Annex 0. *Inflation* in the EU-25 is taken at 1.9% rate per annum. The projections on *growth of GDP per capita* are distinguished for the EU10 (2.0%), USA (1.5%), India (5.0%), Russia (4.0%), Least Developed Countries and Afro-Caribbean Countries (1.5%), and the rest of the world countries (1.0%). I*n CAPRI, technical progress* is modeled as 0.5% input savings per annum (affecting exogenous crop yield trends) with the exception for N, P, K needs for crops which are trend forecasted. This assumption can also be replicated in MAGNET.

Next, the following level of detail is not dealt with within MAGNET and thus is not to be made in concordance, although mentioned here. Country-specific implementation of the Common Agricultural Policy (CAP) for the 25 members states regarding coupling options and premiums per group of agricultural products as presented in Perez-Dominguez and Wiek (2006) are taken for modeling the *domestic policies*. *Trade policies* are modelled according to the final implementation of the 1994 Uruguay round plus some further elements as NAFTA (AMAD, 2005). The *shifts in supply and demand of agricultural commodities* are modeled according to the expert forecasts as presented in EC (2005b). Finally, the *global supply and demand* forecasts are taken from FAO (2003).

6.5 Creating a baseline in MAGNET consistent with CAPRI

The purpose of a comparison between two models of downscaling is to see how in the different models the same scenario works out. This implies that both models must show the same developments on a national level, so we can compare how this is distributed over the NUTS2 regions.

If we assume that we use a CAPRI baseline to calibrate the MAGNET baseline, then the following adjustments needs to be done:

-ensure concordance between regions

-ensure concordance between sectors and products

-ensure for the implementation of the macroeconomic assumptions

-prepare the data to rerun the baseline of MAGNET for the same years as MAGNET

- Calibrate MAGNET to the outcomes of CAPRI baseline 2013. These outcomes can be more extensive but the proposal is to use the indicator “Total value of all primary agricultural products produced” from the database of SEAMLESS (see also the list of CAPRI indicators at NUTS2 level in Annex 0) at a national level.

- Derive the percentage change for selected CAPRI indicators to be compared with MAGNET indicators. For both models the indicators must be defined in constant prices of the base year, i.e. must be volume or relative price indicators.

This procedure would enable a comparison of CAPRI and MAGNET as a downscaling method. If this procedure would be adapted the challenge is not only to describe the differences, but also attempting to analyse the causes of these differences.

6.6 Concluding comments

Although the original idea was to run the SEAMLESS framework next to the PRIMA framework of downscaling, the difference in approach is that big that it doesn’t seem to be very fruitful. Instead of this a methodology of comparison of downscaling results has been developed, that could also be used for comparison with other downscaling methods like the land use downscaling approach by a land use model like CLUE. Before these comparisons are useful, first the quality of the PRIMA downscaling method has to be improved. Especially the empirical foundation of the relations in the model has to be further developed before a comparison exercise is becoming useful.

7 Conclusions and discussion

We have tested the system with a baseline scenario and three European policy scenarios (chapter 5), where these scenarios were inspired by the scenarios developed in WP1 of PRIMA (chapter 2). The purpose of this exercise was to show how the method functions, detailed further implementation of specific policies is required before the system can be applied for real policy analysis. For example, for the implementation of second pillar CAP policies detailed knowledge about the institutional regulation of distribution of budgets and the empirical knowledge about the projects and its effects is required before the simulation outcomes will get any policy relevance. But the basic mechanisms that are needed for such an analysis are available in the PRIMA regional downscaling method.

This report has presented a brief overview of two modelling tools, i.e. CAPRI (chapter 3) and MAGNET (chapter 4) models with the downscaled results, both enabling to provide the policy assessments at the regional (NUTS2) level. A methodological framework is offered to achieve consistent comparison of the simulation results of different models (chapter 6). The appendices provide information that may be useful when such a comparison would be made in practice.

The current downscaling tool developed in PRIMA is a user friendly tool that can easily adapt new insights and knowledge. Although some econometric research is used as a foundation for some parameters in the models, most parameters are taken by intuition. For this reason, the current results of the simulations must not be taken as an illustration of the potential of the system instead of a solidly founded final results. Further experience with the model and further empirical studies are needed to make from the developed tool a reliable guide for policy analysis.

