EU FP6 Programme

TOWARDS A POLICY MODEL OF MULTIFUNCTIONAL AGRICULTURE AND RURAL DEVELOPMENT (TOP-MARD)

CONTRACT NO. 501749

PROJECT DURATION: MARCH 1ST 2005 – MAY 31ST 2008

SPECIFIC TARGETED RESEARCH PROJECT

PRIORITY 8.1 – POLICY-ORIENTED RESEARCH

LEAD CONTRACTOR: UHI MILLENNIUM INSTITUTE

SUBMISSION DATE: JUNE 2008

(Deliverable Number: 15/ WP Number 1)

PUBLISHABLE FINAL ACTIVITY REPORT

Project Partners

University of Highlands and Islands, Scotland, UK	*Agricultural University of Athens, Greece*
Institute for Rural Development Research at Goethe University Frankfurt, Germany	*Federal Institute for Less Favoured and Mountainous Areas, Austria*
Universitat Autònoma de Barcelona, Spain	*Rural Economy Research Centre, Teagasc, Ireland*
Department of Public Economics, University of Rome, La Sapienza, Italy	*Nordic Centre for Spatial Development, Sweden*
Norwegian Agricultural Economics Research Institute, Norway	*Biotechnical Faculty of the University of Ljubljana, Slovenia*
Corvinus University of Budapest, Hungary	*University of Aberdeen, Scotland, UK*

TOWARDS A POLICY MODEL OF MULTIFUNCTIONAL AGRICULTURE AND RURAL DEVELOPMENT (TOP-MARD)

ΠΟΛΥΛΕΙΤΟΥΡΓΙΚΗ ΓΕΩΡΓΙΑ ΚΑΙ ΑΓΡΟΤΙΚΗ ΑΝΑΠΤΥΞΗ

ENTWICKLUNG EINES ANALYSEANSATZES UND POLITIK-MODELLS ZUR MULTIFUNKTIONALITÄT DER LANDWIRTSCHAFT UND DES LÄNDLICHEN RAUMES

HACIA UN MODELO DE POLÍTICA PARA LA AGRICULTURA MULTIFUNCIONAL Y EL DESARROLLO RURAL

I DTREO MÚNLA POLASAÍ I DTACA LE TALMHAÍOCHT ILFHEIDHMEACH AGUS LE FORBAIRT TUAITHE

VERSO UN MODELLO DI POLITICHE PER L'AGRICOLTURA MULTIFUNZIONALE E LO SVILUPPO RURALE

EN POLICYMODELL FÖR MULTIFUNKTIONELLT JORDBRUK OCH LANDSBYGDSUTVECKLING

UTVIKLING AV POLITIKKMODELL FOR MULTIFUNKJONELT LANDBRUK OG BYGDEUTVIKLING

RAZVOJ MODELA ZA OCENO POLITIK VEČNAMENSKEGA KMETIJSTVA IN RAZVOJA PODEŽELJA

A TÖBBCÉLÚ MEZŐGAZDASÁG ÉS VIDÉKFEJLESZTÉS POLITIKAI RENDSZERÉHEZ

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	√

PUBLISHABLE FINAL ACTIVITY REPORT INDEX

1. PROJECT EXECUTION

1.1 Summary Description of the project objectives

The objectives of the research are:

To identify the multiple functions of agriculture in a broadly representative range of European rural contexts and relate these to farm type, scale, household characteristics, farming style and contextual conditions (geography, governance, national and regional policies, markets, land tenure);

To evaluate and where possible measure the precise relationships involved between production and utilisation of private and public goods in the various farming types, scales and styles identified under different household and contextual conditions. In particular, we will focus on measuring the nature and degree of *co-production* ('jointness' or 'competition') between private and public goods at both the input and output ends of the production processes under different conditions.

To evaluate and where possible measure the nature and degree of inter-relationships between private and public goods used or produced by different types of farms and farm household, under different styles of farming and local context and the development of the rural economy and its quality of life;

To analyse the factors influencing or determining the nature and level of different kinds of market and non-market relationships in the production process, as well as their inter-relationships with the local economy and quality of life, in particular the influence of a range of different EU, national and regional policies;

To use the data generated to elaborate a systematic and dynamic computer-based model of the relationships involved, utilising the STELLA software, and showing explicitly how the model can be adapted to suit different farm and household types, styles of farming, and rural contexts;

Hence to provide a tool for policy makers that is a targeted policy model of multifunctional agriculture and rural development (POMMARD) which is sensitive to regional and rural conditions in Europe.

To demonstrate how this *targeted policy model* can assist in evaluating the impacts of policy changes on both agriculture and regional development in different European contexts, and be utilised in 'modulating' policy payments (such as agri-environmental payments under the RDR or direct payments) and varying the menu of rural development measures to reflect different farm functions and rural conditions.

1.2 Contractors involved

Partner No 1: Coordinator
University of the Highlands and Islands, UHI PolicyWeb, UHI Millennium Institute,
UHI Policy Web, Great Glen House, Leachkin Road IV3 8NW, Inverness, Scotland.

Partner No 2:
Agricultural University of Athens,
Iera Odos 75, 11855, Athens, Greece.

Partner No 3:
Institute for Rural Development Research (IfLS) at Goethe University,
Zeppelinallee 31, 60325, Frankfurt, Germany.

Partner No 4:
Federal Institute for Less-Favoured and Mountainous Areas,
Marxergasse 2, 1040, Wien, Austria.

Partner No 5:
Autonomous University of Barcelona, Fundació Empresa i Ciència (FEC),
Edifici Rectorat, Campus Bellaterra, 08193 Bellaterra, Barcelona, Spain.

Partner No 6:
The National Agriculture and Food Development Authority, Rural Economy Research Centre, Teagasc,
Head Office, Oak Park Carlow, Co. Carlow, Ireland.

Partner No 7:
Università degli Studi di Roma, La Sapienza, Dipartimento di Economia Pubblica,
Via del Castro Laurenziano 9, 00162, Roma, Italy.

Partner No 8:
The Nordic Centre for Spatial Development,
Holmamiralens vag 10, Box 1658, 11186 Stockholm, Sweden.

Partner No 9:
Norwegian Agricultural Economics Research Institute (NILF),
Schweigaards gate 33B, Postboks 8024, 0030 Oslo, Norway.

Partner No 10:
Biotechnical Faculty of the University of Ljubljana,
Agricultural Economics, Policy and Law, Groblje 3, SI-1230 Domzale, Slovenia.

Partner No 11:
Corvinus University of Budapest, Department of Agricultural Economics and Rural Development,
Fovam ter 8, H-1093, Budapest, Hungary.

Partner No 12:
University of Aberdeen
Kings College, AB24 3FX, Aberdeen, Scotland.

1.3 Work performed

Specifically by reporting period, the work performed by phase and by workpackage has been the following:

1st Reporting period

Phase 1:

An initial meeting for the PGA (Project General Assembly, the MMPC (Methodology and Modelling sub-Project Committee) and the PSPC (Policy Scenario Sub-Project Committee) took place in Brussels, May 2005 (Milestone 4, M4).

The Research Staff have been appointed by the project partners (M3).

Specifically by workpackages,

- Workpackage 1:
  - Deliverable 4 (D4): First Period Report.
- Workpackage 2:
  - D1: Cooperation Agreement signed
  - D2: Administrative and Financial Report formats and monitoring indicators. Agreement on the use of common formats, as well as on typographical conventions and publications acknowledgement.

Phase 2:

A second meeting took place in Barcelona, November 2005. The groups involved in this meeting were the PGA and the MMPC (M7).

- Workpackage 3: As input for D5 (Report on desk research and preliminary information gathering), due in May 2006, Case Study Area Descriptions are being prepared as well as a literature and data search focused on the diverse aspects of multifunctionality relevant for each country. Common structure and contents for this report were decided upon the Barcelona meeting and subsequent contacts between partners.
  In addition, potential members of National User Groups (NUG) are being identified and contacted; in some countries the meetings have already started.

Phase 4:

- Workpackage 5: Work has commenced on the development of a model using the STELLA software. A preliminary version of the model was presented at the Barcelona meeting, and the mapping of the STELLA model was agreed. A blog has been set facilitating communication and exchange of models and ideas between the researchers involved in the development of the model **http://topmard.blogspot.com**
  In order to improve researchers' training on the use of the software and to complete the first mapping of the policy model (D3), an additional meeting of the MMPC was arranged in Frankfurt, March 2006.

2nd Reporting period

Phase 2:

This phase ended in Month 14. It comprises two Workpackages, the ongoing WP1 and WP3, which also ended on Month 14.

Specifically by workpackages,

- Workpackage 1:
    - Deliverable 7 (D7): Second Period Report.
- Workpackage 3:
    - Deliverable 5 (D5: Report on Desk Research and Preliminary Information Gathering) was due in Month 14th, May 2006, and is to be submitted with the present Period Report.

Phase 3:

A meeting took place in Gorenjska, Slovenia, 8-10 June 2006 (Milestone 10). It was a meeting for the PGA (Project General Assembly), the PSPC (Policy Scenario Sub-Project Committee) and the I&DPC (Implementation and Dissemination Sub-Project Committee).

- Workpackage 4: extensive work on field work questionnaire preparation has been carried out in an iterative way. Questionnaires have been designed in order to carry out interviews to 30 random farms and 10 more carefully chosen to ensure that the key types of MFA in each study area are adequately represented, especially those with innovative features, for instance "joining up" various market and non-market functions, and farming functions with local development and quality of life. As regards the rural business survey, the proposal is 20 interviews with small enterprises, deliberately selected to cover the various types of enterprise and sector that 'transform' non commodity as well as commodity outputs of farm households into market outputs such as recreation, tourism, high quality food, etc. An additional questionnaire on Quality of Life has been prepared and will be administered to the general population of the study area, mainly through three focus groups: school leavers, young mothers, and the elderly. Finally a subsequent survey of about ten key actors will be undertaken after the main results of the first three surveys have been analysed. The results obtained after these interviews will be included in D8 (Phase 3 Report on Primary Data Collection), due in Month 26.
- Meetings of National User Groups (NUGs) are taking place and reports are being prepared, in order to be included in D8.
- In addition, a small and initially unplanned meeting was held in Frankfurt, March 2006, in order to integrate the basic needs of the survey process and to analyse the modelling process needed. The needs on indicators and their purpose were discussed.

Phase 4:

Meeting in Athens and Germany.

- Workpackage 5: A meeting took place in Athens (Greece), in December 06. This meeting, which was not initially planned, was aimed at the further elaboration of the model components and elements, the assessment of data requirements, the specification of further outputs indicators and the building of relationships among sub-systems in the STELLA environment.

3rd reporting period

Although this period mainly covers Phase 5 (Implementation, dissemination, final reporting and the Brussels conference) and its associated Workpackage 7, Phases 3 and 4 were also completed in this period due to earlier delays in the project. These delays also meant an extension of three months to the length of the project – to 39 months in all.

Meetings of the PGA, PSPC, EAPC, MMPC and the Modelling Group were held in
Latina (April 07)
Norway (September 07)
Hungary (February 08)

Brussels (May 09)

In addition the Modelling Group held a special, unplanned, meeting in June 2007 to finalise the work on the Core Model.

Phase 3:
The implementation of the three questionnaire surveys (Farmers, Entrepreneurs, Quality of Life) in all the study areas was completed in the first part of the period, and the first results of analysis were reported in Norway. The interviews with Key Contacts were held back until the autumn in order to allow these to be used to fill gaps for the final stages of the POMMARD model adaptation. These did not require a common questionnaire as the gaps were particular to each study area.

Phase 4:
The integration of the results of Phases 2 and 3 into the POMMARD model, and its adaptation into each study area was started and completed in this period. The analysis of the Quality of Life Surveys was particularly important for one of the key innovative elements of the model, namely linking non-commodities as well as commodity production to quality of life and tourism attractiveness, and thence to migration flows (outward and inward), demographics, and human resources. This econometric analysis was undertaken in June-July 2007, and allowed calculation of the coefficients for the relationship between propensities of different age and education groups to (in- or out-) migrate and the different 'capitals' of quality of life.

In addition, the work on preparing, updating, or adapting Input-Ouput or SAM tables for each study area proved to be very intensive and demanding in this period. This was a further key input for the adapted POMMARD models in each study area.

Finally, the work on the Policy Scenarios was completed and teams established the distribution of key policy payments (CAP Pillar 1, and Axes 1-4, as well as Regional Funding) in each study area for the baseline analysis. The ways in which each scenario impacted on the variables in the POMMARD model was also discussed and agreed. Further, the impact of different policy changes on land use, production systems and financial flows to the study area economy were assessed and integrated with the model. This used a mixture of Key Contact survey information, CGE modelling (CAPRI), and similar approaches.

Phase 5:
The implantation was started an completed. All of the adapted policy models were built, and they were each used to assess the impact of the changes implied by each policy scenario. A set of economic, social, agricultural, and environmental outcomes had been defined, and the model produced such a set of outcomes. These out comes could be compared between the 11 different study areas.

This was also a period of intensive dissemination, with numerous presentations by team members to international and national as well as regional and local workshops, seminars, conferences and meetings (see D12). In addition, meetings were held with the National User Groups in each country to debate thwe results and conclusions. Finally, a very successful final conference was held at the Borchette Conference Centre of the European Commission, with presence from Brussels, National and Regional policy makers; from national User Groups, from international NGOs and lobby groups, from academic colleagues, and from OECD. During this conference a Policy Panel made useful suggestions for analysis using two further

Scenarios, related to the current Health Check debates. These two additional scenarios were assessed by 9 countries

Throughout the period, the Core Model was refined on several occasions, and the Adapted models used in each study area also went through numerous incremental changes as they were tested with real data.

1.4 End results

The end results of the TOP-MARD project are contained in the attached **Final Scientific Report**. This includes background material on the aims, objectives, scientific approach, and study areas. It also includes a description of the policy scenarios used in the project, and applied to the POMMARD model. One of the main results was the creation of the POMMARD model – a Policy Model of Multifunctional Agriculture and Rural Development – built using the STELLA™ Systems Modelling Software, and adapted to the 11 study areas. The POMMARD model is described in detail, and the accompanying operating manual is included as an appendix. The report further includes an analysis of the survey results and a comparative analysis of the results of the policy scenarios using the adapted POMMARD models. It concludes with chapters on the implications for policy and research.

1.5 Project logo

TOP MARD

1.6 Reference to website

http://www.topmard/.org

As mentioned above, a blog has also been set up facilitating communication and exchange of models and ideas between the researchers involved in the development of the model.
http://topmard.blogspot.com

2. DISSEMINATION PLANS AND ACTIVITIES

In the early stages of the TOP-MARD project the main activities focused on developing a series of common and agreed reporting conventions. Subsequently, a series of dissemination channels were identified and encouraged.

2.1 Reporting conventions

A copy of the comprehensive set of agreed typographical conventions for TOP-MARD reports and other working documents is presented in Annex A.

The objectives in preparing these agreed reporting conventions were to:

- develop and facilitate communications between partners in the preparation of reports and publications
- provide a coherent image for the TOP-MARD project
- assist in developing and raising a coherent external profile of the overall project.

The main elements of the conventions were:

- Typographical Conventions - for practice amongst the partners when writing, compiling and editing Deliverables within the project
- Publication Acknowledgement – wording agreed within the partnership. On completion of an output, and on submission to a publication, included the acknowledgement
- Standard presentation formats - compiled for use by partners in the event of a presentation of project information
- A standard report cover - developed, including the project title listed in each partner's national language. On completion of each output per partner, the cover was included prior to distribution.

2.2 Dissemination channels

In the early stages of the project the main dissemination and communications activities were:

- Website – content was developed, with public and members' sections included. Main outputs per partner were included for access by public users. Address is **www.topmard.org**.
- An overview of the project and its main objectives and deliverables was compiled for circulation in general public fora and for use in general publicity activities. This served as a simple delivery of the project's main points
- Notifications of dissemination events such as conferences, seminars and workshops were circulated around the project team, including main deadlines and guidance on submission of papers, posters, etc.

Cooperation activities between individual partners were encouraged, and further dissemination channels were identified as the project progressed and potential outputs and results could be more easily identified. The aim was to provide scope for:

- cooperation in dissemination activities between both partners and individual researchers across the project where either English or an alternative common language could be used
- individual partners to prepare and publish reports using their native language, using local conventions for domestic audiences.

In addition to availing themselves of the notification of intentions to publish service provided by Teagasc, project members were encouraged to use the project web site to make available copies of conference papers and Powerpoint presentations and examples of the STELLA model.

Team members were encouraged to:

- communicate with **Stakeholders** other organisations and groups (farmers, economic agents…) and avail themselves of an opportunities for local presentations, etc and obtain feedback

- Avail themselves of **Local publications** to disseminate information about the project

- Avail themselves of formal publication channels **within partners/national institutions for scientific/technical** non-peer-reviewed articles and press releases

- Prepare and publish **National reports** on:
    - the TOP-MARD surveys and their findings
    - National Model outputs and Policy recommendations

- Prepare and publish papers at **International conferences** (for example EAAE, IRSA, EAAP, International Rural Network, European Society of Rural Sociology, European Society of Ecological Economics, International Grassland Association etc,)

- Arrange a special TOP-MARD **special session or panel at an international conference.** For example**, a** special TOP-MARD session attached to the EAAE Seminar in Viterbo, Italy, 20-21 November 2008 is in preparation.

- Arrange a special presentation of **the POMMARD model** and preliminary results at the annual meeting of the Rural Policy Committee of the Territorial Development Policy Committee of the OECD Paris in December 2007 (Bryden, Johnson and Dax).

- Arrange for a **Special issue of an international journal,** perhaps *European Review of Agricultural Economic*s, or the *Journal of Rural Studies* based on that special session

- Arrange for the **publication of a book** on the project as well as chapters in a relevant book. At least one book chapter has already been published, and a whole volume is being discussed with a well-known publisher at the time of reporting.

- Engage in joint exchanges (conferences, seminars) with the FP6 MEA-Scope project, FARO, and other FP6 and FP7 projects, as well as specific contracts (IPTS and DG-Agri),

- Prepare for the possibility or and avail themselves of **future Invitations of participation in other framework projects (FP6 and FP7)**

A compilation of the details of the dissemination outputs to date notified to Teagasc from the TOP-MARD project is presented in Annex B below. These are categorised under the following headings:

- Book chapters
- Peer reviewed articles
- Conference presentations
- Other miscellaneous dissemination activities
- Popular press
- Workshops.

ANNEX A: TYPOGRAPHICAL CONVENTIONS FOR TOP-MARD REPORTS AND OTHER WORKING DOCUMENTS

Typographical Conventions for TOP-MARD Reports and Other Working Documents

Joanne Brannigan, TEAGASC
With assistance from
Ken Thomson, University of Aberdeen

May 2006

This paper sets out a number of typographical conventions which, in order to reduce subsequent editing and to produce a reasonably consistent project style, should be followed by all TOP-MARD researchers when writing project papers (in English), except for external "dissemination" articles for journals etc., which may have their own editorial style. This is particularly important when authors are providing contributions to a single TOP-MARD "deliverable" document: working documents are not so vital.

These conventions have been drawn up after consultation within TOP-MARD, but use is bound to result in various queries and suggestions: these should be sent to either of the above authors, who will circulate an amended set of conventions as and when appropriate.

When the structure of a TOP-MARD report is decided upon within each WP, a Word template will be set up for individual reports by the appropriate Lead Partner, and circulated to all relevant partners. This template should incorporate the relevant specifications below.

1. Margins

- top 2cm, bottom 2cm, left 2.5cm, right 2.5cm

2. Standard Cover

The standard cover runs over two pages (page one is with logos and page two is listing partners). Use the previously distributed cover template with project title in partners' languages and project logo, which includes (see template):

- Authorship – Institution and Personnel
- Acknowledgement of TOP-MARD partnership
- Date
- Report number and Title and Number of Workpackage
- Contract number
- Use Times New Roman, font size 12

3. Other introductory pages

- Contents with page numbers (use automatic Table of Contents)
- Times New Roman, font size 12
- Separate lists for chapters/sections, figures, tables and (if necessary) appendices
- Page numbering in Times New Roman, font size 11, and positioned at bottom centre. Pages from start of Chapter 1 should be numbered 1, 2, 3, …; those previously i, ii. iii, …, starting with cover page as i (though printing from ii, …)

4. Abstract

- Report title, date, etc. at top (in brief) so that abstract page contains all necessary detail
- Heading of 'Abstract' to be shown, centred at top
- Times New Roman, font size 12
- Abstract(s) in Partner language and additional English version where needed

5. Chapters and Sections

- A report should be divided into chapters comprising sections and sub-sections. For example, Chapter 1
  1.1 Introduction (specific to the WP)
  1.2 Section Heading
  1.2.1 Sub-section Heading
- Item 7 below contains font guidelines for these various types of heading
- The list of references and any Appendix ("chapter") (see 10. and 11. below, respectively) should not be numbered.

6. Main text

- Times New Roman – font size 12
- Single spacing
- One line space between paragraphs
- No indenting of first line
- Left-and right- justified (i.e. blocked)
- Two spaces between end of one sentence and beginning of new one

7. Headings

If not at top of page, all headings should be preceded by two blank lines, and followed by one blank line before start of main text or e.g. subsection title.

Chapter headings

- Chapter number (in standard numbers, i.e. 1, 2, 3, …, not e.g. I, II, III, …)
- Title (on same line)
- Tab space between chapter number and title
- Bold and capitals
- Times New Roman - font size 14
- Left- justified
- Not underlined
- One line space between chapter title and main text in paragraph

Example of Chapter heading: **1. INTRODUCTION**

Section headings

- Bold lower case, except for main leading capitals
- Tab space between section number and title
- Times New Roman - font size 12
- Left-justified
- Not underlined
- One line space between section heading and main text in paragraph

Example of Section heading: **1.1 Demographic Characteristics and Trends**

Sub-section headings

- Bold lower case (except for main leading capitals)
- Italics
- Tab space between sub-section number and title
- Times New Roman - font size 12
- Left-justified
- Not underlined
- One line space between sub-section heading and main text in paragraph

Example of Sub-section heading: ***1.1.1 Population Patterns and Trends***

8. Figures and Tables

- "Figures" include charts, diagrams, boxes, etc.
- Place titles above the figure or table
- Number in sequence within a chapter, e.g. Figure 2.1, Figure 2.2, etc. in Chapter 2
- Same for table numbers, Table 2.1, Table 2.2, etc.
- Give percentages in text as "35 per cent" (with a space), and in figures, tables, etc. as "35%" (no space)
- Ensure that units (e.g. ha, million €, etc.) are given for both axes in figures, and for each row (or column) in tables
- Use tab space between table/figure number and title
- Titles of figures and tables in Times New Roman, font size 12, bold, with main leading capitals
- In main text, use leading capital to refer to e.g. Table 2.4, Figure 4.5

9. Numbers

- Within text, use 'million', 'thousand', 'billion'. If a shortened form is to be used after a numerical value, use 'mn', 'th', 'bn'
- Use decimal points (not commas) to separate integer and fractional parts, e.g. 123.45. A separator comma should be used when writing numerical values of one thousand or more (for example, 1,500)
- Use the € sign (not "Euro"), and insert before the numerical amount, e.g. €1.23
- Give percentages in text as "35 per cent" (with a space), and in figures, tables, etc. as "35%" (no space)
- Ensure that units (e.g. ha, million €, etc.) are given for both axes in figures, and for each row (or column) in tables

10. References

- **Cite and report references according to the Harvard System, i.e. name(s) of author(s) or source, and date, given in the text (e.g. "Smith (2000)")**
- **References should be collected alphabetically at the end of the report, where the title of the journal or source (i.e. the title of the item to be sought in a library, not necessarily the title of a specific paper) should be quoted in full, and in *italics*.**
- **When referencing documents from the European Commission, show source as 'European Commission'**
- **Use hanging indented (Ctrl-T) in reference listing**
- **Left- and right-justified (i.e. blocked)**
- **Date all references and material correctly**
- **Note in reference listing:**
    - **no comma (,) or period (.) after date e.g. "(1995)"**

- **no "Vol." (or use of bold for volume number) or "pp"**
- **no quotation marks (") around title of paper etc.**
- **no first name(s) of author(s), only initial(s)**

Examples of reference using the Harvard system:

Council Regulation (EC) No. 1260/1999 *Laying down general provisions on the Structural Funds*. Official Journal of the European Communities L 161/1, 26.6.1999

European Commission: **http://europa.eu.int/comm/regional_policy/index_en.htm** and **http://europa.eu.int/comm/financial_perspective/index_en.htm**

EU (1999) European Spatial Planning Perspective (ESDP), Part A: Achieving the Balanced and Sustainable Development of the Territory of the EU: The Contribution of the Spatial Development Policy. (download: **http://europa.eu.int/comm/regional_policy/sources/docoffic/offical/reports/pdf/a13-19_en.pdf**) (14.10.05)

Hanley, N. D. (1995) *Rural Amenities and Rural Development: Empirical Evidence. Synthesis Report to the Rural Development Programme*, OECD, Paris.

http://espon.lu/online/documentation/objective/objectives/index.htm

http://europa.eu.int/comm/regional_policy/interreg3

Moussis, N. (1997) *Handbook of European Union.* European Study Service, Rixensart, 97-114

Oglethorpe, D. R. and Sanderson, R. A. (1999) An ecological-economic model for agri-environmental policy analysis. *Ecological Economics*, 28, 245-266.

Proposal for a Council Regulation laying down general provisions on the European Regional Development Fund, the European Social Fund and the Cohesion Fund. COM(2004)492 Final

Randall, A. (2002) Valuing the outputs of multifunctional agriculture. *European Review of Agricultural Economics*, 29(3), 289-307.

11. Appendices

- **To be used only where this aids the readability of the report**
- **Number appendices in sequence (Appendix 1, 2, etc.), referenced in the text where appropriate, and list in the contents page**

12. Miscellaneous

- Page breaks to be used at the start of each chapter
- Use footnotes (not endnotes or comments) where applicable to text, tables, etc.
- Use colour where necessary, but remember that reports are usually copied in black and white
- Do not use automatic headers and footers (other than footer including the page number) as this can be difficult to transfer to other documents

- Spelling can be either UK or USA (for example, ‘centre’ or ‘center’); whichever form is used, please ensure it remains constant throughout the document
- Use “e.g.”, “i.e.”, not “eg”, “ie”
- Note correct forms of “et al.” and “et seq.”
- Use “op. cit.” with care; it is sometimes hard to find the original reference

ANNEX B: FINAL SCIENTIFIC REPORT

1. EXECUTIVE SUMMARY

By John Bryden

This document comprises the final scientific report on the TOP-MARD project. In it we describe the aims, objectives, methodology and scientific and policy background to the research. We also describe the diverse study areas in the 11 countries involved in the research (Chapter 4). Further we introduce and outline the main deliverable, namely the Policy Model of Multifunctional Agriculture and Rural Development (POMMARD), and provide a detailed users manual explaining how this model can be adapted to different regions. Then we outline the different policy scenarios used with the POMMARD model, and report on the results from the analysis of the dynamic economic, social and environmental outcomes over the medium term. We report on the supplementary surveys of farmers, enterprises and citizens undertaken to provide data for the modelling work and assist with interpretation. Finally, we conclude with policy conclusions and implications for further research.

The main aim of TOP-MARD was to develop a new type of model, using system dynamics, which would encompass the complex inter-relationships between the different public and private 'functions' of farming and farm households, territorial economic development and quality of life, and public policies. System dynamics was appropriate in this case because of our interest in the interaction and feed back effects among economic, social, ecological and environmental systems. System dynamics also lends itself to cases where situations, not previously experiences, are of interest. Multifunctionality is just such a case.

We also aimed to review relevant data and research, and undertake three surveys. The latter were deemed necessary to provide essential background information on the functions of agriculture in different rural regions, on how other enterprises in the regional economy used or benefited from these functions, and to draw upon the available local and national expertise on multifunctionality, rural development and policy impacts. We later decided to add a quality of life survey in order to better understand the inter-relationships between agricultural functions, quality of life of local residents, and migration behaviour. Three types of questionnaire-based surveys were carried out, one on farmers one on rural enterprises considered to be linked with the functions of agriculture in some way, and one with rural residents. In addition, oracle type interviews were undertaken with key contacts and experts to assist with adaptation of the model, policy scenario impacts, and interpretation of results. The results of the surveys are discussed in Chapter 5.

National user groups (NUGs) were established by each country team from the start of the project. These groups formed a very important part of the research, providing advice, contacts, and feedback at every stage, and also playing a key role in discussing, legitimating, and disseminating results.

The policy model, POMMARD, is built of 10 modules: Initial Conditions, Policy Controls, Indicators, Land, Non-Commodities, Agriculture, Quality of Life, Human Resources, Regional Economy, and Tourism. After building the core or generic version, the model was adapted to all 11 study regions. POMMARD is an application of system dynamics, and it is discussed in Chapter 6 and the Appendix which provides the very detailed user-manual..

Policy controls define the impact of existing (baseline) and potential (scenarios) policies on the other elements of the system, especially land use and production systems, and monetary flows into the region. Changes in land use and production systems represent a key driver in our case, because of the interest in agricultural multifunctionality. These changes alter the production of private (commodity) outputs as well as public goods and 'bads' (non-commodities). The changes in commodity production, as well as any changes in financial flows, then impact on the material elements of the regional economy and quality of life through a regional social accounting matrix. The changes in non-commodities (public goods and bads) impact indirectly through changes in 'natural capital', which changes (positively or negatively) regional attractiveness for tourism as well as the quality of life of regional citizens. The changes in regional economy, tourism and quality of life in turn alter decisions of different age and gender cohorts to migrate from or into the region. This migration is cause both by changing labour demand and supply, and by changing quality of life which attracts (or repels) supply-driven migration. The demographic module collects all of this information and predicts population by age cohort and educational category. The ultimate impacts of any policy change are thus traced through to a set of outcome indicators reflecting changes in economic variables (e.g. regional income and employment), quality of life variables (e.g. material and natural capital), agricultural variables (e.g. commodity production, farm incomes and employment), and environmental variables (eg nitrogen balances, Shannon index of land cover diversity).

The POMMARD model can also handle other drivers of change. In our case we examined the consequences of an increase in external tourism demand, and of an increase in energy prices. But the model can be stimulated from a wide range of variables, and consequences of any change or set of changes traced through to a set of outcome indicators dealing with the regional economy, regional quality of life, regional population and migration, regional environment, and specific sectors such as, in this case, agriculture and tourism.

We argue that the results of this model (see Chapter 8) are very interesting for policy makers, as they cover the 'new' concerns of quality of life, territorial rural development, and the natural environment in an integrated and inter-connected way. For example, we can see that in some study regions, a cut in direct payments (Pillar 1) to farmers, while generally resulting in reduced farm incomes and employment, can actually increase the income and employment of rural regions. This unexpected result, which is not uniform across study areas but limited to those with high growth and tight employment markets, is due to the consequential shift of relatively low productivity farm labour (and labour-time) from agriculture and into much higher productivity and wage employment within the rural region. If we then 'modulate' the cut in direct payments by allocating it to Pillar 2, we see that farmers incomes are more or less maintained, but the benefits to the region are reduced, because less labour transfers from agriculture to higher wage and productivity sectors. We can also observe different outcomes between high and low farming-intensity regions. For example, different policy scenarios produce very different changes in production of commodities in the more, and less, intensive regions. It seems evident from the results that the less intensive regions are an important 'buffer' for production in times of changing food and energy prices. As food or energy prices rise, there seems to be more scope to increase production in less intensive regions without consequential environmental damage.

Among the policy conclusions (Chapter 9), we would stress in particular the growing need to examine policy impacts in particular rural contexts. This need is growing precisely because the new policy concerns – local or territorial development, quality of life, and environment – are rooted in particular contexts in terms of their state, the social and public institutions influencing them, the operation of related markets such as land and labour, and their geography and natural conditions, all of which influence their assets, opportunities and constraints. The consequences of this also relate to the construction of policies and their implementation – further decentralisation, delegation and subsidiarity is what is needed as we switch from sectoral to more holistic policies needed to produce sustainable development in rural areas. This is not to argue that agriculture should be marginalised or neglected, rather that agriculture, and the policies addressing the issues around it, needs to be viewed as part of specific regional contexts or territories, rather than *vice-versa*.

Looking at the outcomes generated by the analysis of the different scenarios using the adapted POMMARD models, some of the difficulties in making clear general recommendations relevant to the 'Health Check' and applicable across different countries and types of region are demonstrated in the following summary table, which simply looks at the number of study areas in TOP-MARD having a negative evolution of any particular outcome indicator over the period 2007-2025.

Table 1.1 Proportion of Study Areas with negative change in selected outcome indicators between 2007 and 2025 under different policy scenarios

Scenario:-	A1*	A2*	B*	C*	D*	E*	F*	Z*
Population change	27%	30%	18%	27%	18%	18%	18%	20%
Net Migration rate	73%	80%	55%	73%	82%	73%	82%	80%
Regional Per Capita Income	45%	40%	36%	27%	36%	45%	36%	40%
Non-agricultural employment	18%	20%	9%	18%	9%	18%	9%	20%
Utilised Agricultural Area	55%	40%	45%	45%	45%	55%	55%	40%
Gross Value of Agriculture	45%	40%	55%	45%	55%	45%	55%	50%
Agricultural employment	60%	55%	50%	60%	50%	50%	60%	55%
Mineral Fertiliser per UAA**	36%	20%	36%	45%	27%	45%	27%	20%
Excess Nitrogen**	62%	57%	62%	62%	62%	62%	62%	62%

Note * The different scenarios (Chapter 7) are summarised here as:-

A1: 50% cut in Pillar 1 payments
A2: 50% cut in Pillar 1, with 'modulation' of proceeds to Pillar 2
B: All Pillar 2 reallocated to Axis 2 (agri-environment)
C: All Pillar 2 reallocated to Axis 3 (rural development)
D: 50% increase in Regional Funding
E: 100% increase in Energy prices
F: Doubling of tourism demand by 2013
Z: All Pillar 2 funding to Axis 1.

Note ** a negative evolution would indicate an improvement for the environment

On this very simple summary analysis we reach different conclusions about the optimal policy reform to recommend according to which indicator or set of indicators we choose to prioritise. The analysis in Chapter 8 also shows that the conclusions would vary according to which kind of region we might prioritise, an important cohesion issue. The analysis also shows that agriculture, and agricultural policy changes, are often not the most significant drivers of territorial development in rural regions – there are usually other reasons why regional income, employment and population indicators remain positive despite apparently negative impacts of change on agriculture.

The final scientific report is designed to be a ‘stand-alone’ public-domain document which allows people to understand what we have done and why, the construction of the model and its parameters, variables and relationships, the policy and other scenarios we examined using the model, and the results and conclusions we drew from that and related research, including surveys. It would, however, be impossible to include everything between two covers. Other detailed deliverables, some in the public domain on our website, others with the European Commission, complement and provide further detail where this is needed.

2. AIMS, OBJECTIVES AND SCIENTIFIC AND POLICY BACKGROUND

By John Bryden, Karlheinz Knickel and Amaia Arandia

2.1 Aims and Objectives

The *main aim* of the research was to develop the concept of multifunctionality as a rural development policy instrument that is sensitive to economic, social, cultural, environmental and geographical context by analysing:

1. The multiple functions of different types and scales of agriculture, and styles of farming, in different kinds of rural context, in particular non-market functions such as positive or negative contributions to landscapes, biodiversity, water and air quality, food safety, social capital, and the development of rural areas, as well as market functions such as the production of food and raw materials or the supply of farm household labour, capital or other farm resources (such as land and forests) into non-farming and off-farm activities.
2. The production relationships between the public and private goods and services involved, in particular the nature and degree of co-production (jointness or competition) between these private and public goods and services under different farming and contextual conditions.
3. The linkages between these multiple functions and the development of rural areas and their quality of life and environment, giving particular attention to transformation of public goods into incomes and quality of life for the rural population.
4. The *influence of different policies* on production relationships, functions and linkages, in particular we develop realistic policy scenarios that reflect discussions leading up to the Health Check on the CAP and in the more global WTO context. We assessed how different scenarios impact the supply of rural public and private goods and the dynamic impacts on the rural economy, quality of life, environment, and farming itself over the period to 2025.

The innovative elements of the project aims particularly concerned:

1. The explicit recognition and modelling of the linkages between multiple ‘private’ and ‘public’ functions of agriculture, territorial development and quality of life, and environment.
2. The development of a systematic and dynamic computer-based model that is intuitive and transparent in providing a better understanding of the interrelationships involved.
3. The examination of the impact of different policies on these interrelationships using regional adaptations of this model in 11 case study areas that are broadly representative of rural areas across Europe.

The more specific objectives of the research as set out in the Description of Work were:

1. To identify the multiple functions of agriculture in a broadly representative range of European rural contexts and relate these to farm type, scale, household characteristics, farming style and contextual conditions (geography, institutions, governance systems, national and regional policies, markets, land tenure);
2. To evaluate and where possible measure the precise relationships involved between production and utilisation of private and public goods in the various farming types, scales and styles identified under different household and contextual conditions. In particular, we will focus on measuring the nature and degree of *co-production* (‘jointness’ or

‘competition’) between private and public goods at both the input and output ends of the production processes under different conditions;

3. To evaluate and where possible measure the nature and degree of inter-relationships between private and public goods used or produced by different types of farms and farm households, under different styles of farming and local contexts and the development of the rural economy and its quality of life;
4. To analyse the factors influencing or determining the nature and level of different kinds of market and non-market relationships in the production process, as well as their inter-relationships with the local economy and quality of life, in particular the influence of a range of different EU, national and regional policies;
5. To use the data generated to elaborate a systematic and dynamic computer-based model of the relationships involved, utilising the STELLA™ software, and showing explicitly how the model can be adapted to suit different farm and household types, styles of farming, and rural contexts;
6. Hence to provide a tool for policy makers that is a targeted policy model of multifunctional agriculture and rural development (POMMARD) which is sensitive to regional and rural conditions in Europe;
7. To demonstrate how this *targeted policy model* can assist in evaluating the impacts of policy changes on both agriculture and regional development in different European contexts, and be utilised in ‘translating’ EU policy frameworks into regional measures, for example by adjusting the balance between Axes within Pillar 2 of the CAP, or equivalent measures in Norway to reflect different farm functions, their importance for non-farm enterprises, and other rural conditions and local priorities.

The most innovative part of the objectives clearly concerned the building of a dynamic systems model to elucidate and explore the relationships between different policies, and their dynamic impacts over time on agriculture, the environment, the regional economy and quality of life in different kinds of regional context. It is here where the TOP-MARD project goes far beyond conventional demand-driven modelling (for a description of existing modelling activities see for example Zander et al., 2008). The policy model that has been built is transparent with a modular structure based on sub-systems, its use is intuitive and the supply-driven dynamic nature of relationships between agricultural multifunctionality and territorial rural development captures rural realities better than neo-classical models.

2.2 Scientific background

It is generally recognised that farmers, foresters and other land users perform several functions for society other than their usually primary market function of producing food and raw materials. According to Eurochoices (Cahill, 2001) there are a number of different non-commodity outputs that can be covered in a review of the relationships between multifunctionality and rural viability, particularly agricultural employment, landscapes, environmental quality and food security.

In general, these functions may or may not be ‘tradeable’ in the sense of providing those responsible (e.g. the farmer) with a monetary return. ‘Non-tradeable’ functions are generally public or quasi-public goods and typically concern the production of ‘environmental’ goods such as rural landscapes, but also quality products and sustainable rural development, as by-products from commercial activities (Abler, 2001). Typically, the combination of tradeable and non-tradeable functions is described as ‘multifunctionality’, and, especially when applied to the sector of agriculture, this term is endowed with both theoretical and practical policy significance. Cairol et al. (2008) and Renting et al. (2008) see the growing attention for multifunctional agriculture as being related to the evolving demands of consumers and society and as a response to the need to reorganize rural-urban relations in an increasingly globalized world. The changing institutional and market environment of farm households then become important driving forces for the growth of farm activities 'beyond food production'. In this much wider perspective the diverse functions related to agriculture, land use and farm household activities are not restricted to externalities produced (jointly) with agricultural activity, but rather a considerably larger basket of goods, services and 'functions'. Renting et al. (2008) emphasize that this includes goods and services produced for non-food markets (energy, care, tourism, etc.) and 'functions' provided by agriculture as distinctive product attributes on niche food markets (food quality, animal welfare, ecological production, etc.).

In the TOP-MARD project, we are explicitly concerned with the relationships between agricultural multifunctionality (traded and non-traded goods and services produced) and territorial rural development (the development of rural regions, for example NUTS III Regions defined as 'predominately rural' or 'intermediate' by the OECD 1994 classification, and including small towns etc.). This is because EU 'rural policy' as it has emerged in the past 20 years or so has a 'double mandate' – first, to secure 'the European Model' of agriculture as a competitive but environmentally friendly sector; second, to improve living standards and quality of life of people living in rural regions (Bryden and Hart, 2004).

Although most writers take a somewhat 'strict' view of 'multifunctionality' by confining it to 'joint products', implying that the production of a non-tradeable good or service requires the simultaneous production of a tradeable, Buckwell argues that the most common relationship is one of 'competition', while the OECD argues that the available evidence suggests that most significant non-tradeable, non-market, externalities in agricultural systems are produced either jointly or in competition with tradeable, market goods and services (OECD, 2001). The possibility of competition, as a principal relationship, means that an activity involving the production of a tradeable will reduce the production of non-tradeables and vice-versa. However, if we include such non-tradeables as cultural continuity or non-traded value relating to contributions to rural employment and enterprise, both of which are relevant to the wider development of rural regions, it is clear that a broader definition is needed, since no joint production with *particular* commodities is implied or needed, and competition is not necessarily present. This is not, however, to argue that choices between food production and other social or environmental outputs *may* not involve conflicts in some cases.

From a theoretical point of view, the issue is a sub-set of general theories of 'externalities' in production processes, much discussed, for example in relation to regional development (e.g. Marshall, 1890; Krugman, 1990; Van der Ploeg et al., 2008) and the related clustering of economic activities (Knickel et al., 2004), as well as in the growth of firms. Thus, non-pecuniary externalities such as ready access to information about markets and competitors' behaviour, as well as access to high value R&D and design services, are held to be important for the development of cities in regional economics (Richardson, 1968). In the same way that Regional and Firm Economics recognises that both pecuniary and non-pecuniary external diseconomies can and do exist, so too the discourse on agricultural multifunctionality recognises that some non-tradeables (externalities) have negative impacts (for example, pollution).

However, for the purposes of TOP-MARD, the central theoretical idea is that non-tradeables or externalities created within agriculture (and elsewhere, in a wider set of natural and man-made amenities) enter into the production function of new economic activities such as tourism and recreation, as well as other new goods and services such as specialised crafts, drink, foods, and cultural artefacts which are increasingly to be found in diversified rural regions. The idea that there are latent "non-mobile" assets that are important for rural areas can be traced back to a paper for a 1991 EAAE seminar by Cavailhes *et al*. (1993). Bryden developed this argument to some extent in a book on sustainable rural communities (Bryden, 1994), and in subsequent work with Dawe (Bryden and Dawe, 1998; Dawe and Bryden, 1999) and then within the DORA research project, which examined differential economic performance in 16 rural study areas of 4 countries. The work of the OECD (1999) and Van der Ploeg et al. (2008) on amenities in rural development provides a relevant theoretical background while Knickel and Peter (2005, 2008) present corresponding empirical data for 18 model regions in Germany. McGranahan (1999), Deller (2001) and Green *et al.* (2005) on amenities and rural migration patterns in the USA confirm that non-agricultural 'externalities' are also very important for rural development today.

In the 1988 paper on economic development in the predominately rural areas commissioned for an OECD conference, Bryden & Dawe argued that "*important cases exist where such areas have developed effective local strategies to deal with, and indeed capture new opportunities from, globalisation. These strategies essentially involve focusing on 'non-mobile' or 'less mobile' assets. In turn, many of these less mobile assets turn out to be public or quasi-public goods on the one hand or 'positional goods or services' in the sense used by Hirsch (1976) on the other (these are not mutually exclusive categories). However, whether mobile or not, the ways in which more 'tangible' resources like the land, natural resources, people and capital are put to effective local use seems to depend on a set of 'less tangible' factors like institutional performance, local culture, and a group of factors relating to effective access to resources"… the OECD's (1994) work on territorial indicators has informed us that some peripheral localities performed much better than others and, in some cases, better than urban areas (this also accords with experience on the ground, in the form of casual observation). We argue that such differences cannot be explained in terms of traditional theories (either core-periphery or neo-classical). The explanation lies in local capacities to develop and exploit less mobile assets, in the form of economic, social, cultural and environmental capital, and the synergies between these assets. One such asset, but only one, is what is now termed 'amenities' - we suggest that we need to look further than this to both understand differential performance and frame local development strategies in a context of globalisation. In particular, we need to pay more attention to the range of immobile or less mobile assets which are specific to individual rural areas, the relationship between these and assets which are more mobile, and the role of less tangible factors in valorising these assets within the local economy*." *(Bryden and Dawe, 1998, p. 2).*

The idea was later termed the 'Bryden theory' by Terluin (2003) who tested it against other rural and regional development theories, using the results of the RUREMPLOI project (Terluin and Post, 2001). Terluin concluded that the theory had the best explanatory power of those examined.

The role of tangible and less tangible assets in the differential development of rural regions was more thoroughly examined in the 'matched pairs' approach of the Framework 4 project Dynamics of Rural Areas (DORA) from 1999 to 2001 (Bryden, Hart *et al*., 2001 and 2004). Success in this case was largely measured by the ability to hold or increase (through net in-migration) population in rural regions. The authors concluded: "Our analysis of the relative importance of the different factors explaining DEP[1] between the pairs of study areas in each region led to identification of six key inter-related themes which together explain why some rural areas are doing better than others:

1. Culture and society in the shift from state to market
2. Peripherality and infrastructure
3. Governance, public institutions and investment
4. Entrepreneurship
5. Economic structures and organisation
6. Human resources and demography."

In addition, the development of economic activities that transformed natural and cultural assets into commercial activities was a cross cutting theme in stronger economic performance.

It was this growing body of empirically-informed theory that potentially links the production of 'externalities' (positive or negative) on farms with the development of rural territories, which underpinned the thinking behind the TOP-MARD project.

2.3 Policy background

With the Agenda 2000 reform and the European Council of Luxemburg (December 1997) the European Union made sustainability and multifunctionality key objectives of its Common Agricultural Policy (CAP). Already since shortly after the Green Paper on the CAP in 1985, member states have been able to reward farmers who, on a voluntary basis, provide environmental services to protect and enhance the quality of the natural environment, including biodiversity. The MacSharry reform of the CAP in 1992 augmented this possibility and added significant EU funding to the measures. Cultural landscapes are increasingly regarded as being at the heart of European society's concern about the future of agriculture and land use. Finding a new balance between societal demands for high environmental quality and the pressures resulting from competition in a market economy is a key issue.

From a policy point of view, many non-market goods and services produced by farming and farm households are, it seems, *desired* both for their own attributes (e.g. species rich meadows, managed landscapes) and for their potential impact on rural development. New development models aim at sustainable agriculture and maintaining biological and landscape diversities. Knickel et al. (2004) and others point to the fact that it is increasingly acknowledged that agriculture provides rural and environmental amenities and contributes to the maintenance of cultural heritage and the economic viability of rural areas. Pretty (2002) and Hoffmann (2000) argue that agriculture contributes to landscape and nature preservation, not in spite of but through land use.

However, the EU policy measures under the 'Second Pillar' of the CAP are mainly related to policy payments for farmers and less to the mobilisation of actors, networks and activities that aim at the transformation of rural amenities and assets in the rural economy (Shucksmith *et al*, 2005). Until now the Rural Development Regulation is predominantly used to persuade and/or compensate farmers for the production of such desired outputs. In addition, the EU seeks to penalise negative externalities through regulation aimed at preventing or reducing undesired non-

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[1] DEP= Differential Economic Performance (between poor performing and well performing rural regions in the same policy and environmental context)

market outputs such as water or air pollution. Cross-compliance is a further instrument intended to ensure that recipients of single farm payments comply with the standards of environmental regulations.

During both periods 2000-2006 and 2007-2013, the EU's 'Pillar 2' rural development policy funds were and are largely spent on agri-environmental and related, mainly Axis 2, schemes (Critica, 2007). It may thus be regarded as being mainly targeted at increasing the 'supply' of (or perhaps reducing the decline in) environmental goods and services, i.e. at positive environmental services related to farming. Support measures are less evidently targeted at territorial development, or at the transformation of positive externalities of farming into new economic activities and quality of life of rural residents. Apart from anything else, this is something agricultural ministries and departments[2], steeped as they are in agricultural structures and markets policies, the goals of which were supply-orientated, have little or no experience with. One exception exists, and it is the relatively tiny LEADER programme and comparable initiatives, which some countries and regions have used creatively to produce synergies between agricultural externalities and territorial development (Bryden and Dawe, 1998; Bryden, 2007; Knickel and Peter, 2005, 2008; OECD, 2007).