To finish this report, it is worthwhile to address a methodological issue. Originally the idea of the project was to compare upscaled results from local agent based models with the downscaled results from MAGNET. Upscaling of local results to a NUTS2 level was much more difficult than expected, and therefore was not realized. But also from a conceptual point of view, it is questionable if one should target for such a comparison. Because downscaling tackles completely different driving forces than upscaling, the results will be different anyhow. It seems more logical to relate the two approaches in different ways. For example, downscaled results can be used as a scenario environment for local modelling and stakeholder analyses. On the other hand, detailed local studies can be useful to analyse how policies really work out in practice. An abstraction of this information can be used as input for modelling the effects of different policies on regional or national levels. The interaction between upscaling and downscaling should be the focus of future studies on scaling issues. The model developed in this downscaling method provides ample opportunities to develop this in the future.

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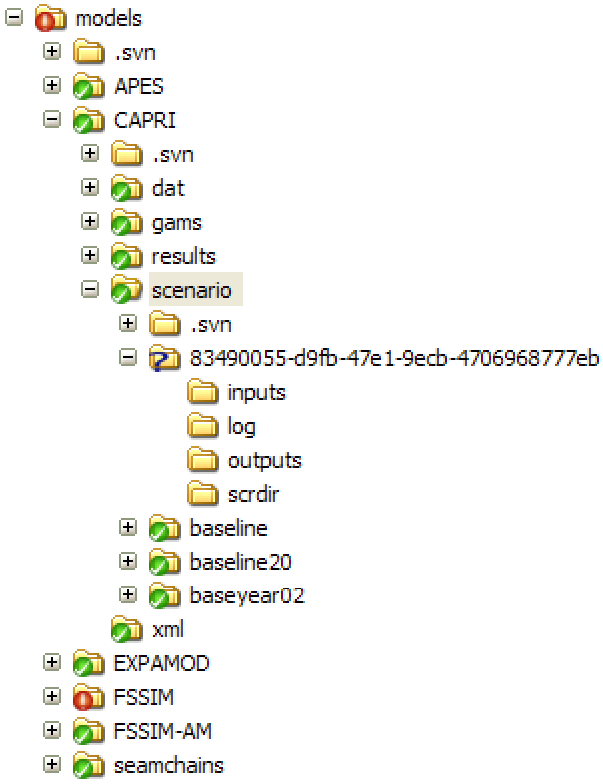
ANNEXES

A. SEAMCAP in SEAMLESS – A special version of the CAPRI model

Within the SEAMLESS project an adjusted version of the simulation engine of CAPRI has been developed (called SEAMCAP) in order to integrate it into the SEAMLESS framework that:
- allows to use external elasticities provided by upscaling model (Pérez Domínguez *et al.*, 2009) to steer the supply response in the regional supply models
- allows to transfer scenario parameters from a Guided User Interface (GUI) of SEAMLESS-IF for scenario handling
- prepares a subset of model outputs to make them available to the user of SEAMLESS- IF.

The baseline and baseyear folders comprise the files from the standard runs of CAPRI and are hard-coded with each delivery of CAPRI for SEAMLESS-IF.



Each of the subfolders in the scenario folder falls into 4 further subfolders called inputs, log, outputs and scrdir. The latter only contains intermediate files produced by GAMS and CAPRI. The log directory currently contains two files, the gams listing file and a log file giving some information on the performance of CAPRI. Both files are created when CAPRI is executed. The content of the remaining two folders is straight forward. One contains the inputs created by the SEAMLESS-IF system within only one file called seamcap_inputs.gdx. In the output folder we find 3 important files. Two of them are standard CAPRI outputs, the CAPRI results cube (Allresults.gdx) and the iteration log (Iterationlog.gdx) and could be used by the CAPRI results viewer. The third file (seamcap_outputs.gdx) contains those CAPRI results that are made available to SEAMPRESS – visualisation tool within SEAMLESS-IF. After an experiment run of CAPRI has finished, those 4 folders are compressed and stored on the SEAMLESS server.

When making comparison of the CAPRI results with e.g. downscaled results from MAGNET, these folders and their content are needed.

Full version of this documentation can be found in (Adenäuer et al., 2009).

B. Codes of CAPRI products

BARL Barley	MAIZ Maize
RYEM Rye	OATS Oats
OCER other cereals	RICE Rice
POTA Potatoes	SUGA Sugar
PULS Pulses	SOYA Soya
SUNF Sunflower seed	RAPE Rape seed
TOBA Tobacco	TEXT Textiles
OLIO Olive oil	APPL Apples pears peaches
CITR Citrus	TAGR Table grapes
OFRU Other fruits	TOMA Tomatoes
TABO Table olives	OVEG Other vegetables
TWIN Table wine	BEEF Beef
PORK Pork meat	SGMT Sheep and goat meat
POUM Poultry	EGGS Eggs
SOYO Soya oil	SUNO Sunflower oil
RAPO Rape oil	SOYC Soyameal and cake
SUNC Sunflower cake	RAPC Rape cape
MILK Raw milk	FRMI Fresh milk products
CHES Cheese	BUTT Butter
CREM Cream	SMIP Skimmed milk powder
WMIP Whole milk powder	COCM Concentraded milk
WHEA Wheat	