At the same time, the objectives of EU 'rural policy' demand that it goes much further than the supply of agricultural externalities. Since the Maastricht Treaty (2002), territorial and social cohesion has been an objective of 'rural' as much as 'regional' or 'social' policy. This is further reinforced in the Treaty of Lisbon. Moreover, the relevant policy documents (including the Rural Development Regulation) emphasise the importance of improving the quality of life of rural residents. This is indeed critical if people are expected to stay in, come back to, or migrate to, otherwise declining rural regions. There is little doubt that this will become one of the core issues to be dealt with following the EU 'Health Check' on the CAP and the subsequent EU Budget Review, both precursors to the next reform of the CAP and the Structural Funds in 2013.

Building on these theoretical foundations and practical policy considerations, the TOP-MARD project was designed to analyse how the various functions of the agricultural sector affect the sustainable economic development and the quality of life of particular rural regions, and how different policies affect these relationships. A central hypothesis was that these relationships differ according to a rather wide range of institutional and other factors that vary between regions as well as between policies. The view was that these relationships may be highly dynamic with numerous feedback effects.

[2] Even if they have been re-named as 'Rural Development' Ministries or Departments, since the policy experience of the incumbents remains rooted in the practices of the past.

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3. SCIENTIFIC APPROACH

By John Bryden, Tom Johnson, Karen Refsgaard, Thomas Dax and Amaia Arandia

3.1 Introduction

TOP-MARD was designed to analyze how the various functions of the agricultural sector in any given territory affect the sustainable economic development and the quality of life of that territory, and how different policies affect these relationships. One of the main objectives and outputs of the research was to produce a model, called POMMARD, which would allow the simulation of the dynamic economic, social and environmental impacts of different future policy scenarios in different rural contexts. A detailed description of the POMMARD core generic model is given in Chapter 6, and the accompanying operational manual is provided in the Annex to Chapter 6.

The project was organized as a large multi-country, multidisciplinary collaboration. About thirty researchers from the eleven European countries involved plus a modelling consultant and researcher from the United States have been involved. The team is also multi-disciplinary - members include economists, sociologists, geographers and ecologists. An important aspect of this project has been the development of a "learning community" among the scientists. The project began with a series of workshops to introduce the ideas of 'systems thinking', system dynamics, and modelling to the participants. Various methods were employed to enhance group learning and networking in a group divided by distance, culture, discipline and language.[3]

This Chapter reports on the process undertaken to plan and build the TOP-MARD dynamic simulation model. It focuses on the development of the learning network.

3.2 An overview of the TOP-MARD model

A central hypothesis underlying the TOP-MARD model is that both market and non-market functions of agriculture can and often do act as 'inputs' (market and 'external') into the production of non-agricultural goods and services in local economies, and into the quality of life of residents. However, these production relationships differ according to a rather wide range of institutional and other factors that vary between places as well as policies. The relationships are also potentially highly dynamic with numerous feedback loops.

The TOP-MARD model described below and detailed in Chapter 6 and the Annex captures the dynamics and spatial dimensions of these relationships in 11 study areas representing different types of rural areas in different European countries. The TOP-MARD model is a dynamic simulation model, programmed in STELLA™. It links EU, National and regional policies, governance, resources, and regional activities to social, economic and environmental outcomes in each region. A single core model has been built from which the 11 adapted regional models were derived. This allows regional differences to be incorporated into the models, yet ensures that the results of policy simulations from the 11 regions are comparable.

[3] All workshops and meetings are conducted in English, but all survey and instruments as well as products must be translated into eight other languages.

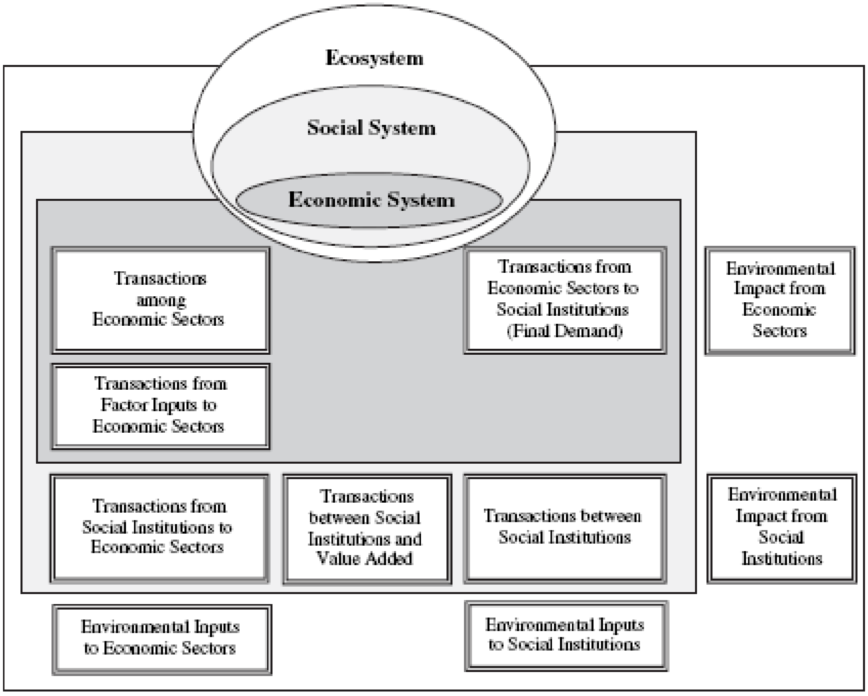
The model is organized into a number of subsystems: a resource sector including the relevant capitals, an agricultural production system and related household activities with the marketed and non-marketed goods and services, a tourism system which draws on market and non-market goods and services, a (residual) regional economy described by a social accounting matrix (SAM) table for the remaining sectors, a quality of life module, a demographic and migration system which draws on the regional economy and quality of life elements, a policy scenarios module, and finally an outcome indicators module which includes economic, environmental, social and quality of life indicators. In modelling these linked subsystems we utilized a capital approach similar to that applied in ecological economics (Erickson et al. 2004). Within this approach capital includes the stocks of productive human, built, social, cultural and natural capital from which flow the goods and services that support human welfare and economic development.

The model is designed to accommodate a wide range of policies and governance mechanisms that might influence the territorial development in different rural and political contexts. A central issue is the challenges related to the gradual shift from agricultural to 'rural development' policy within the European Union and correspondence with the evolving WTO regulations. For example if multifunctionality involves a shift from sectoral to territorial based policy delivery, the model will simulate the changes in regional economic, environmental and quality of life indicators when subsidies to agriculture decline, but investment in local capital increases. If 'the problem' with current EU rural development policy is that it focuses too much on both the 'farm' and 'the supply side' of multifunctionality, then the 'what if' might be to move more policy action and funding over to a 'territorial policy' that deals more with the 'demand' side for multiple functions of agriculture. The consequences might be more diverse farms, stronger links between agriculture and non-agricultural activities, growing population, etc. We hope to identify in this way how the relationships between farming – a range of private and public 'goods' and 'bads' – and the development of rural regions and the quality of life of people living in them can be moved away from undesirable outcomes, and towards desired outcomes.

3.3 Why a system dynamics approach?

Ecological economics is the only heterodox school of economics consistently focusing on the human economy as both a social system, and as one constrained by the biophysical world (Gowdy and Erickson, 2005). Ecological economic models of economic behaviour encompass consumption and production in the broadest sense, including their ecological, social and ethical dimensions, as well as their market consequences. Figure 3-1 below shows how the economic, the social and the biophysical world are interlinked in an ecological economics perspective.

Figure 3.1 An Ecological Economic View of Nested Systems of Accounts.



Source: Gowdy and Erickson, 2005

This figure can also illustrate the important systems of a rural region including its economy, society and environment. The regional economic activities shown in the left part of the figure are the well-known ones, such as agriculture, tourism and other enterprises. Regional economic activities are characterized by monetary flows between the agricultural and related activities, households, public institutions, capital markets, and the outside economy. These activities are linked with the social system and with the ecosystem. The social system within which decisions are being made is shown in the middle with its multiple layers of different contexts. The right-hand panel illustrates how the ecosystem of the region is influenced by the economic activities and the decisions taken in the social sphere.

The three systems are linked in several ways. Economic activities are linked to the ecosystem through changed resource use, as, for example, when agriculture practices impact the ecosystem through phosphorus run-off or when maintenance of grazing land for hay production indirectly improves the habitat for birds or directly through the disposal of waste. The ecosystem also impacts the economic activities directly as when soil erosion reduces agricultural productivity or indirectly when the lack of blooming orchards decreases the tourism in an area.

The other important linkages to consider are the dependencies between the economic and social systems (Erickson et al. 2005). Traditional sectoral economic models focus on the structure of production, while the structure and detail of final users is typically highly aggregated, most often specifying only its four major components of household, government, investment, and foreign consumption. This restricted treatment of households – the major driving force in economies both as consumers and as suppliers of labour and capital – limits the ability of I-O models to specify income distribution, investigate the effect of welfare and tax policies, or model the impacts of changing patterns of household spending. The need for a more detailed treatment of households in this application led the TOP-MARD team to base their model on the more robust social accounting matrix (SAM) (Stone 1970, Pyatt and Round 1985) in which components of final demand and value-added are referred to as institutions. The interdependencies between and among economic activities and institutions are illustrated by the three boxes linked to the social sphere of Figure 1 above. For instance, households, when specified as an institution (not just a supplier of labour), can reveal their non-labour inputs to economic activity in the left-hand box, distribution of labour income in the centre box, and interdependencies with other institutions in the right-hand box (the distribution of rents, profits, and net taxes to households (Erickson *et al.* 2005).

Figure 3-2 shows the POMMARD SAM. The POMMARD SAM explicitly identifies the ecosystem elements of a region in the non-commodity outputs and natural capital. The social system elements are identified in the social institutions, and the distribution of income by households, and the explicit inclusion of social, human and cultural capital

Since the TOP-MARD project is concerned with both the economic development and the quality of life in rural areas it is appropriate to use such a systems approach. It sees these activities as being fundamentally inter-connected and dynamic. This contrasts with the typically static and linear thinking of conventional economics where for example impacts of economic activities on the ecosystem are handled outside the system not influencing the agricultural productivity directly or where the composition of different economic activities does not influence the social capital and, through that, the overall well-being of the system.

Figure 3.2 POMMARD Social Accounting Matrix with Environmental and Social Components

			Payments, Consumption and Impacts of:															
			Production Activities		Factors of Production				Institutions			Capitals					Rest of the World	Total
			Sectors	Production Systems	Agricultural Commodities	NCOs	Labour	Land	Households	Government	Social Institutions	Material	Natural	Social	Human	Cultural		
Receipts by, and Impacts on:	Production Activities	Sectors	Input-Output	Inputs					Consumption			Purchases, Investments and/or Uses					Exports	Total Sector Sales
		Production Systems			Outputs	Outputs												
	Factors of Production	Agricultural Commodities	Inputs						Consumption			Purchases, Investments and/or Uses					Exports	Total Production
		NCOs	Inputs						Consumption			Purchases, Investments and/or Uses						
		Labour	Wages									Purchases, Investments and/or Uses						Total Wage Income
		Land	Profits									Purchases, Investments and/or Uses						Total returns to investment
	Institutions	Households					Wage Income	Invest Income	Transfers								Remits	Household Income
		Government	Taxes				Taxes	Taxes	Taxes								Transfers	Government Revenues
		Social Institutions	Social Impacts															Total Impacts
	Capitals	Material Natural Social Human Cultural	Inputs, Constraints Impacts															Impacts
	Rest of the World		Imports				Wage Income	Invest Income	Imports									

3.4 The STELLA™ approach

To examine this complex set of interrelationships and their dynamics in 11 countries and study areas over time, we built a system dynamics model using the STELLA™ system. STELLA™ was chosen as the platform for the TOP-MARD model for several reasons. First, it is a powerful yet relatively user-friendly modelling system, which is needed if the model is to be useful to policy makers. Second, STELLA™ is ideal when one of the goals is to encourage systems thinking in research and education. Third, STELLA™ is designed to help multidisciplinary teams work through complex problems where a large number of feedback loops, and temporal lags and processes dominate. And finally, it is designed to accommodate systems that include qualitative, and difficult-to-quantify, data. The TOP-MARD modelling efforts had all of these requirements.

In addition, STELLA-based models are ideal for policy analysis because:

1. They make the assumptions underlying the analysis explicit;
2. they allow critics to scrutinize data and assumptions;
3. they allow users to do numerous "what if" analyses and compare these with a baseline;
4. they facilitate sensitivity analyses;
5. they can be used to answer questions in real time;
6. they can be used as part of policy education programs.

3.5 Building the Model

The development of the model occurred slowly as the large team of researchers (29 members from 12 countries) simultaneously grew comfortable with system thinking and dynamic modelling. Because of the cost of convening so many participants from such a dispersed area, workshops were lengthy, multipurpose and very intense. Five workshops were held over two years. The first one focused project planning and an introduction to system thinking and the basics of STELLA™. The second workshop, held at one of the study area sites, reviewed the material from the first workshop and began the process of mapping the basics of the model. The third and fourth workshops focused on adding details to the model, especially with the identification of specific elements in the many dimensions of the model. The fifth meeting was held to finalize the process of identifying local primary data needs for the model.

The workshops were all intense. The process of building a single model from theories, values held and concepts proposed by dozens of disciplinarily, culturally, geographically, and linguistically different participants required that everyone translate their familiar paradigms into a system dynamics framework and into the language of STELLA™. While STELLA™ is designed with this in mind, this was a particularly difficult part of the collaborative model building. Semantics often gets in the way of easy model building, especially when team members have different native tongues. The natural tendency for experts in a field is to 'over-model' the problem. Their detailed understanding of the processes leads them to anticipate relationships other than the direct relationships required by the model. Thus, participants want to see secondary and tertiary relationships explicitly included in the map and the model. Furthermore, in prevailing neoclassical theory economists are accustomed to viewing the world from a static equilibrium perspective. In this regard, the ecologists offer a useful alternative perspective. Neoclassical economists also tend to focus too heavily on market and other variables that are relatively easily measured. Sociologists and anthropologists contribute valuable insights into the less obvious but equally valid dimensions such as institutions, culture, tradition, and social constraints. On the other hand, economists often contribute rigor to the process of describing relationships. So all members, once they are able to communicate their perspective, make valuable contributions to the final model. In the brief description of the model that follows the reader will recognize contributions from several disciplines and perspectives.

3.6 The Model Structure

To model the linkages between regional economic activities, the social system and the ecosystem model we used a capital approach similar to that applied in ecological economics (Erickson et al. 2004). In this approach capital is viewed as a stock of productive resources from which flow the goods and services that support human welfare and economic development. Unlike many traditional economic models, this model is supply driven with demand constraints. In our approach, capital is divided into human, material, social, cultural and natural capital. These capitals are combined with labour and raw materials according to alternative production systems and input-output relationships to produce economic goods and services, quality of life and associated social welfare. The natural capital is identified through the land use, and its division in different qualities within the region constrains agricultural production. Human capital refers to the population's skills, education, health and other quality attributes. Social capital includes features of social life like networks, governance and organisations, which are considered vital to the 'rate of transformation' of public goods and other externalities into local incomes, employment and quality of life. Social capital may also reduce transaction costs and thus make social and economic interactions possible, as well as being relevant for employment and capacity building. Cultural capital defines both a set of values within the local population and a set of actual and potential cultural assets, many of which enter directly into the quality of life. Built capital refers to the array of products produced through the combination of human, social and natural capital. Built capital is an input, as well as a limiting factor for sectoral activities.

In the model we limited this capital approach largely to the natural, human, and built capital. We dealt with social and cultural capital mainly outside the model, although certain elements of both were considered in the Quality of Life module. In our system, Quality of Life in any study area is treated a stock which can be enhanced or depleted by changes in incomes (derived endogenously from the regional social accounting matrix), 'non-commodities' or public goods associated with agriculture (derived from the agriculture/ land system) and employment structure. For present purposes, the cultural, and social capital areas were assumed to be constant, although the core model was built to allow these to be added at a later stage when reliable and significant data becomes available.

In Figure 3-3 below the general relationships between the different components of the model are shown. The three types of capital are included in the resources component. Land use has been chosen as the key variable for natural capital because the amount, distribution and use of (rural) land for different purposes are the primary determinants of regional economic, social and environmental activities. Furthermore, ownership and use of land are closely related to agricultural policy regulations.

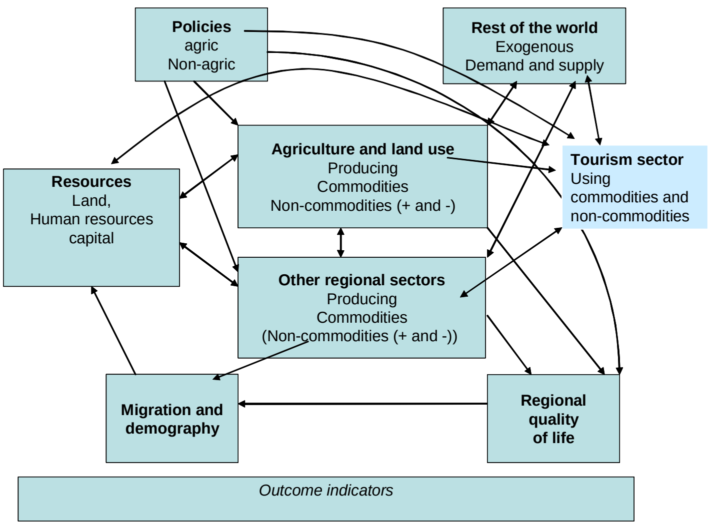
The economic activities include agriculture as farm production units since these are the major decision units. The tourism sector was also dealt with separately, as this was the most common sector involved in transforming non-commodities into local services in the 11 study areas. Other (optional) economic activities may be relevant in some rural areas (for example food processing as important sources of income and employment linked with commodity and/or non-commodity outputs of agriculture.

The policy module embraces potential policy scenarios as exogenous influences on the regional systems. The model permits the analysis of a range of policies that influence land use and other decisions related to multifunctional agricultural activities. Policy may also directly or indirectly affect local non-agricultural economic activities that make use of those agricultural multi-functions. This is one of the novel advantages of the model.

The demand box represents other exogenous influences and constraints on the regional system. While the model is supply driven, based on decisions related to production systems and land allocations, some sectors are influenced by external demand conditions. Prices of exports, for example, determine the income of the region's residents. External wages may affect in-migration rates. These exogenous variables will typically change only to reflect the global and EU-wide consequences of policy changes.

The indicators are meant to give a variety of information about the performance of the territory, as measured by migration patterns, employment rates and also more complex indicators such as social cohesion, quality of life etc. Some of these indicators can be calculated directly from the model, while others need additional information from surveys of the territory. The regional economy links the activities where there exists a market and thereby also gives values for the economic performance indicators. However the overall performance of each territory is measured through indicators of quality of life.

Figure 3.3 The Structure and Modules of POMMARD



The regional economy module (other regional sectors) was constructed from input-output and/or SAM models, either pre-existing in study areas, or specifically developed for this project using established techniques.

However these economic impacts do not include the increases or decreases in quality of life beyond those related to market transactions. Experimental economists and psychologists have developed methods for measuring quality of life and happiness (Easterlin, 1995; Inglehart and Klingemann, 2000; European Foundation for the Improvement of Living and Working Conditions, 2002; Centre for Comparative Social Surveys; Hagerty *et al*, 2001; http://www.ssb.no/samfunnsspeilet/utg/200201/13/,). These methods encompass material well-being, but also include other important factors in human well-being. Their analyses include perceptions of importance and happiness with consumptive goods and services, the natural environment, personal and working life, and family and community as well as sense of community and demographic background. This research suggests that (economic or material) growth does not always increase happiness, utility or well-being. Instead the correlation between absolute income and happiness extends only to some threshold of "sufficiency"; beyond that point only relative position influences self-evaluated happiness (Daly, 2005).

Perceptions of quality of life have been shown to be extremely important for migration decisions, and different age groups, genders, educational attainment groups and ethnicities refer to different quality of life drivers as important for decisions to stay or to migrate. Since population levels (and hence migration patterns) are regarded as crucial indicators of 'success' in terms of human sustainability of rural regions, both economic and quality of life measures are therefore important to understand causes for inward and outward mobility decisions and a broad understanding of the impacts of rural development. The TOP-MARD researchers have successfully experimented with these methods. As reliable and measurable indicators of quality of life are identified and linked to existing economic, social and environmental variables in the TOP-MARD model they are being incorporated into the model. This required a special additional survey of rural citizens in each study area, focusing on young people, women of child-bearing age, and the elderly.

The development of a detailed demographic module, specifying different age groups, genders, and education levels, and linked to the quality of life and the human capital modules allowed detailed analysis of the implications of different policy scenarios for demography, supply-driven migration, and human capital in each study area.

3.7 Benefits of using dynamic systems modelling

There were several reasons for using STELLA™ to model the multifunctional agriculture and territorial development system as a framework for our analysis of the relationships between production of public and private goods (and bads) in agriculture and the territorial economy and quality of life, as well as assessing the impacts of different kinds of policy scenarios on these relationships.

First of all, STELLA™ provides a workable and transparent pedagogical tool for a trans-disciplinary group and for enabling the engagement of non-experts in the research and policy scenario analysis. It uses a basic stock-flow system with 'buffers' to follow dynamic outcomes of policy or other changes over time.

Secondly, STELLA™ is a visual tool, implying that it is relatively easy to use for people who are not necessarily 'modellers' making it easy to show the impacts or outcomes of different policy scenarios to policy-makers and others.

Third, STELLA™ is designed for learning and creates a learning process involving empathetic thinking and using context-neutral language. In addition, the complex mathematics required to solve dynamic systems can be hidden from the end-user if they are uncomfortable with it. In this way it can easily communicate with different disciplines and with end-users.

Fourth, STELLA can handle imprecision [e.g. ranked order variables, stories, etc], and has an easy interface to enable the use of sensitivity analysis where data is not available, or available only in rough estimates. This is an important point when exploring a set of research questions for the first time and where large scale research-based data is not likely to be available.

Finally, and most importantly in our case, STELLA™ is a dynamic systems model which can show the impacts and outcomes of policy and other changes over time, and which allows the user to incorporate feedback processes, non-linear relationships, constraints, time lags, and other useful features.

The data demands can, however, be considerable. In some cases we need coefficients like the age, gender and education-specific elasticities of migration response to changes in different elements of Quality of Life which are simply not available 'off the shelf' anywhere! Another example would be the response of biodiversity to changes in land use, production or farming styles. This is not a criticism of STELLA™, which at least allows one to conduct simulations or to even assess feasible sets of values. Indeed it can be argued that working through such issues forces us to think more clearly about the information needed to answer some of these questions, whether we use STELLA™ or not!

3.8 Survey Work

In addition to the development and application of the POMMARD model, questionnaire surveys were undertaken as follows:

1. Of at least 30 farm households in each study area, of which 20 were randomly chosen and 10 were deliberately selected to reflect the specific patterns of multifunctionality in each study area. The purpose was to elaborate further on the characteristics of farm households involved in the various 'functions' of agriculture, and to gather data not available from secondary sources.
2. Of at least 20 non-farming enterprises in the study area, selected by the study teams in consultation with the National User Groups (NUGs) and also using the responses to the farm household questionnaires.
3. Of at least 30 rural residents focusing on young people – as potential leavers or the study area –, families – women of child-bearing age –, and seniors – mainly retired and in some cases in-migrants. The purpose was to gather data on the perceptions of quality of life by the citizens in each study area in order to gain more understanding on the impacts of rural development policies and assist with calibration of the model, in particular the relationships between quality of life attributes and migration behaviour and intentions. The average number surveyed was 53, of which 61.9% were female, 32.9% youth aged 0-19, and 21.7% seniors aged over 61.

In addition, an 'oracle survey' of Key Agents (experts, officials etc) in each area was undertaken to fill gaps in data and understanding required to complete the POMMARD model and convert Policy Scenarios into model inputs. As the content of these was specific to each study area, depending on data or information gaps to be filled, no common format was prescribed.

Meetings were also held with EEA in Copenhagen to identify and elaborate environmental indicators. Several team members also attended – and presented at - a special meeting on alternative approaches to modelling multifunctionality and rural development organised by IPTS (JRC) Seville in December 2006. Some team members also took part in a special session at the EAAE Seminar in Prague, Czech Republic (September 2006), entitled "Impacts of Decoupling and Cross-Compliance on Agriculture in the Enlarged EU". Three papers and a poster on modeling within TOP-MARD were also presented at the 107th EAAE Seminar *"Modelling of Agricultural and Rural Development Policies"* in Seville, Spain, January-February, 2008. Valuable feedback was obtained from these trans-national events, as well as from a series of national meetings with professional organizations and ministries.

Farm Household Surveys

These gathered information which would help link types of farm and multifunctionality found in each study area to non-farming activities and enterprises, both on and off the farm. The main content is outlined in Box 3-1 below and the full questionnaire is reproduced as an Annex. The survey helped to identify the relevant list of 'functions' of agriculture in each study area, and also the non-farming enterprises to be interviewed in the survey of entrepreneurs.

Box 3.1 Outline Structure and Content of the Farm Questionnaire

Part I: Dealt with production, work and income on and off the farm, and covering all the members of the farm household. It also asked for information on succession, and any planned changes on the farm.
Part II: Focused on commodities and non-commodities or public goods, and the relationship between these. It asked about the farmers' perspective on the nature and impacts of non-commodities, as well as steps taken in recent years to improve environmental and animal welfare aspects, and use made of relevant policies
Part III. Turned to aspects of social and built capital, including involvement in a range of local organisations, use of research institutes, support for innovative ideas, views on their region's economy and quality of life, and their location and distance travelled for services. In addition, respondents were asked to identify three of the most important non-farm enterprises in their region dealing with multifunctional commodity and non-commodity outputs from their farm.

Survey of non-farming enterprises thought to be transforming commodities and non-commodities from farms.

This survey sought to gather information on the importance of specific commodities and non-commodities (public goods) for their own enterprises. This information was essential for the analysis of transformation of public goods into other economic activities, and for the calibration of the POMMARD model. The focus was on enterprises that are or may be connected to market and non market goods and services produced by agriculture and land users in the different study areas. This connection may, for example, be through a tourist market or product, local foods and other products, or the use of landscapes, festivals or recreational resources in marketing. However, it may also refer to negative impacts, for example through water or air quality.

Box 3.2 Outline Structure and Content of the Non-Farming Enterprise Questionnaire

Part I. Covers the profile of the enterprise and entrepreneur, the activity of the enterprise including products and services, recent changes and reasons for these, reasons for locating in the study area, employment and business ownership.
Part II. Deals with the enterprise's purchase or use of agricultural commodities and non-commodities, including the relevance and importance of the range of 'functions' previously identified for each study area.
Part III. Covers the perception of enterprise owner or representative on contextual changes in the study area.
Part IV. Turns to built capital and infrastructure in the study area.
Part V. Turns to the entrepreneurs assessments of social capital, business support and institutions in the study area.

Quality of Life Surveys

The Quality of Life surveys used a 'capitals approach' familiar to ecological economics. Basically, the surveys explored the importance of material, natural, cultural, social, and human 'capital' for the quality of life and migration intentions of residents in different age and educational groups in the 11 study areas. It broke these capitals down in some detail, and also explored the residents' perceptions of the quality of these capitals in each study area. The data gathered was used to provide input data for the modelling of quality of life impacts on the inward and outward migration behaviour and intentions of those interviewed. Briefly, this involved estimating the 'elasticities of migration response'[4] to changes in different elements of quality of life for different age and education groups, and the results and precise methods used are discussed in Chapters 5 and 6 and in the Annex containing the POMMARD manual. The modelling of migration in such detail, and linked with quality of life elements, is a unique feature of our POMMARD model.

Once again, a questionnaire was used for these surveys, and care was taken to selectively sample population groups considered important to the sustainability of the rural areas concerned. In particular, care was taken to include women with young children, youth, and the elderly. The National User Groups (NUGs – See Section 3.9 below) advised on the best approach in each study area, which often meant approaching schools and pre-school groups. The structure and content of the questionnaires is summarized in Box 3-3 below. A key element of this was the juxtaposition of the respondents estimate/ ranking of the elements making up their own quality of life and their evaluation of the quality of those elements in their own area. We used the 'gap' between these two as a key piece of information in our analysis for the Modelling work.

Box 3.3 Quality of Life Questionnaire

Part I. Covers the migration/ residence history of respondents, asking about their motivations for movement, and the relative importance of different quality of life factors for such movement or anticipated movement. Respondents are also asked to rank the importance of the 'five capitals' for them. This is followed by a further question which asks them to rank the importance to them of individual elements in each of the five capitals. The final question in this Part follows this up by asking respondents to rank their satisfaction with each of the detailed elements of the five capitals in their own study areas.
Part II then examines the importance of the specific functions of agriculture for the different quality of life elements identified by respondents. Thereafter, respondents are asked to make a detailed assessment or ranking of the elements making up their own quality of life.

3.9 National User Groups (NUGs)

We regard the NUGs as an essential part of this type of research and they were established at the start of the TOP-MARD project, and met between two and five times throughout the project. In most cases, they were also represented by at least one member at the final conference in Brussels in May 2008.

The NUGs comprised about eight relevant and knowledgeable actors mainly from the study area, and thus reflecting and providing local culture, knowledge and expertise. They were involved in the project during the early stages of fieldwork and through to the production of

[4] An elasticity of migration response is the % change in migration for any given % change in a stock of each capital. Elasticities of response can be negative or positive.

results and final reports. They provided input for the selection of the study area, questionnaire design, identification of special or interesting cases of multifunctionality and its transformation into new economic activities in each study area, identification of key contacts for the 'oracle' survey, feedback on results and follow-up and of policy implications at local level. Our previous experience with such groups (for example in the DORA project) demonstrates that they also form a 'front line' for dissemination of findings to policy makers and other agents of change.

At a more specific level, several topics were raised during the meetings, such as the following:

1. the identification of farming types and/or systems and their relationship with the 'goods' and 'bads' produced;
2. the potential impact of recent CAP changes, such as the 2003 reform, on multifunctionality;
3. the identification of possible alternative policy scenarios and their potential impact on multifunctionality;
4. the different views on Rural Development, and its sub-regional components and drivers;
5. the identification of perceptions and components of Quality of Life.

3.10 Meetings of Study teams, Project General Assembly (PGA), committees and working groups

Ten scientific meetings were held during the project, seven of which included meetings of the Project General Assembly (PGA) and, normally, meetings of the Methodology and Modelling Committee (MMPC) and the Policy Scenarios Planning Committee (PSPC). The PGA was chaired by the co-ordinator, Professor John Bryden; the MMPC by Dr Thomas Dax; the PSPC by Professor Kenneth Thomson.

With five exceptions these meetings were held in study areas, so that as many researchers as possible had the opportunity to witness multifunctionality and rural development in contrasting rural regions. The five exceptions were the first and final meetings held in Brussels, a special meeting held in Athens to link modelling work with survey data, and two special meetings of the Modelling Group, held in Frankfurt and Brussels. The Modelling Group was chaired by Professor Tom Johnson.

Team meetings were held as follows:-

Dates	**Meeting held in**
May 2005	PGA etc Brussels
November 2005	**PGA etc Spain (*Bergueda*)**
March 2006	Frankfurt (Modelling Group)
June 2006	**PGA etc Slovenia (*Gorenjska*)**
December 2006	Athens (Methodology & Modelling Ctte)
April 2007	**PGA etc Italy (*Latina*)**
June 2007	Brussels (Modelling Group)
September 2007	**PGA etc Norway (*Hordaland*)**
February 2008	**PGA etc Hungary (*Bacs-Kiskun*)**
May 2008	PGA Brussels

3.11 The Use of Software in TOP-MARD

Other than *STELLA*™ systems software, which included *Social Accounting Matrices* (SAMs) for each study area, *Kohonen's SOM [self-organising map] networks*, used for the classification of study areas, was implemented as a *Visual Basic* application in *Excel*. The calculations used for assessing policy efficiency in *DEA [Data Envelopment Analysis*] were made by *DEAFrontier* software. Some teams used *CAPRI/JordMOD* for assessing the consequences of policy changes for production and land use, but since these are national level farm based models the results were checked and further elaborated during the key agents survey.

Analysis of the results of the quality of life survey used a *Logit* analysis with in-migrant/non-migrant as the dependent variable (0 – 1). A second regression was run for (potential) out-migrant/non-outmigrant (0 – 1). We assessed relationship between the importance and quality of each of the five capitals (Material, Natural, Cultural, Social, Human) and migration decisions. By estimating the slope of the equation, we estimated the probability of being an in or out-migrant for three groups – youth, families and elderly.

3.12 Conclusions

The unique aspect of TOP-MARD concerns the linking of functions of agriculture with the development of the local territory and quality of life, and doing this in a large and diverse range of different rural contexts. In exploring this intellectual and policy domain, conventional tools of economic, social and geographical analyses are not adequate. We have therefore opted for a systems approach, so that the dynamic relationships between agricultural functions (market, non-market, and hybrid) and the success or failure of local economies and societies, and the role that different policies have in these relationships, can be formally explored and tested. In this way we have a model that can examine the impacts on both farm households and local communities of expansion or contraction of policy effort in different areas, and different contexts. The model should thus be helpful for policy development and prioritisation at both local and EU levels.

The model has been used with a set of 'realistic' policy scenarios, and produced some non-intuitive and surprising results. These were presented briefly to a panel of senior regional, national and EU level policy makers in Brussels at the final meeting of the TOP-MARD project (May 2008). Judging by the level of interest in, and at, that meeting, we consider that the POMMARD model will be effective as a tool for assisting and persuading policy makers. We also know that the process of building, adapting, and applying the model has been very effective at bringing very diverse concepts into a single model. The model itself has helped participants understand the relationship between the elements that they are most concerned with and those of their collaborators. From this perspective, the amount of learning, or more accurately co-learning has been substantial.

As with all newly developed models, there is always more to do: for example, further refinement of the model itself, different scenarios, and better data are always possible. The work in modelling for policy makers is an on-going process. However, we can say that we met our objective in building such a model, applying it to 11 varied study regions in Europe, and analysing the dynamic impacts of a set of policy scenarios which are realistic future options. The analysis provides new insights on these longer terms impacts and show how impacts vary from region to region.

The survey work was necessary to provide data for the model as well as to interpret results. The NUGs were invaluable in providing local knowledge and contacts, discussion *fora* for methods, questionnaires and results, and also as a means of dissemination and follow-up on policy issues.

In retrospect, a longer time period for the project would have allowed the very arduous task of building the POMMARD model to have preceded the survey work, which would have improved the design of the questionnaires and the utility of the surveys. On the other hand, a longer timescale would have missed the important policy event at EU level, namely the Health Check on the CAP, for which POMMARD is well suited.

4. COMPARISON OF STUDY AREAS

By Arild Spissøy and Karen Refsgaard

The empirical work in TOP-MARD was undertaken in eleven study areas. All the teams carried out a preliminary (mainly desk) study of their study area early in the project. Based on this study, each team wrote a description of their area which was compiled into one report, Deliverable 5 (D5) – *Report on desk research and preliminary information gathering*. The study area report was a result of Phase 2, Work Package 3 (WP3) Desk Research and Prior Information Gathering, which had the following objectives:

1. To scope out what relevant information and ideas are available in each country and study area and hence what precise needs are for primary data from structured field research by literature review of public data, consultation with key local and national experts and agencies, and a review of related research activities.
2. To complete this scoping study in advance of primary data gathering.

The objective of D5 was to give a description of the study areas, report on the preliminary information gathering about multifunctionality in agriculture and its importance for rural life and development in the study areas, and a short literature review relevant to the concept of multifunctionality in the respective areas and its influence on the local development. The composite report for all study areas was prepared by Norwegian Agricultural Economics Research Institute (partner no. 9). This comparison extracts some of the interesting features of the study areas that were revealed in the descriptions.

4.1 The study areas – characteristics

In TOP-MARD a wide range of countries each with a 'study-area' was chosen to explore the diversity of multiple functions, co-production, and impacts on rural development across Europe. In this way it was possible to examine key features of the problematic across a variety of both natural environments and institutional arrangements. Every area was different from each other, and there were differences within the areas from community to community and from valley to valley. There were differences in farm structure, in income, in topography, in climate, in type of farming, in farm production, etc. Outside land and agriculture there were differences with regard to the composition of economic sectors, in the importance of tourism, in population density, structure and growth, in rural-urban dynamics, in migration, and in rural quality of life in general. Finally the governance structures and policy regimes also differed. Nevertheless, thestudy areas faced many similar problems and challenges, and there were many similarities in the range of public goods associated with agriculture. Although only a minor part of the areas' incomes came from agriculture, farming was still considered to be important, with a large influence on people's welfare, as well on other businesses, especially tourism.

4.1.1 Criteria for selection

According to the work description, we should identify the broad characteristics of multifunctionality, farming and rural development in each study area. According to TOP-MARD's technical annex, the case study areas should be selected:

> "*on the basis of (a) the significance of the policy issues relating to multifunctionality for the area and region, (b) the need for the overall selection to provide a not unrepresentative range of rural (NUTS III or equivalent) study*

areas at the level of an enlarged EU (25), a reasonable representation of farming types, styles and scales, and farm household circumstances and characteristics." (Technical Annex, Section 7.1, p 26)

The selection was coordinated to ensure a wide spectrum of areas in relation to climate, topography, agricultural production, and thus the multifunctional nature of agriculture in the areas. According to the Work Description, the study area should be NUTS III (county) scale or equivalent. The Swedish, Norwegian, German, Hungarian, Slovenian, Italian, and Greek study areas are all NUTS III. The Spanish study area is a NUTS IV area since the Barcelona province NUTS III area contains the large city of Barcelona. The Irish study area is one of three counties within the large NUTS III area of the Western region. And the Scottish study area consists of two counties within the NUTS III area of the Caithness, Sutherland and Ross and Cromarty (UKM41) in the Highlands.

In the study area report (Deliverable 5), the study areas are described according to the following template:

1. General description of the area, relevant characteristics (geographic, physical, etc), including location maps;
2. Demographic patterns;
3. Recent economic history: most important sectors, occupations, etc.;
4. Agriculture in the area: description of farming systems and characteristics, patterns of land use, main cultures and livestock, etc.;
5. Relevance of the case study area in the multifunctionality context; and
6. Policies relevant to multifunctionality and the transformation of the various functions into economic and social development in the study area.

4.1.2 Physical characteristics

As seen from the map below, the study areas were spread over a large part of Europe– from Västerbotten on the border with the Arctic Circle in the north, to Latina, Berguedà and Trikala in the south – and from Mayo far west in Ireland, to Bàcs-Kiskun and Trikala in the east.

Figure 4.1 Topographic Map over Europe Indicating The Study Areas. The study areas are shown within the red border lines on the map below.

With respect to the *physical conditions* – geography and topography, there are huge differences, from the flat plains of Hungary to the entirely mountainous area of Norway. In Bàcs-Kiskun the difference between the highest (174 m) and lowest (94 m) points is just 80 meters. In Hordaland it is hard to find a flat hectare! The Scottish and Irish area contains both flat and mountainous areas, Wetteraukreis (Germany) is located between the Taunus and the Vogelsberg mountains. Wetteraukreis itself consists mainly of flatland with some hills – and is very suitable for agricultural production.

An example of the diversity within an area is Latina in Italy. There are four main areas internally homogeneous in a territorial, economic and cultural sense within the province: the Pontino plains, the Lepini mountains, the southern coast, and the internal area of the Ausoni and Aurunci mountains. The physical characteristics cover partly the differences in economy and culture. There is simultaneously the presence and links between rural and modern urban. This gives it a high potential in terms of the development of multiple functions of agriculture.

As with the physical characteristics, there are big *climatic differences* from the Nordic study areas to those in the Mediterranean. The northernmost, Västerbotten in Sweden, lies just below the Arctic-circle (66º N) latitude. Trikala, the Greek study area is the southernmost just below 40º latitude. Despite its long coastline, Västerbotten has an inland climate. In the west it is protected from the Norwegian Sea by the mountains, and in the east by the Gulf of Bothnia which freezes in the cold winters. Västerbotten experiences a sub-arctic climate with much snow and long cold winters, contrasting with *relatively* warm summers with little precipitation. Although there are mountains only in the west of the county, the whole area is considered mountainous in EU's scheme for 'less favoured areas' agricultural support due to climatic conditions. To illustrate the differences in climate, here are some extremes: The mean annual day time temperature in Västerbotten is 2 degrees Celsius. In January the mean temperature is -7 degrees Celsius and in July it is 15 degrees Celsius. The average date when the minimum temperature first falls below zero is 15 September and the average date when the minimum temperature rises above zero is 1 May. The annual precipitation (including rainfall and snowfall) is 900 mm. In Latina (Italy), the mean temperature is 13.4 degrees in January and 30.4 degrees in August, with about the same annual precipitation. The highest annual mean precipitation is found in Hordaland, where some parts of the county receive as much as 3000 mm a year. This contrasts with Bàcs-Kiskun (Hungary) which receives 520 mm rain a year.

The study areas constitute a mix between coastal and inland areas. The areas in Scotland, Norway, and Ireland are all affected by the prevailing westerly winds and by the Atlantic Gulf Stream. That means many rainclouds and relatively small differences between summer and winter temperatures. Latina on the western coast of Italy experiences a typically Mediterranean coastal climate. The Greek area of Trikala, and Berguedà in Spain, have a dry Mediterranean inland climate. The areas in Slovenia and Austria are located on the southern and northern side of the Alps respectively, experiencing a high altitude inland climate. The Hungarian and German areas are at low altitude in the inland of Europe.

The German study area is located close to the Rhine-Main conurbation. Latina in Italy is located between Rome and Naples. Berguedà in Spain is close to Barcelona. Northern parts of the Hungarian area are not far from Budapest. The middle parts of the Norwegian area are within a relatively short distance of Bergen. The Scottish, Irish, and Greek areas, large parts of the Swedish study area, and parts of the Norwegian area are the most remote areas. Closeness to large cities might be important for the potential for alternative employment possibilities as well as marketing of goods and services either by farmers themselves or by other businesses, and thereby the significance and value of the public goods agricultural activity produce. The regional urban–rural dynamics was a feature we investigated in TOP-MARD.

4.1.3 Demographics and social characteristics

The total population living in the chosen study areas in total exceeded 2.5 million people.
The greatest number of people lived in the Hungarian study area (more than half million),

while the smallest populations were found in the Spanish and Scottish study areas (both having a population around 38 thousand inhabitants). Approximately one third of the total population of the study areas belonged to the age group 40-64 years old, 29,6 percent were 20- 39 years old, and 15 percent were elderly people (65+). The proportion of population below 19 years old was above average in the Austrian, Spanish, Irish, Italian and Norwegian study area. In those areas there were fewer youngsters and more elderly compared to the age structures in the German, Greek, Swedish and Scottish study areas.

Västerbotten in Sweden is the most sparsely populated with a population density of 4.6 inhabitants per km². Its rural areas are even more sparsely populated: Umeå municipality, with the main City of Umeå, has 110,222 of the total of 256,710 inhabitants in the county, and so the population density in the rural areas is only 2.6 inhabitants per km². In Hordaland, the city of Bergen distorts the average population density, Bergen having more than half of the population of the County. Hordaland without Bergen has a population density of around 14 inhabitants per km². The German area is the most densely populated with 271 inhabitants per km².

Table 4.1 The Study Areas, Population, Population Density and Proportion of Surface Which Is Mountain Area.

Country	Study area	NUTS 3 Code*	Population 2002	Population density Inhab/km²	Proportion Mountain area
Austria	Pinzgau-Pongau	AT322	162.300	37,2	1,00
Germany	Wetteraukreis	DE71E	298.120	271	****
Greece	Trikala	GR144	132.600	39,0	0,86
Hungary	Bàcs-Kiskun	HU331	541.000	64,1	****
Ireland	Mayo	IE013*	117.446	21	****
Italy	Latina	ITE44	519.850**	219,7	0,49
Norway	Hordaland	NO051	448.343**	33**	1,00
Scotland (UK)	Caithness and Sutherland	UKM41*	88.600	6,9	0,54
Slovenia	Gorenjska	SI009	197.100	92,4	1,00
Spain	Berguedà	ES511*	39.224***	33.10	0,81
Sweden	Västerbotten	SE081	255.200	4,6	0,90

**= Study area within the NUTS 3 code. For Spain Berguedà lies within ES511, Barcelona province.*
***=2005 numbers*
****2004 numbers*
***** no numbers, but relatively mountainous in Ireland, mainly flatland in Hungary and Germany.*

The population of Wetteraukreis increased by 12.4% from 1990 to 1998, much higher than the national average increase of 3.5%. The proximity to major conurbations and the high quality of private and public transport for commuters has been an important factor behind this development. Indeed, good infrastructure and the possibility to commute from more remote areas to cities and administrative centres are features that were stressed in most areas as very important for keeping a rural settlement pattern.

Most of the areas experience migration from the remoter areas towards towns and cities. The more rural regions, and the more rural parts of regions with larger towns and cities in them, all experience differential migration, particularly with out-migration of younger age groups.

In addition, most regions experience increasing in-migration from overseas, often seasonal or regular workers in agriculture, agro-industry, fish processing, and tourism in particular. Increasing numbers of these often temporary or seasonal migrants are coming from Eastern Europe and the CIS states, but in Southern Europe they are from North Africa.

There is a large diversity in the proportion of secondary school graduates leaving the region after completing secondary school. The average exit rate of the study areas reached 28.4 percent. However, there are some extremes at both ends of the ranking. The highest exit rate was reported by Scotland, where almost 90 percent of the secondary graduate leaves the region after finishing their secondary studies. On the contrary, only 6.6 percent of Norwegian secondary students do so, mostly because of the presence of high quality higher education and training within the study area itself. The exit rate is also very low in Germany (9 percent) and Slovenia (10 percent) compared to other study areas.

Many of the areas are also experiencing an *aging population*. This is most notable in Bàcs-Kiskun, Mayo and Latina. In Mayo, the percentage of farm households having at least one member below 45 years of age has fallen from 80% in 2001 to 60% in 2004. The average age of the farm holder rose from 52/53 years to 54/55 years over the same period. Generally, larger farm units were the most demographically viable. Trikala has experienced a small decline in population of 0.6% from 1991 to 2001, while a 6.9% increase in Greece as a whole. Over the same time span, the share of the population above 65 years increased from 15% to 20%.

The average *unemployment rate* of the study areas was 5 percent in 2001. The proportion of unemployed was the lowest in Norway (2.5 percent) and Austria (3.4 percent). Only the Hungarian and Greek study areas faced a two-digit unemployment rate. There was a reciprocal proportionality between educational level and the unemployment rate.

Table 4.1 Average Unemployment Rates in Percent and Education Level in 2001

	Primary	Secondary	Tertiary	Total
Austria	5	3.2	1	3.4
Germany	7	5	3.5	5
Greece	7.1	14	11.9	10
Hungary	14	8	3	11.3
Ireland	6.3	5.6	4.5	n.a.
Italy	3.2	6.3	5.2	4.7
Norway	2.9	2.8	1.7	2.5
Slovenia	15	6	3	7.3
Spain	10.4	8.3	5.5	8
Sweden	6	5	4	4.7
Scotland	6	4	2	2.5
Total	6.5	4.9	2.8	5

The unemployment rate among primary graduates was more than twice the average in Slovenia (15 percent), while it was the lowest in Norway (2.9 percent) and Italy (3.2 percent). Those with secondary education were in the worst situation in the Greek study area, as 14 percent of them could not find a job. The lowest unemployment rate in this educational group was reported by Norway (2.8 percent) and Austria (3.2 percent). The highest unemployment in the tertiary educational group was 11.9 percent in Greece.

4.1.4 Land Ownership and Access Rights

Land ownership and access rights to natural areas for the population influence the connection between local residents and their natural surroundings. This has an impact on the use and enjoyment of the land, whether the land is used for farming, recreation, or other. In Caithness and Sutherland (in Scotland), most of the land is owned by large landowners. In Wetteraukreis (in Germany), 75% of the farmed land is rented and the demand for leasing is high. In Hordaland (in Norway) there are no large landholdings, but a rather equal distribution of land between landowners, while the farmers own most of their land. However, a large proportion rent additional grassland from neighbours who have stopped farming. The existence of public rights of access to unenclosed land in the Scandinavian countries and Scotland means that nature can be more easily enjoyed by the residents of these areas as well as visitors. In the other countries, access to land, rivers, and farm roads is more restricted. This is important for people's possibilities to utilise the area. Roads and tracks, rivers, and hills may be closed to the public in some areas, in which case they must be considered private goods. However, where such assets are open to the public, they can be considered as public goods – even though the land is privately owned.