C. Assumptions on GDP growth in CAPRI model

	growth rates GDP		growth rates GDP
BL000000 "Belgium and Luxembourg"	1.015065895	Turkey	1.040475166
DK000000 "Denmark"	1.015065895	WBA "Western balcans"	1.043910608
DE000000 "Germany"	1.015065895	MED "Other mediterrean countries"	1.040243732
EL000000 "Greece"	1.015065895	URUPAR "Uruguay and Paraguay"	1.038112083
ES000000 "Spain"	1.015065895	MER_OTH "Bolivia, Chile, Venezuela"	1.042965583
FR000000 "France"	1.015065895	CH "Switzerland"	1.015065895
IR000000 "Irland"	1.015065895	REU "Rest of Europe"	1.015065895
IT000000 "Italy"	1.015065895	RUS "Russia"	1.034889068
NL000000 "The Netherlands"	1.015065895	UKR "Ukraine"	1.035925346
AT000000 "Austria"	1.015065895	FSU "Former Soviet Union without Russia"	1.07846155
PT000000 "Portugal"	1.015065895	MOR "Morocco"	1.043485057
SE000000 "Sweden"	1.015065895	MIDEAST "Middle East"	1.037496614
FI000000 "Finland"	1.015065895	NGA "Nigeria"	1.054869119
UK000000 "United Kingdom"	1.015065895	ETH "Ethiopia"	1.086163613
CZ000000 "Czech Republic"	1.018473343	ZAF "South Africa"	1.040592566
EE000000 "Estonia"	1.018473343	AFR_LDC "Africcan LDCs"	1.064791504
HU000000 "Hungary"	1.018473343	AFR_REST "Africa Rest (practically ACP)"	1.059133145
LT000000 "Lithuania"	1.018473343	IND "India"	1.079213554
LV000000 "Latvia"	1.018473343	PAK "Pakistan"	1.046294165
PL000000 "Poland"	1.018473343	BGD "Bangladesh"	1.059497121
SI000000 "Slovenia"	1.018473343	CHN "China"	1.091832198
SK000000 "Slovak Republic"	1.018473343	JAP "Japan"	1.009290085
RO000000 "Romania"	1.018473343	MALIND "Malaysia and Indonesia"	1.051236225

BG000000 "Bulgaria"	1.018473343	TAW "Taiwan"	1.035855445
CY000000 "Cyprus"	1.018473343	ASI_TIG "Asian Tigers: Hong Kong, Singapore, South Korea"	1.035855445
MT000000 "Malta"	1.018473343	ASI_SE "Asian South East (Vietnam, Thailand, Brunei)"	1.057700541
Norway	1.015065895	ASOCE_LDC "Asian and Ociania LDC (Afghanistan, Bhutan, Cambodia, Laos, Maldives, Myanmar, Nepal, Timor Este, Kiribati, Solomones, Samoa, Tuvalu, Vanuatu"	0.029
AL000000 "Albania"	1.043910608	ASOCE_REST "Rest of Asia"	1.041471863
MK000000 "Macedonia"	1.043910608	ANZ "Australia and New Zealand"	1.026281103
CS000000 "Serbia"	1.043910608	USA "USA"	1.022303912
MO000000 "Montenegro"	1.043910608	CAN "Canada"	1.020704254
HR000000 "Croatia"	1.043910608	MEX "Mexico"	1.031315534
BA000000 "Bosnia and Herzegovina"	1.043910608	ARG "Argentina"	1.043907807
KO000000 "Kosovo"	1.043910608	BRA "Brazil"	1.04645732
		MSA_ACP "Middle and South America ACP"	1.04212447
		RSA "Rest of South and Middle America"	1.048906534
		TUN "Tunesia"	1.043485057
		ALG "Algeria"	1.030451411
		EGY "Egypt"	1.048845754
		ISR "Israel"	1.038192708
		VEN "Venezuela"	1.04212447
		CHL "Chile"	1.04464781
		URU "Uruguay"	1.044938331
		PAR "Paraguay"	1.031285835
		BOL "Bolivia"	1.04212447