4.2 The multifunctional agriculture and related functions

Agriculture is a primary industry, and imbued with very long traditions. One can argue that the history of human development is to a large extent the history of agricultural development. So, even in areas where agricultural production today is of little importance to gross regional income, farming is still considered by many to have an important historical and cultural position. In all the areas, farming is upheld as important for local traditions and culture, and for people's identity. To help uncover the different functions of farming, each research team held meetings with a national users group that consisted of farmers, experts, and other key-personnel.

Wetteraukreis is an example of a rural area that holds on to traditions, especially in respect of culinary specialities. These are kept alive and 'protected' in farmers markets, festivals and events. Inhabitants of the Rhine-Main conurbation hold the area in high esteem because of its rural charm and recreational value. Traditional events together with the attractiveness of the landscape are important for both visitors and tourists. While the statistical relevance of agriculture as measured by employment and contribution to GNP is marginal, its regional relevance concerning quality of life, natural assets and tourism appears to be high.

The functions of agriculture emphasised in the area descriptions were similar in character. However, there were some differences in people's concerns, appreciations, and problems, related to the presence of farms and farming, all of which differ between (and within) the chosen study areas. The 'non-commodities' emphasised as important for the quality of the area and for people's lives differ to some extent among the study areas. An example of the different concerns people have is that in Norway uncontrolled afforestation of former farmland and pasture is considered a problem for both aesthetic and recreational reasons, whilst in Germany and Scotland people seek to protect the forests and hedgerows from farmers who want to use the area for crop or livestock production. In some areas, farmland management helps to protect wildlife, whilst in other areas farmers and wildlife are in conflict. The same applies to biodiversity. In areas with intensive farming such as Wetteraukreis and Bàcs-Kiskun, biodiversity suffers, but extensive farming in smaller parcels, such as in Gorenjska Slovenia, is thought to enhance the biodiversity of the area.

Compared to other industries, agriculture is very land-intensive. It is thus unique in the way it shapes the landscape in which people reside and win livelihoods. Many of the local traditions and cultural activities originate from farm practices. Even if many people have a distant relationship to *farming*, everybody living in or visiting an area is affected by the cultural landscape produced by farming. In this way, closeness to farms and the production of food and fibre also may help to prevent ‘agro-illiteracy’ and the presence of a farm in the neighbourhood may contribute to an understanding of biological processes. In Hordaland, schools and kindergartens visit farms to learn about farm animals, biological cycles, and soil cultivation. The commodities and the non-commodities produced and the related production processes by agriculture and farm household are perceived as important for peoples’ identity and feeling of home, implying that the residents’ perceptions of agriculture are linked to the multifunctionality of agriculture.

The teams reported that the traditional agricultural landscape is regarded as important by members of the NUGs – especially for attracting tourists. Some pointed out that there is a trend towards more exploration tourism – tourists want to experience the ‘old-fashioned’ traditional lifestyle. Farm tourism has become an important business, especially in Pinzgau-Pongau (Austria), Gorenjska, and Latina. NUG members from mountainous regions, such as Trikala and Pinzgau-Pongau, emphasised that the natural resources and beauty of wild mountains, snow and rivers; constitute a very significant tourism-demand factor.

Many farmers in Europe today are part-time farmers. Only 50% of the farmers in Mayo had farming as their sole occupation in 2000, while the number was 70% in 1991. While only 15% of residents had farming as their main occupation, farm-work as a subsidiary occupation has increased from 20% in 1991 to 35% in 2000. Most farmers in Hordaland are ‘part-time’ farmers. On average, only 16% of the farm household (including the spouse) income comes from agricultural activities. In Hordaland, one observes that the absolute and relative income from farming is decreasing more in areas with increasing non-farm job opportunities and low unemployment rates. Farmers and their spouses spend more time working off the farm than on it. Farm household members are working in many occupations - teaching, construction, public services, mining, tourism, etc. This means that farm households support rural settlements, and contribute to rural development in many and varied ways. It is evident that agriculture, with both its commodity and non-commodity functions, generates an important number of direct and indirect employment positions in the rural economies, and that these contributions are not always measured by conventional means. Farms provide a significant proportion of the labour force in many of the areas. In Trikala, for example, the existence of professional farmers has an important social role in the rural communities in relation to cohesion and traditional lifestyle. Farmers are regarded as sources of local knowledge and expertise in organisations, enterprises, etc. and for entrepreneurial capital.

The primary sector has traditionally been the main productive sector in Trikala in Greece. In 1971, two thirds of total employment was in agricultural activities. In 2001 30% are still occupied in agricultural activities, which is high compared to the national average.

As a consequence of the differences in physical, social and historical conditions, both *the styles and the scales of agriculture* vary and differ among the study areas. In the Hungarian area, almost half of the cultivated area is occupied by large corporate (formerly cooperative) farms. The average size of these corporate farms is 500 ha, whilst the average farm size in the Greek study area is 3.9 ha. Agricultural production across the study areas varies from sheep meat and milk, to oil and wheat. Wetteraukreis, “the German granary”, is one of the most productive agrarian regions in Germany, as well as in Europe. This is due to a moderate climate and a very fertile soil. The production is intensive arable crop production, with sugar beet, wheat and oilseed. Some farmers combine crop production with pork production. In Berguedà, the most important livestock enterprises are pigs and cattle, while cereals are the most important crop. In Hordaland, milk and sheep production are the most important, and the marketed crop production is mainly fruit, both soft and hard. In Sweden production of reindeer meat is important. Farmed land is used solely for grass production for winter fodder and grazing. In Trikala, wheat, maize, cotton, tobacco, fruit, and vegetables are the most important crops; while sheep and goats are the most important livestock.

In Latina province there is a rich and intensive agriculture in the plains and a rather diversified agriculture in the inner area. This constitutes a wide variety of activities and of possible interactions. While the possibility of a multifunctional development is very high and promising in the latter, in the former such a development is less likely to produce spectacular results. The flat area of Agro Pontino is one of the most fertile areas in the centre-south of Italy. It is nonetheless a varied type of agriculture, with areas of excellence and a number of unexploited potentials. In the Agro Pontino, agriculture and agro-industry are quite well integrated. The main production activities concern all the Mediterranean fruits, vegetables, flowers, and dairy farming, with the noteworthy presence of water buffalo farming, which produces the highly specific and characteristic mozzarella cheese. The water buffalo dairy sector is not subjected to the EC quota system. All this together testifies to a high agricultural intensity. The challenges for the future of the agriculture of the province concern both environmental questions, and the problem of product quality. The internal territory of Latina is extremely heterogeneous and diversified, with areas of high tourism potential. Olive trees and livestock are the main agricultural enterprises. This is the area where multifunctional agriculture presumably has the most positive impacts on the overall situation of the territory.

In all areas there is both intensive and extensive agriculture. The negative environmental impacts from agriculture have in Spain been associated with the most intensive production systems. The negative impacts refer mostly to intensive cattle, pig and irrigation systems. The waste from intensive stockbreeding leads to high levels of nitrates in soils and aquifers.

Due to climatic and physical differences, the conditions for farming are very different in the different study areas. Only 2% of the area in Hordaland is agricultural land as compared with 54% in Wetteraukreis and 47% in Bàcs-Kiskun. The importance of agriculture in gross production is small in many of the areas. However, agriculture is regarded as an important *activity* in all the areas.

The agricultural commodity production is quite different from area to area within the TOP-MARD study areas. The externalities, including public goods and public bads, associated with production are also quite different. The social functions of farm residents as part of local communities seem to be more alike. TOP-MARD's concern is to cover a wide range of concerns and problems. The difference in multifunctionality from area to area reinforces the relevance of the project.

4.3 Other important industries in the study areas

The tertiary sector is the most important economic sector in all the study areas. However, In Hordaland and Caithness and Sutherland, fishing and aquaculture are quite important businesses with off-shore industry in oil also being dominant in Hordaland. Caithness and Sutherland also have the decommissioning of a nuclear power station, and new renewable energy enterprises (mainly wind). As with agriculture, these activities mostly require a dispersed population pattern. Mayo is very rural in the Irish context - only 32% live in concentrations of more than 1,500 people (the national average is 58%). Although employment in agriculture decreased by 19% from 1999 to 2003, and increased by 38% in the services sector in the same period, the rural parts are heavily reliant on employment sectors such as agriculture, forestry, fishing, and tourism, which by their nature, are small scale and dispersed. The potential for future employment in Mayo is seen in developing enterprises in communication and information technology, tourism, internationally traded services, and life sciences and medical devices.

Both Bács-Kiskun and Latina have substantial food industries and manufacturing. The most important occupations in Bács-Kiskun are in the trade and retail sectors.

Forestry and wood product related industries account for almost 6% of employment in Västerbotten, compared with 2.4% in Sweden as a whole.

Over 40% of Västerbotten´s employment is in public services of various kinds (compared with a national average of 33%), the most important being education, health and care for the elderly. To some extent, this reflects the virtual absence of a manufacturing sector, and the lack of employment in business and financial services, but it also reflects the age structure of the population. Indeed the public sector is a very big employer in most of the study areas. Health care, schools and public administration constitute a large share of employment.

The industry and regional economy of the Wetteraukreis is highly diversified, and the range of enterprises and companies is very diverse. Thus, high-tech industry and global players are located here as well as traditional handicrafts, small-scale enterprises and family businesses.

Berguedà in Spain is the smallest study area in our sample. Its modern history is largely defined by the river which runs through the middle of the county to Barcelona. The region was the first area in Spain to be industrialized back in the mid-19th century, with textile factories and mines constructed along the riverside. There is little mining or textile work being done now, and the factories and the colonies that once housed the workers, many of them built in a uniform art-nouveau "modernist" style, have been turned into residential centres or tourist attractions and museums. These "colonias" were veritable purpose-built villages, with factory, workers living quarters, church, etc, all built in the same architectural style, often overlooked by the industrialists magnificent mansion perched at a safe distance from the hoi polloi on a nearby hilltop. In the 1970s, Berguedà industry was affected by a strong crisis, specially the textile sector. The closure of the mines worsened the economic and demographic situation. In the last fifteen years, the region has recovered thanks to the building and services sectors. In the period 1991-2001, employment increased in the service and building sector and decreased in the agricultural and industrial sectors. The manufacturing employment is 26.6% of the total and the agricultural working population is only 5.4%. Berguedà industry is very diversified, mainly metallurgical and textile factories. It has very poor ties or relations with the local agrarian and forestry resources. Some exceptions are: four sawmills using wood from the area, a feeding staff factory, several meat factories, a rabbit slaughterhouse, a hemp processing establishment, and several cheese factories.

Tourism - mainstream and niche - makes a substantial contribution to economic development in many of the regions, with Pinzgau–Pongau being the most prominent in this respect. The study area counted 16.6 million overnight stays in 2004 which was 14% of all overnight stays in Austria. Tourists from abroad accounted for 78% of all overnight stays. Infrastructure and institutions directed towards tourists have been built up in a sustainable manner. The local authorities and tourist actors have been very concerned over the importance of preserving the natural and cultural capital in the area. The amenity value of unspoiled mountains, clean rivers, and attractive buildings and farm land is considered a major asset in attracting tourists from all over the world.

4.4 Infrastructure

Most of the study areas have long distances to conurbations with large populations and high-quality, diverse employment. The rural regions are therefore very dependent on the quality of often locally provided and maintained infrastructure. Commuting often involves long distances on poorer-quality roads. Private transport is often required due to the lack of unsatisfactory regional and local public transport systems.

An efficient road network is highlighted in the literature for developing an area's potentials, and for enhancing the capacity in movement of people, goods, energy, and information.

Many of the study areas in TOP-MARD are mountainous. This makes the building of an efficient infrastructure challenging. For example, in Hordaland, the existing road network consists of 250 tunnels, 9 large bridges, more than 900 smaller bridges, and 21 car ferries. The county has one of the highest budgets for infrastructure in Norway – some 160 million Euros were allocated to national investments in infrastructure Hordaland in 2008.

Railway lines and access to (major) airports may be important for the development of the areas. This is especially important for the ability to attract tourists and conferences to an area. For some towns and communities in the study areas, a railway line or closeness to an airport is essential for the existing conference facilities, guide bureaus, hotels, and outdoor activity firms.

4.5 Agricultural and Rural development support schemes[5]

In post-war Europe, agricultural policies were guided by the aim of avoiding a return of food shortages, and to maintain farm families on productive land. The conventional thinking in the westernised countries was to maximise farm enterprise profits and reduce their market risks, and thereby ensure lower-risk investments, continued settlement and high production. In the eastern bloc, the aim was the same, but the policies adopted were different due to differences in the economic and political system, ownership structures and especially collectivism. Here, agricultural policy was part of larger territorial and industrial strategies.

All the countries in the study have programs directed towards protection of natural habitats and more environmental friendly production such as special support schemes towards organic farming. For example, the Irish Scheme of Grant Aid for the Development of the Organic Sector is a sectoral development under the Rural Environment Protection Scheme, so as to improve the organic sector and provide producers of basic products with an opportunity of enhancing income. It also aims to help guide production in line with foreseeable market trends, encourage development of new outlets for agricultural products, help improve production, handling and preparation of organic produce, and facilitate the adoption and application of new technologies. Another example is in Slovenia, where farmers with traditionally extensively used uneven fields get special support to maintain these as they are. They are thereby given an initiative not to use new technology and machinery, avoiding intensive management of the land.

[5] The policies, especially the CAP, are described more detailed in Chapter 2

In Austria, the maintenance of natural and cultural rural landscapes is supported unanimously by the stakeholders and policy makers. As one of the leading rural tourism countries, Austria is well aware of this asset. Agriculture created and shaped landscapes throughout the long run of history, and agricultural management is indispensable for avoiding massive afforestation (or natural regeneration) and hence irreversible change of landscapes, particularly in high-mountain regions. Anyhow, landscapes do not have only constant characteristics but are subject to a persistent process of change. Viable rural landscapes have to meet the requirements of rural dwellers and the agricultural population as well. Thus the maintenance of rural landscapes does not mean the preservation of ancient or historical landscapes without any dynamic; this would not meet the changing needs of the rural population.

The policies most relevant to multifunctionality in Pinzgau-Pungau can be seen in the targeted measures of CAP and the Structural Funds instruments, as well as some aspects of locally oriented environmental policies. As Austria has just one Rural Development Programme (RDP) covering the whole country (with the exception of the objective 1 area in the most eastern part of Austria, Burgenland, which provides for the same measures under that programme), there is a horizontal approach which is not only valid in the study area but all over the country. Three sets of objectives are defined in the Austrian RDP: compensation for special services by farmers, preservation of assets with regard to the maintenance of holdings, and improving competitiveness. It is focused on seven priorities. 60% of the budget for the measures within RDP is provided by the federal budget and 40% by the provincial budget. The most important RDP measures in the study area are the less favoured area (LFA) compensatory allowances within priority III (LFA and areas with environmental restrictions) and the agri-environmental measures in ÖPUL within priority IV (Agri-environment measures). This is due to the high proportion of mountain farms, alpine pastures and organic farms in the area. There are some complementary support payments for agriculture and forestry on the province level. The Austrian team reported that a spatial analysis of the distribution of the CAP funds, for Pillar 1 and Pillar 2, had been applied at a regional level and showed quite contrasting up-take of measures between regions. In particular, the analysis underlined the importance of mountain farming support in the Austrian context which is also visible in the study area of Pinzgau-Pungau .

Austria is one of the countries where the Leader approach has been taken up from the beginning. In particular, the experience from former Leader-like national measures, the former FER programme (Förderungsaktion für eigenständige Regionalentwicklung), promoted by the Federal Chancellery, has contributed to the commitment and success of Leader participation. In the LEADER+ programming period (2000-2006) the financial support programme of the EU was coordinated by the Federal Ministry for Agriculture, Forestry, Environment and Water Management (BMLFUW). Even though the Leader+ Programme is co-financed exclusively by the agricultural funds of the EU, the fields of activity of all three EU Structural Funds are (theoretically) eligible for promotion. This made it possible for Leader+ to be continued as integrated programmes, giving selected Local Action Groups extensive discretionary powers in the choice of measures they wish to implement for the development of their region. The Leader+ Programme realises to a great extent the approach that, in regional development literature, is referred to as “bottom-up approach”. While the LEADER+ Programme Austria was conceived and approved of as a national programme, the processing structures are designed in accordance with Austria’s federal structures. Accordingly, the Provincial government authorities were responsible for the implementation of the programme. As in the previous period, a national network acted as service point and supporting agency to enhance innovative action and exchange of experience between involved regions.

As for large parts of Austria, the study area comprises significant activities of LEADER+ groups. 47 of all the 53 municipalities in the study area are members of the three active LEADER + Groups in the period 2000-2006. The municipalities strive to deepen the cooperation of stakeholders in the region and to create a host of projects, in particular including new kinds of cooperation between agriculture, tourism and restaurants. The mid-term evaluation of LEADER+ in Austria drew a rather positive picture of implementation of LEADER+.

In addition, the Structural Funds have been used for regional development. Particularly in the period 1995-1999, the Objective 5b areas support provided a significant incentive and gave rise to deepened discussion on the development of regional strategies in this region. The entire region is also participating in the Interreg IIIA cross-border cooperation programmes Austria-Germany and Austria-Italy. Large parts of the study area have also been included in the Natura 2000 designated areas, reflecting its environmental sensitivity.

The sensitivity of the area recalls the main focus of mountain policies which reflect the multiple tasks of mountain farming, i.e. concentration of support to farmers with substantive agricultural production difficulties, agri-environmental schemes to encourage continuation of farming and secure farm management under these conditions, and a specific orientation towards high quality production. The shift towards a more explicit quality orientation is a rather recent element in Austria’s mountain policy, but it seems that there is quite at this time considerable momentum to increase and shift activities towards this aspect, particularly in a mountain area context like the study area.

Policies that are relevant to multifunctionality in Trikala are related to both the farm and non-farm sectors. In relation to farming, CAP Pillar 1 payments are directed towards the local farming systems. These payments are estimated at 30 million Euros per annum and mostly concern cotton, cereals, livestock-premia and direct aids. Greece lists eight policies relevant to multifunctionality and the transformation of these functions into local development. Among these are special schemes directed towards traditional Mediterranean crops, extensive livestock grazing, accommodation and craft activities of farm households, and agricultural and rural heritage. These are all schemes that can be argued represent a shift in focus from strict agricultural policy towards either environmental related activities or diversification on farms. **Leader I and II** have also influenced rural development in Trikala. The Local Action Group (Kalabaka-Pyli) has been successful in promoting endogenous local development on an area-based and partnership approach. The Leader I budget amounted to around 8.5 million Euros and emphasised rural tourism (45% of expenditure), SMEs (21%), Food and Timber Processing (19%). Leader II amounted about 11 million Euros and was mostly concerned with investment in rural tourism (37%), SMEs (16%) and Food and Timber Processing and Marketing (25%). Under **Leader +** the total budget that Kalabaka-Pyli will manage is about 9 million Euros.

In Germany, the concern towards the negative impacts of farming on biodiversity, wildlife, and the environment has resulted in a new cross-compliance instrument that may have positive impacts on soil quality, wildlife and landscapes. Extensification of agriculture is also supported with agri-environmental payments of the *Hessische Kulturlandschaftsprogramm* and the *Hessische Landschaftspflegeprogramm*. The latter is the most important instrument in the implementation of the Natura 2000 network in Wetteraukreis.

The German team also emphasises the significance of a local advisory service initiated from the public administration of Wetteraukreis for farmers who want to become active in direct selling and marketing. The programme will help to open up new sources of income and to save jobs. In recent years, approximately 120 farms have established direct selling of local products.

The EEC agri-environmental Regulation 2078/92, and its successors, have been implemented in Ireland through a whole-farm scheme, Rural Environment Protection Scheme (REPS). The initial REPS, commonly referred to as REPS 1, was launched in 1994. Under REPS 1, a total of €108m was paid out to participating farmers in Mayo. REPS II, running from 2000 to 2006, had paid out €81m to farmers in Mayo up to the end of April 2006. REPS III started in February 2004, and up to the end of April 2006 had paid out €26m to participating farmers, 3,000 of which were active within the Scheme. Within Mayo, up to the end of April 2006, a total of €216m had been paid out to participating farmers across all the various REPS. The REPS is designed to reward farmers for carrying out their farming activities in an environmentally friendly manner and to bring about environmental improvement on existing farms. The Scheme is co-financed 75% by the EU and 25% by the Irish Exchequer. Farmers receive an annual payment, which is on a declining scale as farm area allocated increases, and those with land in designated areas such as SACs, SPAs, or NHAs,[6] receive 'top-up' payments. Additional payments may be made for participation in Supplementary Measures (Pillar II funds). Under the National Development Plan (NDP), a number of opportunities exist for grant assistance to organic operators to invest in equipment and facilities for production, preparation, grading, packing and storage of organic products. Thus, the Scheme of Grant Aid for the Development of the Organic Sector aims to improve the organic sector and provide producers of basic products with an opportunity of enhancing income, to help guide production in line with foreseeable market trends, or encourage development of new outlets for agricultural products, to help improve production, handling and preparation of organic produce, and to facilitate the adoption and application of new technologies.

In 2001, the whole of Sweden except Norrbotten, Västerbotten, Västernorrland and Jämtland were included in the horizontal Leader+ programme. Even in the areas that were excluded the authorities have adapted the Objective 1 programme to support LEADER-like groups. For instance, new companies have been started, employment rates increased and young people have been engaged in rural development through initiatives made possible by the LEADER programme. The national Leader+ programme is financed through EAGGF Guidance, or Pillar 2 of the CAP. Evaluations so far completed suggest that environmental and cultural heritage objectives have been fulfilled, while those concerning employment and equality between the sexes seem harder to achieve. In the Leader+ program, the cooperation between private, public and non-profit organisations has been working well.

A LEADER-like group (not financed by the Leader programme) is the project "*Stad och Land*" (Town and Country) a local development programme which operates in the Umeå Region. The County Council, Objective 1, the County Administrative Board in Västerbotten, the Umeå Region, and voluntary groups have contributed to the financing of the project, which will end in 2006. The aim is to create economic growth and increase the number of people living and working in the Umeå Region. Examples of activities or projects run by "*Stad och Land*" is "*Bo-i-Nordmaling"* (Live in Nordmaling) where the aim is to stop the negative out-migration through marketing and cooperation and "*Bondens egen maknad*" (the farmers own market) where farmers are encourage to promote and sell their own, locally produced products directly to the public on a market in Umeå city centre

In 2007, a new Rural Development Programme for Sweden will replace the existing program. The new program will cover Objective 1 areas and Leader+ (Ministry of Agriculture, Food

[6] SAC= Special Areas for Conservation; SPA=Special Protection Area; NHA=Natural Heritage Area.

and Consumer Affairs 2006). The government proposal outlines the overall strategic direction of the Rural Development programme – which is presented in terms of rural development which is economically, ecologically and socially sustainable.

Measures taken by the new program are intended to secure a sustainable use of natural resources, strengthen the spirit of entrepreneurship, and result in growth, employment (both within agriculture and forestry industry and also within other industries in rural areas) and an attractive living environment. The new program will continue to be closely linked to environmental policy and will also contribute to the fulfilment of the 16 national Environmental Quality Objectives. A commitment from rural societies and groups with a bottom-up perspective will be supported. One difference between the existing program and the new one is that in the latter activities and entrepreneurs not involved in farming will be able to participate, especially when it comes to policies regarding quality of life in rural areas and the diversification of the rural economy.

The Government decided in July 2006 that the new rural development program will have four axes, in conformity with the EU Regulation (Million of SEK per year are presented by each Axis)

Axis 1: Increased competitiveness in agriculture and forestry - 693 million (14%).
Axis 2: Administration of natural resources in rural areas. Measures for the environment and landscape - 3527 million (71%).
Axis 3 Increased diversification of the rural economy and secure quality of life 419 million (8%).
Axis 4: Applying of the Leader method for implementing of the new rural development programme - 339 million (7%).

Most of the measures taken by the new programme will fall under Axis 2, which can be described as environmental subsidies going to farmers who keep the landscape open and cultivated and who preserve biodiversity. In Axis 2, more money than in the previous programme will go to measures for an open and varied landscape in northern Sweden.

The Swedish government has given each County Administrative Board in Sweden the responsibility to develop (with other local actors) a *Regional Development Program - RUP*[7] - for the period 2007-13. The aim of the RUPs is to improve coordination between local regional development strategies (such as the *Regional Growth Program in Västerbotten - RTP Västerbotten),* and other national/EU policies (such as the Environmental Quality Objectives, Objective 1, and the ERDP) which seek to promote sustainable development. RUP Västerbotten is thus intended as a reference document for the other more "concrete" policies or strategies operating within the county. Both public and private organisations have been involved in the work with the strategy and the aim of the document, and the consultation has been to identify, prioritise and focus on the opportunities and challenges the county faces in coming years. The RDP will also highlight issues important for Västerbotten on a national level.

All of Berguedà, except for 3 municipalities is considered mountainous. A total of 224 farmers receive 'less favoured and mountainous area' compensatory allowances. The amount of the annual compensatory allowance during the period 2005/006 is a minimum of 300 euros and maximum of 2,000 euros. Almost all livestock farmers receive the maximum amount. The demand of Agri-environmental measures has been rather small in Berguedà. In 2004,

[7] *Regionalt utvecklings program*.

only 20 applied: 11 related to the conservation of pastures; 4 related to ecological livestock; 4 related to ecological crops; 2 related to apiculture and 1 to dry sunflowers.

In Berguedà there are grants to improve the quality of life for farmers directed towards investments in farmers' main residences. The conditions to receive such aids are either that the residence is linked to farming activities or complementary activities, and are in a rural nucleus of less than 3,000 inhabitants, or built on an isolated farm plot. In 2002, 11 such grants were given. The total investment stimulated by these grants was 213,218 euros (average of 19,383 euros) with 50,241 euros subsidy (28% of the total). All investments were for the rehabilitation and/or improvement of the houses.

There are also special grants to establish or improve tourism facilities. These are, for example, used to transform houses into "*Residències cases de Pagès*" or to improve already existing facilities and publicity.

Parts of the county (mainly the area affected by fires) were the beneficiary of LEADERII Programme during the period 1994-1999. The whole county is included in the LEADER+ Programme (2000-2006).

There are 27 different support schemes available for farmers through the Norwegian Agricultural Authority. In addition, there are some support schemes available for the food industry and the authorities of municipalities and counties benefiting agriculture.

The support schemes may be categorised in production support, price support, production area support, regional and freight subsidy, environmental programmes, education and skills upgrading support, welfare and relief worker support, support for forestry planning and planting, and special programmes on organic farming.

The number of – and support for - the different support schemes is a subject of yearly negotiations between the central government and the two farmers unions. The total amount of governmental support to farmers is about Euro 1.375 billion. In addition, the border protection schemes, i.e. the indirect support provided to allow farmed products to be sold on a protected inland market, are estimated to cost Euro 1.125 billion. Support per man-year is Euro 36,250. Support in percent of gross production value is close to 70% (2004 numbers).

The 27 support schemes are administered nationally. Some of the procedures and preparations are made at the governmental agricultural office in each county, but the regulations are the same in all parts of the country. In the yearly negotiations about the different support schemes between the central government and the two farmers unions, there is always a clash of interests between the two unions about the distribution of funds in the different schemes. Some schemes are more in favour of small mountain farms, some more in favour of larger flatland farms. This disagreement is partly a result of centralised negotiations. Many farmers, and farm union representatives, in the study area are dis-satisfied with the way that the support funds are distributed. They argue that the schemes and funds are suited to the rich farmers with big estates in the good agricultural areas, not for the poor and marginalised farmers.

As of 1 January 2004, the new state-owned company Innovation Norway has replaced the following four regional support scheme organisations: The Norwegian Tourist Board, the Norwegian Trade Council, the Norwegian Industrial and Regional Development Fund, and the Government Consultative Office for Inventors.

Innovation Norway promotes nationwide industrial development of value to both the business economy and Norway's national economy, and helps to realise the potential of districts and regions by contributing towards innovation, internationalisation and promotion. The core group of clients is Norwegian companies, predominantly SMEs. Innovation Norway does not have special programs on agricultural development, but there are special programs directed towards *rural* development. It has the function of coordinating different funds at regional level decoupled from industry, and to use their network to distribute ideas and investigate market opportunities.

The yearly agricultural and rural development expenditures in Hordaland in recent years, split according to the CAP structure, show that Pillar 1 type support accounts for a large share of total rural support. Only a small portion of the funds goes to industries other than agriculture. Pillar 1 type support accounts for 52% of the total support schemes for agricultural and rural development in Hordaland. However adding the cultural landscape support increases the direct payments to farmers with additional 16%. Schemes within Pillar 2 Axis 1 like support, stands for 3%, Pillar 2 Axis 2 like support: 21% (incl. the cultural landscape scheme), and Pillar 2 Axis 3 like support: 20%.

In Hungary and Slovenia, the problems related to post-war agricultural policies were different from the other countries in the study, and, until at least the pre-accession period, have been dealt with by other types of initiative and technologies. The transition into a new economic system and new governing bodies has faced farming and the agriculture industry with huge challenges. The national policy in the new member states has to work towards compliance with the EU system.

After the transition and EU-membership, Slovenia lists the following rural development measures:

1. LFA support (preservation of agricultural landscape and production potential in mountainous areas)
2. Agri-environmental measures (reduction of negative environmental impacts of agriculture)
3. Agri-environmental measures (preservation of natural amenities, biodiversity and traditional landscape)
4. Agri-environmental measures (preservation of protected areas; Triglav National Park)
5. Food quality schemes (support for cooperation of producers in production and marketing of certified agricultural and food products; e.g. geographic denomination, geographic origin, organic products)
6. Support for economic diversification of agricultural households (increasing economic viability of rural areas)

In addition, the rural areas take part in several cohesion policy measures:

1. Cohesion funds: investments in major transport network (improved accessibility for rural areas; but possible degradation of agricultural land, quality of landscape)
2. Cohesion funds: investments in environmental infrastructure (conditions for more sustainable use of natural resources; improved conditions for land-based activities (agriculture, forestry, also rural tourism)
3. ERDF: support for investments in tourist destinations (addressing the tourist potential of the region, rural employment; (problem: only a few of the potential destinations are eligible due to poor criteria)
4. Improved access of vocational training and other lifelong learning services; improved skills for the agricultural workforce to adapt to market needs (improve efficiency of

agricultural production, diversify, or target niche markets in agriculture and related activities).

4.6 Conclusion: the Study Areas in relation to the TOP-MARD project.

The comparison shows that a wide and diverse variety of rural regions and different ways of farming were selected for analyses in the project. The selection of areas is therefore entirely consistent with the work description of the project.

The study areas have been influenced by somewhat different policies and schemes, notably at local level. They cover different styles of farming. They differ in relation to economic history, social conditions and demographic patterns. The topographic map of Europe illustrates the differences in relation to climatic, geographic, and physical conditions. Although external costs and benefits of agricultural production are not fully internalised in agricultural support schemes, the multifunctional *role* of agriculture seems to be recognised in all of the study areas. Although it is impossible to select a completely representative set of study areas in the statistical sense, this comparison and presentation show that the TOP-MARD selection *is not unrepresentative* of the diversity of rural areas and farming types within Western Europe and the CEECs. We therefore believe that the research results from our study areas, and comparisons between these, provide a robust foundation for making more general comments and conclusions for policy makers and others.

5. EUROPEAN ANALYSIS OF SURVEY RESULTS

By Tibor Ferenczi, Krisztina Fodor, Attila Jambor and Karen Refsgaard,

Information gathered in the farm household and entrepreneurs survey served as the primary source for the analysis which helped to identify the different functions of agriculture with regards to special characteristics of agricultural firms, their role in rural development and the creation and transformation of public and private goods and services. In addition, a Quality of Life survey of at least 30 rural residents, focusing on young people, the elderly, and women with children was undertaken to explore the importance of different elements of quality of life (using the 'capitals' approach), the role of agriculture in terms of these elements, and their relationship to decisions to leave, enter or remain in the study area as a resident (i.e. migration decisions).

Data in the farm household and entrepreneurs survey was gathered using a personally administered questionnaire applied to a representative group of 30 farms, 10 farms specifically selected for their innovative multifunctionality, and 20 non-farming entrepreneurs considered to be engaged in transforming public and private goods associated with farming in the area. Data for the Quality of Life survey was also gathered using a carefully designed questionnaire, usually applied in focus groups to allow careful explanation and discussion of the surveys intention and content. The surveys are described in greater detail in Chapter 3.

Although representativity of farms was problematic due to the small sample size, and to an extent diminished by the decision to include 10 specially selected farms, the teams consider their samples to be not unrepresentative of farming, multifunctionality and farm household characteristics in their study areas. However, a few variables in certain relationships are often over- or under-represented, and the aggregate data for any study area cannot always be comparable with official statistics based on census or large samples. On the other hand, the survey provided information not otherwise available in official sources. However, with respect to the multifunctionality of the agriculture data collection was considered by the teams to be representative. Multifunctionality is considered by many to be more present on larger farms and these farms are over-represented in the sample.

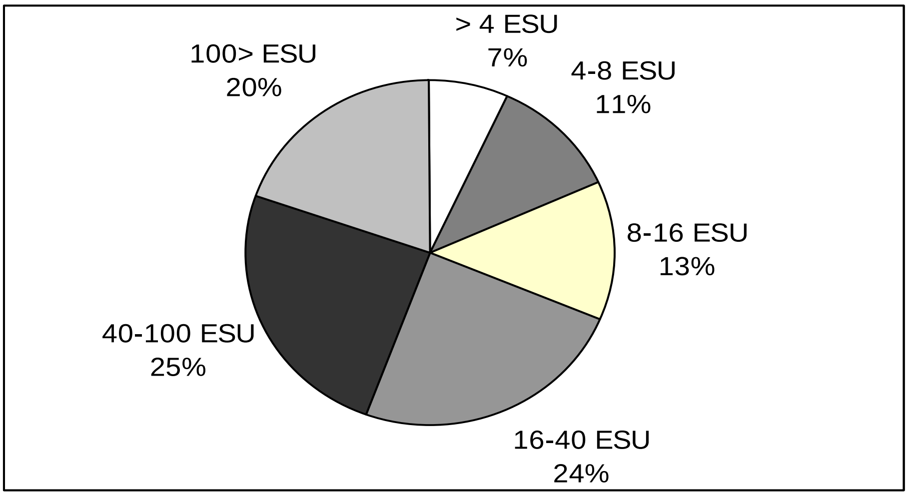
Therefore conclusions and statements made based on the analysis of the farm surveys are applicable for the analysed enterprises, and can often only be generalised and used with qualifications.

5.1. Farm survey

In addition to the regional context, farms were analysed according to size, type and regional location. Furthermore, conventional and organic farming methods were compared using information from the questionnaire.

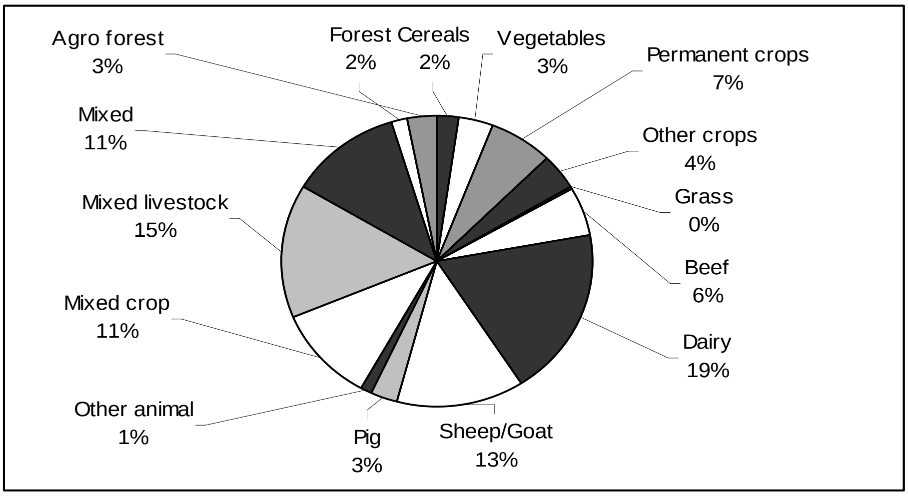
In terms of size almost one fifth of the surveyed farms had fallen into the largest group (above 100 European size units), while 7 percent had belonged to the smallest (below 4 ESU) as demonstrated in Fig 5.1.

Figure 5.1 Economic Size of Sampled Farms



Farms were typified according to their standard gross margin and types of production. Farms involved in animal husbandry formed the majority of the sample. The three most typical categories which included almost half of the analysed farms were dairy cow, sheep and goat, and mixed livestock (see Figure 5.2). Consequently crop farming was significantly under-represented. This is partly because farms in mountain areas, and those with grazing livestock, were over-represented, due to our choice of study areas.

Figure 5.2 Type of Farming of Sampled Farms



Due to the sampling process the share of organic farms is 17.4 percent which is significantly exceeds the EU average.

Almost 60 percent of the farms participating in the study were located in under-populated areas, while one fourth of the surveyed enterprises were located in villages or small towns.

Data collection has covered 45 thousand hectares of arable land and the average farm size exceeded 100 hectares. According to the analysis, Scottish farms had the largest average size, while Hordaland (NO) had the smallest average size. Scottish, Irish and Austrian farms are based on livestock grazing; and farms involved in sheep-, goat-, and cattle production have the largest average size.

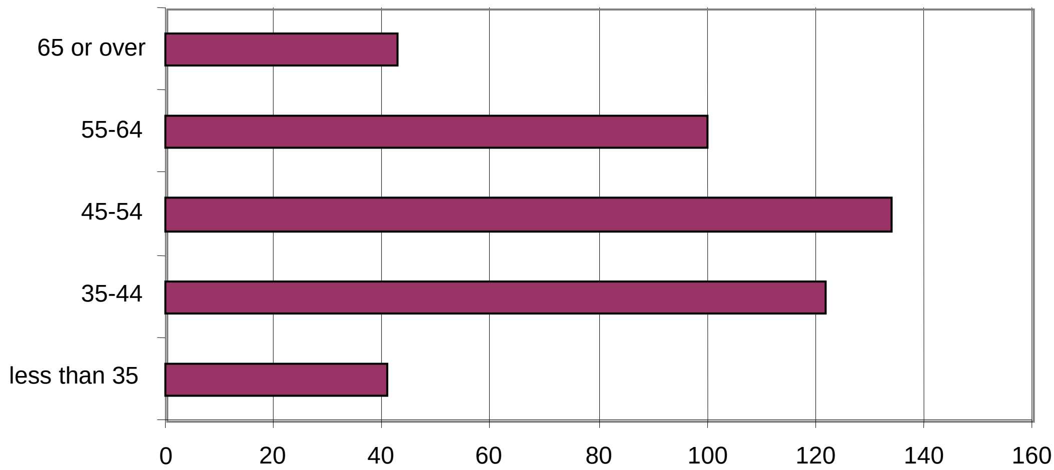
The analysis revealed that German farms have the highest proportion of rented land, and Austrian farms the lowest. This is because Austrian farms are mainly engaged in livestock grazing and seldom rent-in land while German farms are involved in arable farming where renting of additional land is more usual.

In addition to pasture-based animal husbandry, livestock production using stables requires feed, fodder and often bedding from arable farming. The survey results show that more than 40 percent of the farms produce grains and 14 percent produces other crops such as forage crops. Besides the already mentioned grasslands, the number of farms with forested area was also significant.

One third of the agricultural holdings had cattle while one fourth had sheep livestock. The share of other types of animals is less important.

The majority of the farmers participating in the survey were middle-aged; the average age being 49 years. One third of the farm holders had tertiary level education (Figure 5.3).

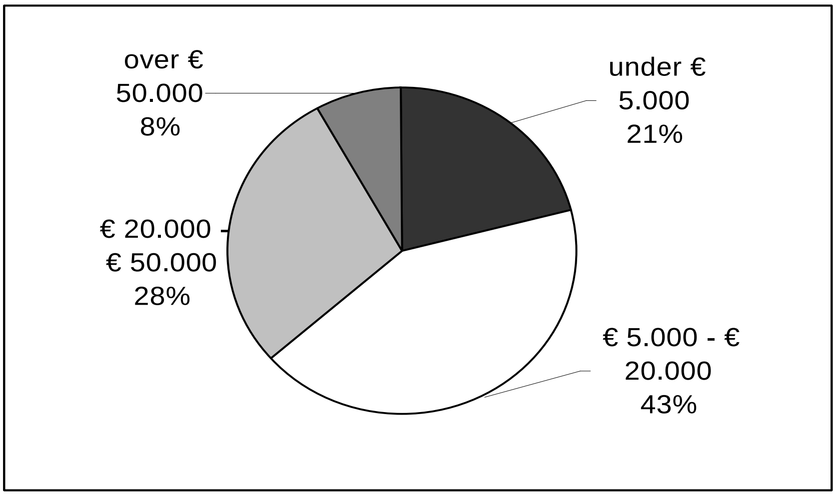
Figure 5.3 Distribution of Holders of Sampled Farms by Age



The research had also covered the non-agricultural activities of holdings. More than 10 percent of the farm processed their own outputs and were involved in rural tourism. During the research process, opportunities for the development of certain new activities related to multifunctionality were also analysed. Data gained from this process revealed that farmers consider direct marketing of their own products the simplest to develop.

With respect to profitability and income sources the research found that although more than three-quarters of farm holders are employed in agriculture, only half of their income comes from agricultural activities. According to data collected the average income produced by agricultural activities was almost 21,000 Euros (income distribution: see in Figure 5.4). The highest average income from agricultural activities is obtained by Italian farmers while the Austrians reported the lowest income.

Figure 5.4 Distribution of Sampled Farms by Net Farm Income



The analysis revealed significant differences between countries in terms of perceived future income prospects. Hungarian, Norwegian and Italian farmers expect positive changes in the future while Austrian, German and Slovakian farm holders are more pessimistic. It is conspicuous that a pessimistic attitude is typical of the smallest farms.

The effects of different subsidies and funding were included in the study. Almost 80 percent of farms included in the survey had received some kind of financial support. However, the share of farms receiving subsidy is lowest in Latina (IT) where only 30 percent had received direct financial support. By way of contrast, every single Irish farm and all except one in each of Scotland and Sweden in the sample received subsidy. Most farmers in the sample were also satisfied with the measures and financial support system. A significantly higher number of large farms had received some kind of financial support.

The opinion of farmers about their region was also analysed. The data indicates that farmers perceive the economic development of rural areas negatively although they evaluated their region friendly and homely.

5.2. Entrepreneurs survey

Twenty entrepreneurs were selected from each region who were deemed likely to use public and private goods from farming as tangible or intangible (‘externalality’) inputs into their own businesses. The scope of the enterprises included conventional processing and sales activities, renewable energy, rural tourism and recreation, and new forms of integrated activities. They included innovative enterprises. .This sample was deliberately selected, with the advice of NUGs and feedback from the farmers interviewed, and was not intended to be a representative sample of all entrepreneurs in the region.

In addition to cross-national comparison, the responses of entrepreneurs were analysed based on other variables such as economic sectors and regional location.

Compared to agricultural holdings, significantly higher number of these entrepreneurs was located in more urbanised areas. Almost one quarter are located in larger towns and cities, while 40 percent are located in villages or small towns.

One third of the entrepreneurs were operating in tourism and catering as well as the processing sectors (Table 5.1)

Table 5.1 Distribution of Sampled Enterprises by Main Type of Business

Type of business sector	Number of enterprises	Share of enterprises, %
Agriculture, hunting, forestry and fishing	21	9.2
Manufacturing and mining	75	32.9
Wholesale and retail trade	23	10.1
Tourism and recreation	77	33.8
Other services	32	14.0
Total	228	100.0

Entrepreneurs chosen to the sample were mostly small or medium sized with an average of 23 full-time and 5 part-time employees. And they were in general satisfied with the quantity, but not with the quality, of the local labour supply. Half of the businesses had no changes in the number of employees and do not expect any changes in the foreseeable future. Furthermore there were only a few entrepreneurs who had or have any intention to decrease the labour force.

German employers prefer full-time employment while in Bács-Kiskun (HU) part-time employment is more common. Hungarians were the most satisfied with the quality of the labour force while Slovenians were the least satisfied. Based on the responses given in the survey the local labour force barely satisfied the needs of Slovenian and Greek entrepreneurs.

70 percent of the demand of businesses for agricultural products was met locally, while 30 percent acquired such raw materials directly. The reliance on local commodities and raw materials is the most typical in Hordaland (NO) while Scottish enterprises were least dependent on local produce.

In some ways unsurprisingly entrepreneurs involved in tourism and catering are the largest consumers of local agricultural products. Commercial enterprises act as both consumers and retailers in their relationship with farmers.

Certain questions in the survey were related to the functions of agriculture. In their responses the entrepreneurs named raw-material production, landscape management, and food quality the three most important functions of agriculture. Table 5. demonstrates the types of relations of the enterprises with local farmers.

Table 5.2 Types of Relations of The Enterprises with Local Farmers

	Number of farms	Share in total number of farms in area,%
Sale of production inputs to farmers	26	14.7
Purchasing of agricultural (raw) products	115	65.0
Use of farm household labour	16	9.0
Providing a service to farms	40	22.6
Other	20	11.3
Total	177	-

Similarly to farmers, entrepreneurs found their local environment friendly and homely, but also emphasized the lack of regional independence as a negative feature.

5.3. Quality of life

In the quality of life survey rural population was divided into three main groups: elderly people, women with young children and young adults. This targeting was related to the importance of measuring motives for inward and outward migration, and the relationship with the various elements of quality of life, including material, natural, cultural and social capital. As with the other surveys, in addition to cross-national analysis, data were grouped according to whether the respondents their settlement in the area (always lived there, potential out-migrants or in-migrants) further according to criteria such as age, gender, educational level, income, and location.

Half of those questioned were born in the region they live in and do not intend to leave the area in the foreseeable future. Respondents named family reasons as the most important cause of migration. People moving to a new region for better quality of life mentioned that they were attracted by the environment and recreational activities; while out-migration of people from a region is for employment, higher education, and access to culture.

Among the surveyed regions, out-migration is highest in Caithness/Sutherland (UK) and in-migration highest in Hordaland (NO). Young adults usually migrate because of educational reasons while young adults in the labour force migrated in order to find better employment opportunities. The migration of the middle aged and elderly population was guided by family and life quality reasons. However, there are differences between Northern and Southern countries, between genders, and between education groups, and often these differences are cancelled out in the aggregate analysis. Thus, for example, the “Male” often evens out the "Female"- effect in relation to natural and cultural capital, and the northern part of Europe evens out the "material capital"- effects found in southern Europe.

As described in Chapter 3, we used a ‘capitals approach’, investigating the importance of material, human, natural and cultural capital in both quality of life and actual or perceived migration behaviour. In Table 5.3 we give an overview of the different capital groups for each country across different variables, and also for the countries combined. At the end there are some diagrams which show the capital means for some of these groups between countries.

Table 5.3: The importance of various capitals (var_2.1 to var_2.5) and average QOL-rating (var_6.1) across all countries within different groups

ALL COUNTRIES!		Material capital	Natural capital	Cultural capital	Personal Wellbeing	Social capital	Average QOL rating	N
Gender	Male	21,84	17,28	10,00	25,22	25,66	4,10	204
	Female	18,52	17,74	9,77	25,27	28,69	4,01	364
Youth (Age 0 to 19)		19,66	16,14	10,93	24,80	28,47	4,10	185
Family (age 20 to 64)	No high school	26,47	16,32	11,47	19,71	26,03	4,09	34
	High school or associate	20,53	17,44	8,92	26,32	26,80	3,88	133
	Bachelor or graduate	15,39	19,11	10,50	27,04	27,96	4,04	98
Seniors (age 61 +)		20,87	19,15	8,44	24,44	27,05	4,14	117
Migration status	Stayer	20,98	17,14	9,24	24,70	27,95	4,04	322
	In-migrant	17,43	18,84	10,06	26,24	27,41	4,14	189
	Out-migrant	21,13	14,59	11,68	25,68	26,88	3,86	97

In terms of material capital, housing was evaluated as the most important element, and respondents are satisfied the most with this capital. People valued the quality of drinking water and air the highest among the natural capital. Sufficient local education was the most often mentioned cultural capital. Health care has been evaluated as the most important aspect of personal wellbeing. Furthermore having strong connection with family and friends has been ranked as the most important aspect of social capital.

On the whole Irish were the most satisfied with the quality of life while Hungarians the least satisfied (Table 5.4).