D. Model variables with regional dimension only at country aggregate scale

Variable name	Unit	
Aggregate scale: N retained by crop in kg per ha and region	kg/ha	Not endorsed
Aggregate scale: N from mineral fertilizer in kg per ha and region	kg/ha	Endorsed
Aggregate scale: N at tail applied in kg per ha and region	kg/ha	Not endorsed
Aggregate scale: N from crops residues and atmospheric deposition in kg per ha and region	kg/ha	Not endorsed
Aggregate scale: P2O5 retained by crop in kg per ha and region	kg/ha	Not endorsed
Aggregate scale: P2O5 at tail applied in kg per ha and region	kg/ha	Not endorsed
Aggregate scale: P2O5 from mineral fertilizer in kg per ha and region	kg/ha	Endorsed
Aggregate scale: P2O5 from crop residues in kg per ha and region	kg/ha	Not endorsed
Aggregate scale: P2O retained by crop in kg per ha and region	kg/ha	Not endorsed
Aggregate scale: K2O at tail applied in kg per ha and region	kg/ha	Not endorsed
Aggregate scale: K2O from mineral fertilizer in kg per ha and region	kg/ha	Endorsed
Aggregate scale: K2O from crop residues in kg per ha and region	kg/ha	Not endorsed
Aggregate scale: Subsidies received per ha and region	Euro/ha	Endorsed
Aggregate scale: Subsidies received per annual woprk unit and region	Euro/AWU	Endorsed
Aggregate scale: Ammonium losses per ha	kg/ha	Endorsed
Aggregate scale: Ammonium losses from mineral fertiliser application	kg/ha	Not endorsed
Aggregate scale: Ammonium losses from manure application	kg/ha	Not endorsed
Aggregate scale: Share of Animal output in total output value	none	Endorsed
Aggregate scale: Value of Animal production per region and hectare	Euro/ha	Endorsed
Aggregate scale: Value of Cattle production per region and hectare	Euro/ha	Not endorsed
Aggregate scale: Value of Cereal production per region and hectare	Euro/ha	Not endorsed
Aggregate scale: CH4 emissions	kg/ha	Endorsed
Aggregate scale: Value of Crop production per region and hectare	Euro/ha	Endorsed
Aggregate scale: Family labor use	Annual Working Units	Not endorsed
Aggregate scale: Global warming potential of all emissions	kg/ha	Endorsed
Aggregate scale: Total agricultural Input value per region and hectare	Euro/ha	Endorsed
Aggregate scale: Regional income per total labor input	Euro/AWU	Endorsed
Aggregate scale: Land value	Euro	Endorsed
Aggregate scale: Energy use by mineral fertiliser	MOE	Endorsed
Aggregate scale: Measurement to assess consumers welfare	Mn Euro	Endorsed
Aggregate scale: N2O emissions	kg/ha	Endorsed
Aggregate scale: Total surplus in Nitrate application	kg/ha	Endorsed
Aggregate scale: Value of other than cattle animal production per region and hectare	Euro/ha	Not endorsed
Aggregate scale: Value of Oilseed production per region and hectare	Euro/ha	Not endorsed
Aggregate scale: Total agricultural output value per region and hectare	Euro/ha	Endorsed
Aggregate scale: Total agricultural output value per region and hectare net of subsidies	Euro/ha	Not endorsed
Aggregate scale: Total surplus in Phosphate application	kg/ha	Endorsed
Aggregate scale: Total surplus in Potassium application	kg/ha	Not endorsed
Aggregate scale: Income from applying Tariffs on imported goods	Mn Euro	Endorsed
Aggregate scale: Terms of Trade	none	Endorsed
Aggregate scale: Total income in Agriculture (without second pillar income) = Output + premiums - input	Mn Euro	Endorsed
Aggregate scale: Total value of all inputs but labour for producing agricultural primary products	Mn Euro	Endorsed
Aggregate scale: Total value of all primary agricultural products produced^	Mn Euro	Endorsed
Aggregate scale: All outlays of the first pillar of the EU budget. This pillar finances CAP premiums Subsidised exports and intervention costs	Mn Euro	Endorsed
Aggregate scale: Expenditures for intervention within the CAP regulations. (no second pillar payments)	Mn Euro	Endorsed
Aggregate scale: Total labor use	Annual Working Units	Not endorsed
Aggregate scale: Subsidies paid direct to farmers within the CAP regulations. (no second pillar payments)	Mn Euro	Endorsed
Aggregate scale: Total profit of processing industry	Mn Euro	Endorsed
Aggregate scale: Expenditures for subsidised exports within the CAP regulations. (no second pillar payments)	Mn Euro	Endorsed
Aggregate scale: Welfare in the EU Agricultural sector = Benefit of all actors in the agricultural sector.	Mn Euro	Endorsed

Source: SEAMLESS-IF. Variables stored in the SEAMLESS DB table indicatorvaluecountryaggregate (see also (Adenäuer et al., 2009). When a comment "not endorsed" is displayed, the indicator is considered intermediate in the SEAMLESS project and is thus not stored in the SEAMLESS database. It is however stored in the file "All_results.gdx".