Table 5.4 Integrated level of satisfaction with living standards (using the five-point Likert scale, with 0=low and 5=high), by countries and location

	Mean
Country	
Austria	4.4
Germany	4.1
Greece	3.4
Hungary	3.3
Ireland	4.7
Italy	3.7
Norway	4.4
Scotland	4.2
Slovenia	3.8
Spain	3.9
Sweden	4.2
Location	
In the countryside	4.3
In a village or small town with less than 2,000 inhabitants	4.1
In a larger town	3.9

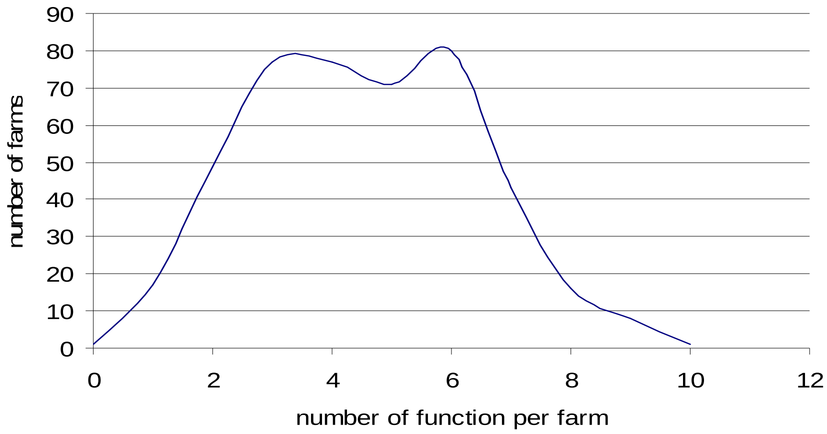
5.4. **Multifunctional agriculture**

The following functions related to agriculture and farm household activities were identified in the farm survey of our project:

1. Production of farm goods
2. Processing of products
3. Providing accommodation
4. Other tourism activities
5. Landscape management
6. Water management
7. Soil management
8. Air quality management
9. Animal Welfare
10. Preservation of wildlife (biodiversity)
11. Contribution of farm household labour to local economy
12. Climate
13. Renewable energy production
14. Preservation of the cultural heritage
15. Social Cohesion
16. Entrepreneurship

Functions such as social cohesion and entrepreneurship are typical for almost all analysed farmers. In two out of three farms there are household members who have other, off-farm work in the region. Attempts on protecting water and soil quality are also important but not linked equally to other functions. Processing of farm products is also an important function which is related to other functions. See distribution of farms by activities in Figure 5.5

Figure 5. 5 Distribution of Farms by Number of Fulfilled Functions



During the comparison of these functions, economic size, farming type and style, as well as location were taken into consideration.

The production of agricultural goods as basic function was not an object of the research since agricultural farms were analysed in detail in the first part of the study.

27 percent of the farms surveyed performed some kind of processing activity. All the surveyed Swedish farmers processed the goods they produced. Naturally there are certain types of enterprises where processing is more significant, e.g. enterprises involved in horticulture and forestry. The share of organic farms was notably higher among those who performed some kind of processing activity than among those who did not.

Only 9.5 percent of the surveyed farms provided tourist accommodation. This activity is most common in Pinzgau/Pongau (AT); while German, Hungarian and Italian farmers are the least involved in providing accommodation. Tourism related activities and services were mainly performed and provided by large farms.

Other tourism related activities are the most typical in Hordaland (NO); while, as with provision of accommodation, none of the German and Hungarian farmers were involved in any of the other tourism related activities. Those farms with other tourism activities were also more likely to provide accommodation and undertaken on-farm processing.

6.4 percent of the surveyed farms had an activity aimed at improving landscape quality. Scottish, German, Hungarian and Swedish farms were, for the most part, leading the way. The largest farms were involved in such activity since more than half of the farms reporting activities improving landscape quality had over 100 hectares of land.

45 percent of the surveyed farms claim to have managed to achieve substantial positive changes concerning water management. One fourth of the German and Slovenian while half of the German, Swedish, Italian, Hungarian and Scottish farms contributed to the improvement of water quality and quantity. In case of the improvement of water quality attempts to reduce fertilizer and pesticide use seemed to be effective. Not surprisingly, these enterprises emphasized damage to water quality as the most important negative environmental effect of agriculture.

Since there was no direct data on the physical impact of farming on soil quality, surrogate or proxies used were the use of fertilisers and pesticides and change in intensity. Survey data revealed that half of the farms undertook some action that would relieve the pressure on soil quality. Greek farmers think they were able to achieve the best results; in contrast Irish and Spanish farmers were less optimistic. The fact that one quarter of the farms claiming success were practicing organic style farming might explain the perceived reduction of toxic material usage. By contrast, the share of organic farms among those who did not think they had been able to improve soil quality was only 10 percent.

14 percent of the farms had subsequent changes in the husbandry system or improved animal welfare. Gorenjska (SI) was leading the way with one quarter of its farms having investments aimed at improvement of animal welfare. The share of this type of investment was also high in Norwegian and Italian farms. These farms are usually larger in size and characterised by organic style farming. In addition to improving animal welfare, half of the surveyed farmers plan to increase their livestock in the future.

Farm household labour’s contribution to local economy is basically related to the off-farm income-earning activities of household members. Almost two thirds of the farms have at least one family member working off the farm. Half of the farmers perform some kind of off-farm income-earning activity. The smaller the farm is, the more likely it is that the farmer has a source of off-farm income.

Farms investing in more environmentally-friendly machinery, decreasing the number of ruminant animals (i.e. decrease methane emission), reducing energy use and contributing to renewable energy production were regarded as linked to the function dealing with air quality. Almost one-third of all surveyed farms met these criteria. Every other German and Slovenian farm had one of these activities. Large dairy farms typically met one of the above-stated criteria.

The survey extended to future possible decisions on the multiple roles of agriculture (Table 5.5).

Table 5.5 Distribution of Farms with Interest in Developing New Activities by Location

	Agri-tourism	Nature- and landscape management	Care and therapeutic services	Learning activities for local schools and children	Organic farming	Registered high food quality schemes	Direct selling of products/short chain	New off-farm income sources
Number of farms								
Outside a built-up area (in open countryside)	70	79	11	53	49	65	75	50
In a village or small town (<5,000 persons)	31	42	8	25	40	41	56	27
In a larger town or city	6	10	2	4	12	6	14	7
Total	107	131	21	82	101	112	145	84
% of total farms								
Outside a built-up area (in open countryside)	26.8	30.3	4.2	20.3	18.8	24.9	28.7	19.2
In a village or small town (<5,000 persons)	21.8	29.6	5.6	17.6	28.2	28.9	39.4	19.0
In a larger town or city	17.6	29.4	5.9	11.8	35.3	17.6	41.2	20.6
Total	24.5	30.0	4.8	18.8	23.1	25.6	33.2	19.2

According to the survey analysis criteria, farms were taking a cultural role where *the farmer or one of the household members were part of a farm tourism organisation, a local educational or cultural association, or had produced handicrafts*. A quarter of the farms were somehow connected to a local organization which had an influence on the cultural development of the region. This kind of function is least typical of Greek, Italian and Spanish farms. Medium size farms mainly dealing with animal husbandry are more often connected with culturally-connected organizations. Only three percent of the total surveyed farms have some type of handicraft activity. In addition to the above mentioned, participation in the local church is also important.

The research considered those farms to facilitate social cohesion which had at least one membership of any local organisation. 90 percent of the farms chosen to the sample met this criterion. In Pinzgau/Pongau, Caithness/Sutherland (UK), Gorenjska (SI) and Västerbotten (SE) all surveyed farms have at least one household member who is a member of a local organisation.

Entrepreneurship was examined where farmers had completed a secondary level of education or higher, or attended training programmes, were planning to increase farm household activities or where an increase in income is expected. At least one of these criteria applied to 85 percent of the farms. Entrepreneurship is less typical for Irish farmers (which are larger and mainly involved in crop farming) since only less than half of the farms belong to this group. The processing of own products is the most important non-agricultural activity among these farms. These entrepreneurial farmers evaluate their region more critically than others.

5.5. Relationship between functions

Farms surveyed characteristically have several functions. More than two-thirds of the farms have at least four different types of functions. One farm among the 440 surveyed had as many as ten different functions. Functions such as social cohesion and entrepreneurship were typical for almost all analysed farmers. Two thirds of the farms had household members receiving income from other off-farm sources, indicating the importance of farm families for the regional labour market. Efforts to protect water and soil quality were also important but the relationship with other functions is less significant. Processing of farm products was also an important function which could be related to other functions.

Table 5.5 Cross Correlation Coefficients Between Farm Functions

	Processed prod	Farm HH accommodation	On farm tourism and recreation	Landscape quality	Water	Soil	Animal welfare	Farm HH labour to local economy	Climate	Culture	Social	Entrepreneurship
Processed prod	100	7.6	11.9	10.2	51.7	60.2	15.3	70.3	36.4	26.3	96.6	90.7
Farm HH accommodation	21.4	100	14.3	4.8	40.5	50.0	16.7	69.0	23.8	57.1	100	83.3
On farm tourism and recreation	43.8	18.8	100	9.4	37.5	40.6	12.5	68.8	34.4	53.1	93.8	96.9
Landscape quality	42.9	7.1	10.7	100	57.1	57.1	14.3	71.4	39.3	35.7	92.9	85.7
Water	30.8	8.6	6.1	8.1	100	93.4	18.2	67.7	44.9	25.8	89.4	88.9
Soil	32.4	9.6	5.9	7.3	84.5	100	17.4	65.3	41.1	26.0	89.5	88.1
Animal welfare	29.5	11.5	6.6	6.6	59.0	62.3	100	67.2	45.9	29.5	93.4	88.5
Farm HH labour to local economy	29.5	10.3	7.8	7.1	47.7	50.9	14.6	100	35.9	27.4	94.0	87.9
Climate	30.1	7.0	7.7	7.7	62.2	62.9	19.6	70.6	100	27.3	93.7	86.7
Culture	30.7	23.8	16.8	9.9	50.5	56.4	17.8	76.2	38.6	100	100	89.1
Social	28.8	10.6	7.6	6.6	44.7	49.5	14.4	66.7	33.8	25.5	100	84.8
Entrepreneurship	28.7	9.4	8.3	6.4	47.2	51.7	14.5	66.2	33.2	24.1	90.1	100

Functions can be grouped according to their resources (production of agricultural goods, tourist accommodation, other tourism activities, and farm household labour's contribution to local economy); environmentally related activities (improving landscape-, water-, air and soil quality, animal welfare, climate change); and the economic and labour market relationships between farms and regions.

5.6. Conclusion

The survey results revealed that agricultural enterprises generally have other important functions in addition to their core production activities, fill a significant role in regional economies and maintain close relationships with other regional enterprises. People living in the surveyed regions generally have a positive attitude towards agriculture and its impact on the region. The activities and functions analysed could be grouped based on agricultural resources, their effects on the region as well as on their environmental and social functions. The creation of these groups allows the clustering of regions thus makes way for further analysis.

6. THE POMMARD MODEL

By Tom Johnson

6.1. Introduction

This chapter describes the structure and use of the POMMARD model. In the first section, the design of POMMARD is described, including the component modules in the model and the logic of each. The penultimate section is a description of the possible uses in POMMARD in scenario or policy analysis. The final section intends to draws some brief conclusions.

6.2. System Dynamics

As indicated in Chapter 3, POMMARD is an application of system dynamics. Unlike static economic models in which the equations controlling variables describe their equilibrium levels, system dynamics models describe the processes by which variables change as they strive to achieve an equilibrium. In system dynamics models, equilibrium occurs when all variables describing change equal zero. In general, systems never achieve equilibrium because external stimuli continuously change the equilibrium values.

All equations in a system dynamics model include time explicitly. Since the system of equations is composed of equations of motion or change, it describes the instantaneous rates of change of all variables. The values of the variables themselves are calculated by integrating the equations of motion. As an example, consider an equation describing the rate of production of some commodity. Production is typically expressed as tonnes per year, or some similar annual unit, although the equation describing the rate of production is an instantaneous rate at time *t*. The amount produced over period of time *t1* to *t2* is calculated by integrating the equation for change between any two points in time.

The rate of production at any point in time ($Production_i$) is the rate at some previous time plus the integral of the changes in rate between that previous time and the present. In the equation below, the rate of production at time *t* is the rate at time *t1* plus the integral of changes between time *t1* and *t2*.

$$\Pr oduction_i(t2) = \Pr oduction_i(t1) + \int_{t1}^{t2} (Change_i(t))dt$$

Many systems include second- or higher-order differential equations. In the production example above, the inventories of the commodity are calculated by integrating the equations for production less a similar equation for consumption. The amount of inventory accumulation or decumulation over period of time *t1* to *t2* is calculated by integrating the differential equation for production less the equation for consumption between any two points in time.[8]

The inventory at any point in time is the level at some previous time plus the integral of the production less consumption between that previous time and the present. In the equation below, the inventory at time *t* is the level at time *t1* plus the integral of changes between time *t1* and *t2*.

[8] This is admittedly complicated, but it is a system of second order differential equations. Inventories is the integral of production, and production is the integral of changes in production. This requires a shift in thinking from a static, annual world view.

$$Inventory_i(t2) = Inventory_i(t1) + \int_{t1}^{t2} (Production_i(t) - Consumption_i(t))dt$$

By adding equations describing the rate of change and consumption, this would become a dynamic model of a production and consumption system.

The Stella system dynamics simulation software used in this project converts flow charts of systems into systems of differential equations. Stella uses numerical integration techniques to solve the system of equations and describe the path of each variable over time. Numerical methods provide solutions very close to the precise analytical solutions but have a number of advantages. The most important advantage is that the analytic solution is usually very difficult or impossible to find. Numerical methods are relatively fast and easy to find. Other advantages are that non-linear, discontinuous and stochastic equations can be included.

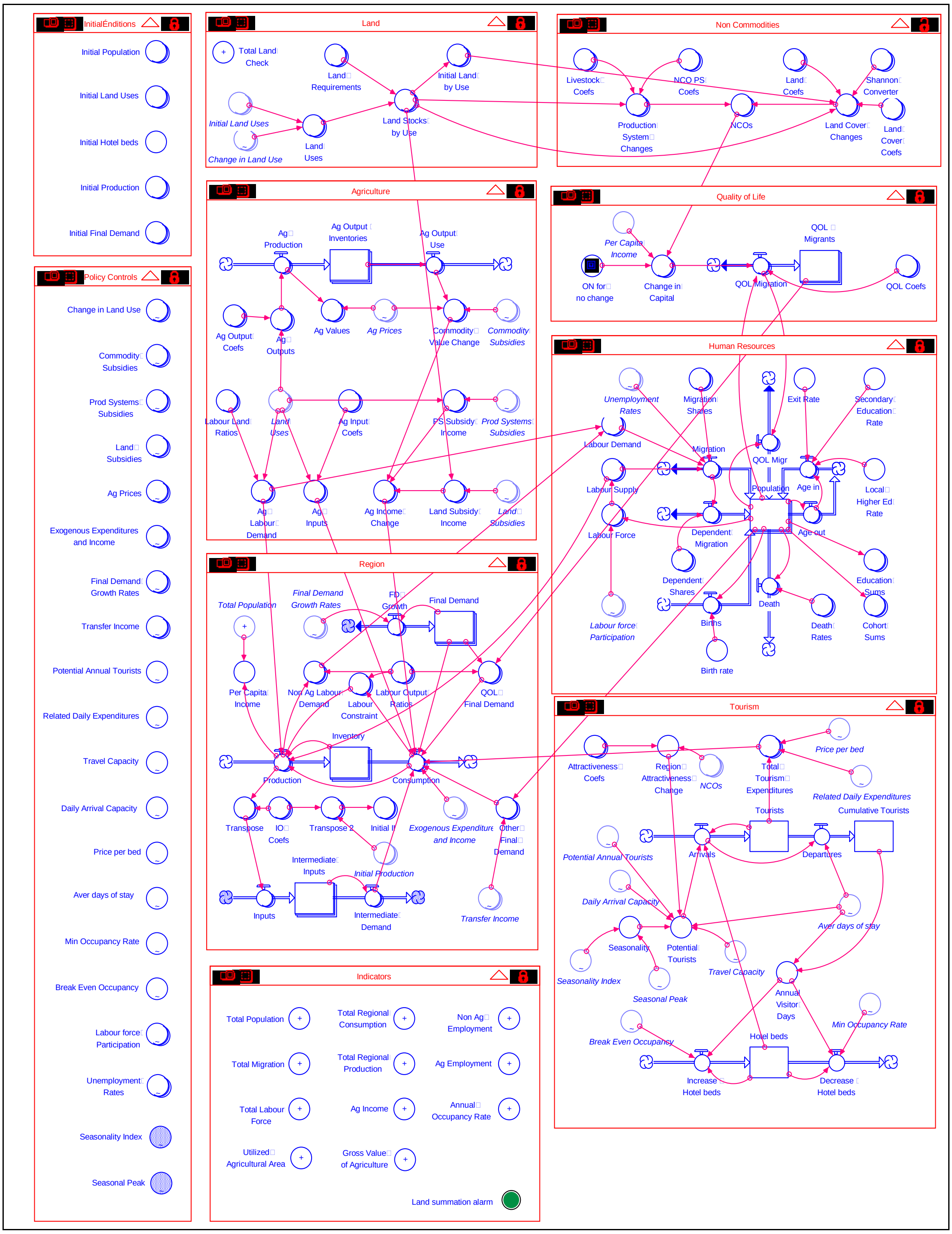
Stella uses the most precise numerical integration algorithms and is a relatively powerful simulation tool. It provides an ideal foundation for the POMMARD. In the rest of this chapter, the POMMARD model will be described.

6.3. Structure of POMMARD

Figure 1 is a flow chart for the POMMARD. It describes the overall structure of the model. The model contains 10 modules: Initial Conditions, Policy Controls, Indicators, Land, Non-Commodities, Agriculture, Quality of Life, Human Resources, Region, and Tourism.

As described in Chapter 3, POMMARD is largely supply oriented (with demand constraints). Land use is the primary economic driver in this model. Land use determines agricultural production of commodities and non-commodities. It also determines the amount of labour employed in agriculture. The regional economy is, in turn, driven by the supply-oriented agriculture module (and other special modules) and demand drivers from the larger (state or global) economy. The initial conditions and policy controls provide inputs to the model for scenario analysis. Finally, indicators allow the user to monitor changes in key variables.

Figure 6.1 Overall Structure of The POMMARD



6.3.1. Land Module

Land is the primary resource or capital affecting the supply of agricultural commodities. Agricultural production, non-commodity outputs (NCOs), labour requirements and other input requirements are determined by the choice of production system. Land is classified according to land cover and other physical characteristics (referred to as Land Type), and according to use (Land Use).

Farmers' choices of Production Systems (at the study area level) is a key economic driver in POMMARD. Production systems describe the nature of agricultural production including its profitability, relationship with the rest of the economy, social impacts, and environmental impacts. We assume a linear relationship between the level of each production system and the required amount of land of each type (indicated by the Land Requirements coefficients). Land used in each production system at each time *t* is obtained as the sum of the Initial Land Use and the Change of Land Use. Land Uses, together with the Land Requirements, determine the land stocks by use in each production system over time. Finally, changes in land use influence variables in the Agriculture, Human Resources, Non-Commodities, and Region Modules.

Finally, policy changes and alternative scenarios could be introduced through changes in land use.

6.3.2. The Non-Commodities Module

This module is an important link to the Quality of Life Module due to the migration it induces. There are eleven types of non-commodity outputs included in this model. Some of these are related to land use and other to production systems. The eleven NCO categories (elements) are as follows:

1. Forest % (percentage point change): cumulative change in area devoted to forests
2. Arable Land % (percentage point change): cumulative change in area devoted to arable land
3. Grass Land % (percentage point change): cumulative change in area devoted to grass land
4. Permanent Crops % (percentage point change): cumulative change in area devoted to permanent crops
5. Shannon Index (index, 0 to infinity): entropy measure of land use diversity
6. Mineral Fertilizer (kilograms/year) : total mineral fertilizer applied per year
7. Excess Nitrogen (kilograms/year): total surplus of nitrogen applied over that used by plants applied per year
8. Biodiversity: total utilized agricultural land under low-input farming systems
9. Livestock Unit per Hectare: total number of livestock units per hectare
10. Land Cover Change (hectares): total negative change in cropland
11. CO2 Balance: total net emissions of CO2

The first group are the NCO Land Cover Changes which includes categories 1 through 5.

The first four of these non-commodities are related to land changes. These are calculated from the changes in types of land and are represented as percentage point changes. For example an increase in forest land from 10% to 15% is a 50% increase but a 5% point change.

The fifth NCO type is the Shannon Index. This index is calculated from total land stocks by use, of each type of land.

The second group is the NCO Production System Changes which includes categories 6 through 11.

Categories 6 through 8 and 11 represent the total amount of each non-commodity produced by one unit of each production system.

Category 9 is the livestock unit per hectare which is calculated by the total amount of livestock per hectare of land in each production system.

Category 10 is the land cover change. Land cover change is equal to the negative of annual change in the stock of annual cropland. Because cropland is generally a less desirable land use than other farmland uses, increases are recorded as negative changes.

Finally, the Non-Commodities Module links to the Quality of Life Module through the NCOs production.

6.3.3. The Quality of Life Module

POMMARD includes several components of quality of life (QOL), including income and environmental conditions. In addition to monitoring the change in QOL over time, this module predicts the effects of these changes on population. The model allows for 5 capitals (natural, material, cultural, historical and social) but only natural and material capitals are being used in the model. Changes in quality of life create a supply-driven migration that is in addition to the demand-driven migration (i.e., migration to fill vacant jobs). QOL migration is differentiated among youth, working aged adults and retirees.

The QOL migration coefficients (elasticities) are based on regression analyses of data collected in the study areas. The calculated elasticities are the proportion of net migration (in migration *less* out migration) of each cohort due to changes in each type of capital.

The model includes different migration responses depending on the age of the migrants. The first category is youth (age 0-19). Here we are measuring the tendency for young people to leave the region after completion of secondary education.

The second category includes those who are active in the labour market (age 20 to 64) but who migrate (in or out) due to QOL rather than to exploit job opportunities. We assume that each autonomous in-migrant in the working aged cohorts creates demand for his or her job. This supply-driven migration is determined by the QOL coefficients and the changes in capital. This group is accompanied by their dependents.

The third group includes retirees (ages 65 plus) who migrate in response to perceptions about QOL.

People in the second group are assumed to join the labour force and to add to regional production proportionately to their numbers. Since their production is in addition to the demand-driven production typical of an input-output based model, we assume that their addition to the labour force is accompanied by an increase in final demand sufficient to absorb their contribution to regional production. Migration of retirees does not affect the labour market directly but does change the population, demographics, and income in the region.

6.3.4. The Agriculture Module

Agriculture is assumed to be supply-oriented and is organized into alternative production systems. Farmers make decisions about the production systems they will adopt based on policy and other exogenous information. The choice of production systems determines land use.

Agriculture purchases of inputs depend on land use and agricultural input coefficients for each production system. These input purchases augment demand for regionally produced products. Land use, together with the labour-land ratios, determines the agriculture demand for labour.

Agricultural production, determined by the amount of land allocated to each production system and the agriculture output coefficients, adds to the agriculture output inventories. The rate of outflow of these inventories is assumed to be equal to the agriculture commodity use. The dynamic stock of agricultural commodities is then calculated by integrating the net of inflows and outflows over time.

Agriculture production is linked to the Region Module by agriculture labour demand, purchase of locally produced inputs and agricultural income which induces some consumption demand. Policy changes are introduced through exogenous changes in the prices of agricultural commodities and in policy subsidies and payments. Changes in prices of agricultural commodities are introduced through a commodity price change vector. Net farm income is calculated from changes in production systems, changes in commodity prices and commodity, production system and land subsidies.

6.3.5. The Human Resources Module

The demographics of the region are determined by a cohort survival algorithm which combines births, deaths and migration. The cohort-survival procedure is augmented by educational achievement and migration. There are four age cohorts (0-19 years, 20-39 years, 40-64 years, and 65 and over) and six levels of educational achievement (pre-school or in-primary, in-secondary, in-tertiary, primary educated, secondary educated and tertiary educated). Births are determined by the annual rate of birth among families aged 20-39.

Two types of migration contribute to the demographics of the region: the migration induced due to quality of life changes (from the Quality of Life Module) and the migration induced in response to regional labour demand relative to labour supply.

Labour demand is the sum of labour requirements in the agriculture and non-agriculture sectors. Labour supply is determined by the population and the labour force participation rates. It is assumed that members of the 65 years and over cohort and people pursuing an educational degree do not participate in the labour force.

The demographics of migrants are determined by the total migration share rates (age cohorts and education level). Migrants are assumed to migrate with families including both youth and elderly members. The migration of dependents is based on the migration rates of workers and the dependent:worker ratios. The model generates flows of dependents for the 0-19 in-primary and in-secondary school groups and over 65 age groups for the primary, secondary and tertiary education categories.

The population in each age-education category is then obtained by integrating the births, aging, net quality of life migration, net migration, net dependents less deaths and aging.

The Human Resources Module links to the Region Module through the consumption by each age-cohort. In addition, policy changes and alternative scenarios can be introduced with the labour force participation and the unemployment rates.

6.3.6. The Regional Economy Module

The regional economy module is based on the dynamic macroeconomic model developed by Leontief and adapted by Johnson (1986). These models are similar to ecological or mass-balance systems. In such systems, mass changes[9] from one state to another as a function of the difference between its current level and its equilibrium level. In an economic system, production and consumption move toward equilibrium at a rate that depends on the difference between demand and supply, that is, as a function of the unplanned change in inventory. Inventories depend on production and consumption. When production and consumption are equal, inventories are in equilibrium. Production is determined by a behavioural feedback relationship. When inventories are larger than ideal, then production will decline. When inventories are too small, production will increase.[10]

Total regional sectoral output is the sum of intermediate outputs (production of goods and services to be used as inputs by other sectors) and final demand for the products of that sector. Final demand is disaggregated into external final demand or exports, agriculture demand, investment demand, and planned inventory change.

In general, the economy is not in equilibrium. Because of unexpected changes in demand, there are unplanned changes in inventories of sector commodities. The actual change in inventories is the difference between production and consumption. Like an ecological system, the change in production is a function of unplanned inventory change. The economy responds to the unplanned inventory change (the imbalance) by increasing or decreasing production in the opposite direction. The equation below describes this dynamic relationship.

$$\dot{ROUT}_{i,1} = v(IO_{i,i} * ROUT_{i,1} + RFD_{i,1} + ADEM_{i,1} + INVEST_{i,1} + \dot{INVENT}^{E}_{i,1} - ROUT_{i,1})$$

for i=1…*s*

where,

v is the response constant[11] of the production system.

s is the total number of sectors

[9] Mass-balance systems is a name of a type of model. See http://en.wikipedia.org/wiki/Mass_balance

[10] Note that this is a behavioral relationship, not an accounting one. The accounting relationship says “if production increases inventories will INCREASE.” The behavioral relationship says, “it inventories increase, production will DECREASE.”

[11] The response constant is the dynamic lag between inventory changes and production responses. This creates a dynamic feedback loop common to systems models.

E is the superscript that indicates variables are at their equilibrium levels

$\dot{ROUT}_{i,1}$ is the vector of change in production of each sector

$ROUT_{i,1}$ is the vector of production in each sector

$IO_{i,i}$ is the matrix of current account input-output coefficients

$RFD_{i,1}$ is the external final demand for regional output

$ADEM_{i,1}$ is the demand by the agriculture module for regional output

$INVEST_{i,1}$ is the local demand for commodities for investment purposes

$\dot{INVENT}_{i,1}$ is the planned change in inventory in each sector

Because production is itself a rate, this is a second-order differential equation—inventories are stocks that are determined by the flow and inventory change, but the level of inventory change determines the change in the rate of output change. Thus, the rate of production is determined by changes in the rate of production, which requires a second-order differential system to solve the model. We do this by treating the production flow as a stock (annual production), which is related to a flow, the change in production.

In POMMARD, the primary driver of the regional economy, and the main linkage between agriculture, tourism, and the regional economy, is final demand of regionally produced goods and services. Consumption is also one of the more convenient places to introduce policy-related shocks to the model. Thus, total consumption is the sum of several categories of demand, including (1) intermediate demand by non-agriculture sectors; (2) intermediate demand by the agriculture sector; (3) final demand (including exogenous income to households but excluding the agriculture and tourism sectors); (4) tourism final demand; (5) exogenous final demand generated by quality of life induced migration; (6) other final demand derived from transfer of income to the regions residents; (7) agriculture income change due to commodity price changes and subsidies; and (8) changes in exogenous expenditure and income due to policy changes.

The intermediate demand by non-agriculture sectors is determined by the IO coefficients and the production in each of these sectors. The intermediate demand by the agriculture sector is equal to the agriculture output times the sector's input coefficients. The final demand is obtained by the initial final demand at the initial time period of analysis and the growth rates in final demand. The tourism final demand is derived from the annualized total tourism daily expenditures. To obtain the exogenous final demand generated by the quality of life migration, it is assumed that QOL migrants are like current residents in terms of employment and skills levels and that this final demand is proportional to final demand derived from the initial final demand (e.g. that one related with exports). Other final demand, by contrast, is obtained by the multiplying transfer income[12] by the total population in each cohort group. Agriculture income change is derived from the changes in prices and subsidies. Finally, changes in exogenous expenditures and income are induced through policy changes in the region economy.

As explained above, rates of consumption and production are dynamically linked through changes in inventories. An increase in consumption draws down inventories but induces a production response equal to the new consumption plus the decline in inventories. We assume that desired inventories are equal to 1.0 time consumption, which means that an increase in consumption induces a 2.0 time consumption production response until inventories recover

[12] Transfer income is the annual payments by government to each person based on age.

and then attain the new desired level. Thus the dynamic response is 2.0 time consumption minus inventories. Typically, dynamic IO models impose a capacity constraint on production by making production equal to the minimum of consumption requirements (including replenishment of inventories) and the capacity of each sector. In this model, this feature is ignored because of lack of information on sectoral capacity, capital purchase coefficients and fixed investment coefficients. Production is constrained by available labour however. This creates a short lag in production response as labour supply responds to new labour demand.

The Regional Economy Module links to the Human Resources Module through the non agriculture labour demand, which is determined through the labour output ratios and the production by sector. It also calculates the per capita income used in the Quality of Life Module. Finally, policy changes and alternative scenarios can be introduced through exogenous expenditures and income, transfer income and final demand growth rates.

6.3.7. The Tourism Module

The Tourism Module determines total tourism expenditures, which, in turn affect the size of the regional economy. Tourism is demand-driven in POMMARD, although demand responds to changes in community characteristics including quality of life, road capacity, hotel beds, giving it a supply related feature as well. The attractiveness coefficients link tourism demand to the NCO, forest % in the region. The sector is constrained by hotel beds, in-region tourist limits, and daily arrival capacity. If all hotel beds are filled, tourists are turned away. Those that stay remain in the region for the specified time period. Moreover, the model makes the tourism sector subject to seasonality, which leads to periodic stress on hotel capacity during peak season and results in relatively lower occupancy rates for the rest of the year. Hotels beds are added when the expected annual occupancy rises to a level that justifies investment in additional beds. Beds are allowed to decline when the average occupancy rate falls below that level needed to cover variable costs. Additions and closures are based on the previous year's occupancy, so there is a lag in changes. Those tourists within the capacity constraint arrive according to the seasonal schedule.

The tourism module is linked to the Land and Agriculture modules through the regional attractiveness change, which is determined in part by changes in land use by production systems. Tourism is linked to the Region Module through its income, purchases, and employment. The regional attractiveness change is based on the attractiveness coefficients and the change in NCO production in the non-commodity forest % (from the Non-Commodities Module). In addition, policy changes and alternative scenarios can be induced through price per bed, related daily expenditures, average days of stay, minimum occupancy rate, break even occupancy rate, seasonality index, seasonal peak, potential annual tourism, travel capacity and daily arrival capacity.

6.3.8. Other Modules

POMMARD includes three other modules which facilitate the implementation of scenarios and the interpretation of the results. These are the Initial Conditions module, the Policy Controls module, and the Indicators Module.

6.4. Using POMMARD

POMMARD was designed to be applied to a variety of regions. Production systems, land types and uses, sectoral definitions, commodities produced and other variables will differ from region to region. It was necessary, therefore, to make many model components adjustable. This requires a more sophisticated model structure in which relationships are generic rather than specific. It also means that data for particular regions must be easy to enter into the model. In order to simplify the process of data entry, spreadsheet templates were created. These templates also facilitated the introduction of baselines and scenarios.

POMMARD was designed for policy analysis. The first step in analysing policy is to generate a baseline projection for the regional economy (see Chapter 8). A baseline scenario typically assumes quite constant rates of change in exogenous factors. While it is possible to predict dynamic processes such as business cycles and even policy changes in such models, it is usually more useful to start with more simple baselines. POMMARD accommodates the construction of such baselines with a number of variables that permit the introduction of constant growth rates or exogenous constant changes. Sector-specific annual growth rates in final demand for non-agriculture sectors and sector-specific exogenous expenditures and income are examples.

Alternative scenarios are then developed by introducing changes in the policy controls converters, or more commonly, by discrete changes in the exogenous drivers of the model. A wide variety of exogenous variables, especially policy intervention variables, have been built into the model, including final demand growth rates, changes in land use, mix of production systems, agricultural prices, subsidies, exogenous expenditures and income and transfer income.

Two model runs are described below. The first is a baseline for a hypothetical region assuming slow growth in the economy, and thus in population. The second is an alternative "land use change" scenario that involves the shift of 3,000 hectares from the beef cattle production system to the mixed livestock production system, starting in 2007. This might occur due, for example, to changes in support policies. Figures 2, 3 and 4 below show the baseline and the alternative scenarios, respectively.

Even this simple scenario demonstrates that all variables are potentially affected when a small change is made in the system. In this case, the 3,000 hectares shift changes the level of consumption in the agricultural sector which leads to different purchases from the rest of the regional economy. The change also increases the employment levels (from 1250 workers to 1273 workers) which stimulates an increase in net in-migration.

Another important source of dynamics in the economy is the effect of quality of life related migration. In the alternative scenario, the change in land use increases per capita income by a small amount (no more than 31 Euros per year at any time). This increase in income induces a small increase in migration of retirees. Since the income of retirees is lower than average, this leads to a decline in per capita income and a reversal of the induced migration. Taken together, the effect is to generate more volatility in the economy until stability is re-established.

Figure 6.2 Total Regional Consumption in Land Use Change Scenario

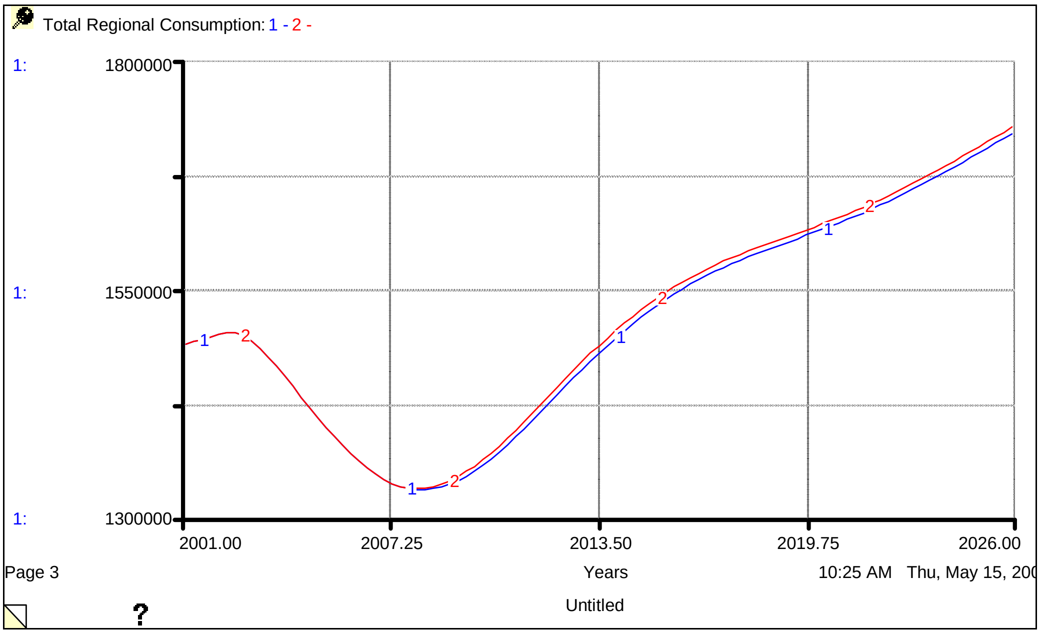


Figure 6.3 Ag Employment in Land Use Change Scenario

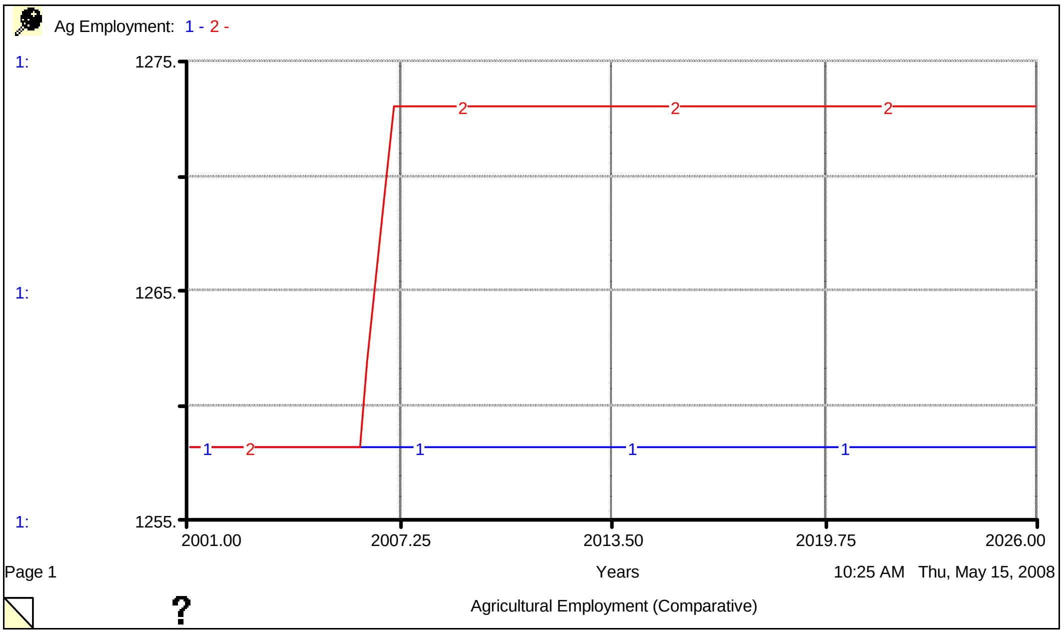
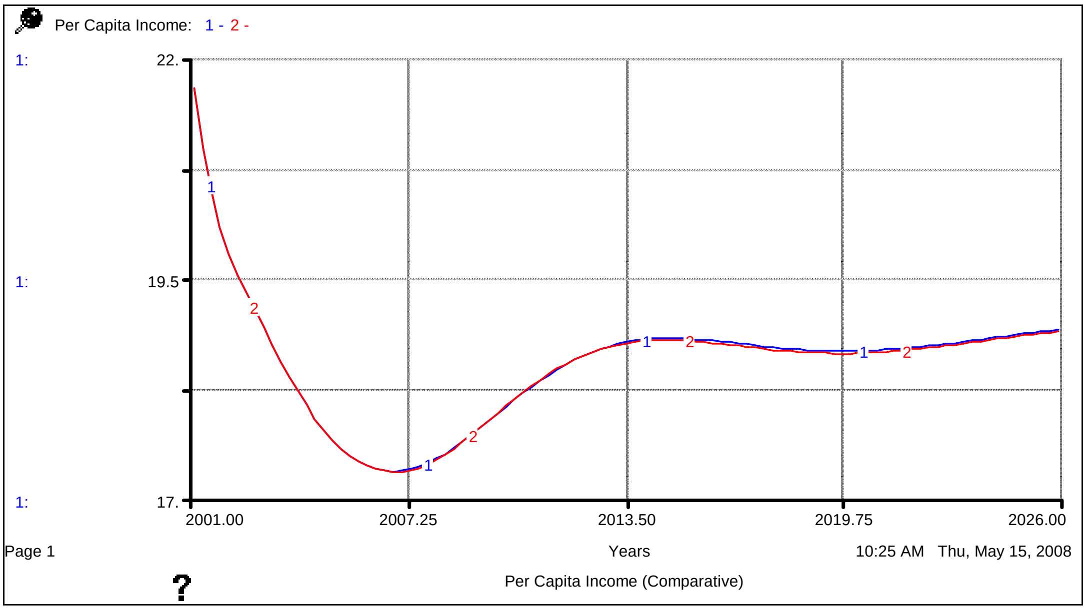
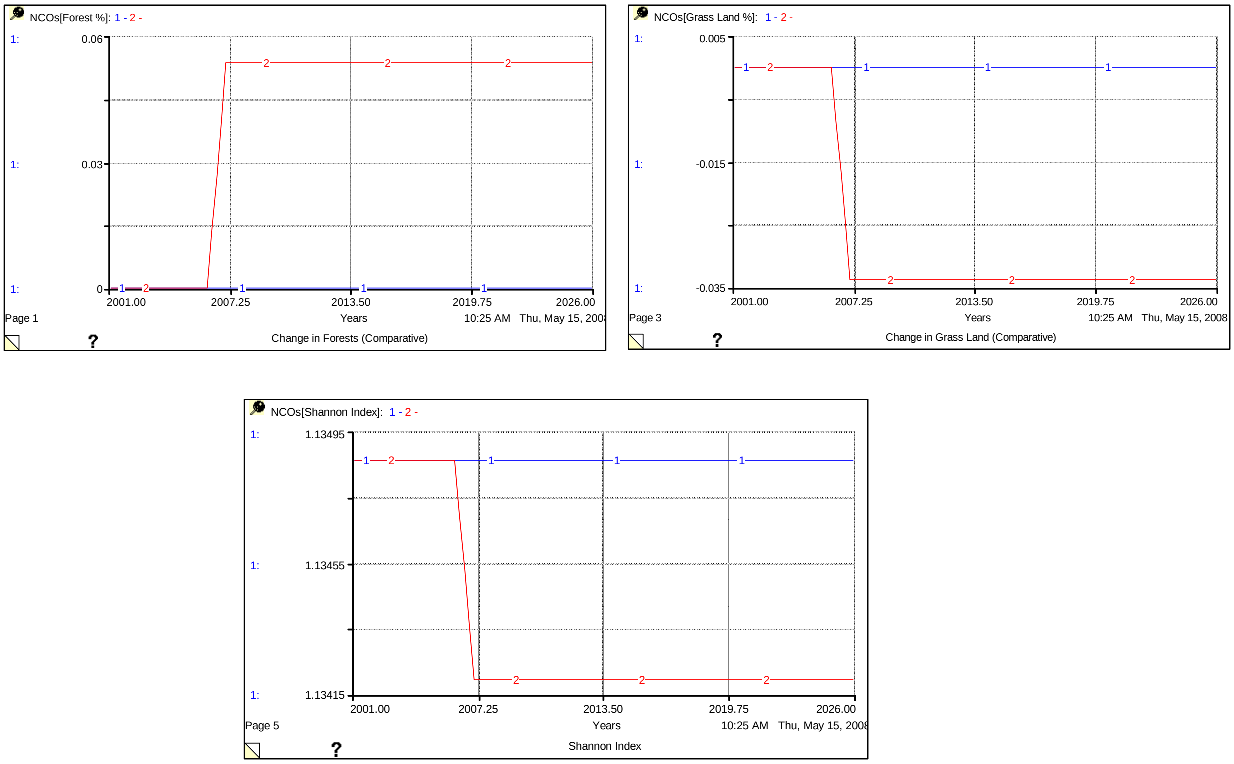


Figure 6.4 Per Capita Income in Land Use Change Scenario



Finally, the change in land use leads to small changes in the production of non-commodities. As Figure 5 shows, forest land and grass land change in relatively low magnitudes (0.05% and -0.03% change, respectively), and the Shannon Index, a measure of diversity, declines slightly (from 1.1349 to 1.1342).

Figure 6.5 NCOs Indicators in Land Use Change Scenario



6.5. Conclusions

The POMMARD model incorporates a variety of dynamic feed back mechanisms of TOP-MARD interest in its case study areas, similar to those found in ecological systems. Experimentation with the model indicates that there are short-run, medium-run and long-run lags that make complicated dynamic patterns. In the short run, seasonal changes in tourism lead to dynamic patterns with a cycle of one year. Feed-back between income and migration generates dynamic patterns with impacts that extend for a decade or more. Demographic feedback effects generate impacts of several generations in length.

Experimentation also reveals how the interactions between economics, ecology, and quality of life sometimes involve negative feed back effects, such as the relationship between income and migration, and in other cases involve positive feedback effects, such as the multiplier process among regional sectors. Fortunately (and realistically), all these feedback effects are stable and lead the system toward steady states.

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7. POLICY SCENARIOS

By K. J. Thomson and T. Ferenczi

7.1 Introduction

Chapter 6 of this Report has described the POMMARD model which was constructed for numerical analysis of multifunctional agriculture and rural development within the 11 case study areas of the TOP-MARD project. The appendix to Chapter 6 provides the POMMARD Manual, used by teams to adapt the model to the 11 study regions, and to define the input data relating to the initial conditions and change parameters of the model as implemented by the project teams, e.g. region-specific land production systems and their marketed commodities, the starting values of agricultural, demographic and economic variables for the initial years (and 2007), and (where these differ from standard values) the values of behavioural parameters in the various modules of POMMARD.

This Chapter describes the Scenarios which have been defined in order to "*identify and analyse the influence of different EU, national and local policies on these relationships, functions and linkages*" (TOP-MARD project Description of Work (DoW) Project Summary). These Scenarios each form the basis for separate POMMARD simulations (projections into the future), and comprise:

1. two "Base Scenarios", one using data for 2001 or a nearby initial data year, and the other defined to include changes to date (2007) and to be used as a comparator scenario
2. eight "Alternative Scenarios", each representing a reasonably conceivable change in policy conditions after 2007.

Though no time-scale for the TOP-MARD study was specified in the DoW, the nature of the investigation, which covers demographic and social developments as well as economic and environmental ones, and the policy-making timetable of the EU, suggested a medium- to long-term time horizon for these simulations, i.e. at least ten (10) years, with the possibility of a further similar period to allow demographic trends to work themselves out. Even so, some environmental developments, such as restoration of lost habitats, go beyond this period.

It should also be borne in mind that each scenario must be a "moving picture" rather than a static one, since wider developments in the global economy, in social behaviour and possibly in climatic conditions, will impose trend behaviour on many key POMMARD variables. Moreover, each scenario is a projection (not a prediction), and might be subject to unpredicted and unpredictable "shocks" of both an economic and contextual nature.

Chapter 8 discusses some of the results from the analysis of the scenarios using the POMMARD model adapted to the eleven study regions.

7.2 Scenario Justifications

A base scenario should represent an easily understood and plausible comparator for alternative simulations, and be based on relatively robust data (e.g. starting values, exogenous policy values) and parameters (model coefficients, describing the nature of the behaviour of the case study area society, economy and environment). These data and parameters determine the projected values of all POMMARD variables (and hence the scenario) out into the future.

TOP-MARD teams were asked to collect case study area data for 2001 or the nearest available year ("2001") as a starting point. This year was a major census year for most countries, and is long enough in the past for all available data to be published. Moreover, the year "2001" recognises the adoption of the Agenda 2000 reforms, including area payments under the CAP, and the start of implementing the Rural Development Programmes for the period 2000-2006. On the other hand, it preceded the date of entry into the EU of two TOP-MARD countries (Hungary and Slovenia), whose agricultural and economic systems had therefore not fully adopted the EU framework. However, both countries were already undertaking pre-accession modifications to their national agricultural policies, and were applying the EU's SAPARD programme which was designed to "assist the implementation of the Community acquis [and to] support measures to enhance efficiency and competitiveness in farming and the food industry and create employment and sustainable economic development in rural areas" (EU Commission website, Agriculture and Enlargement).

However, use of the year 2001 or thereabouts without modification as the starting point and comparator for all scenario simulations would have ignored the major changes in the EU's agricultural and rural development policies which followed the adopted of the Mid-Term CAP Reform package in 2003, the accession of Hungary and Slovenia into the EU in 2004, and the start of a new budget and Programming period in 2007. Thus, in addition to the "Initial" Base Scenario projecting forward from 2001 onwards, a second ("Main") Baseline scenario was adopted. In this, policy conditions (and other conditions, such as population numbers, if data was available) for post-2001 years were incorporated. The base year for the Main Baseline scenario was chosen as 2007, for which CAP conditions, such as the total budget for the new European Agricultural Fund for Rural Development, and for the new Rural Development Programme budgets, as well as Single Payment rates, were known. By extrapolation and annualisation where necessary, conditions could then be assumed out to 2013, assuming no further changes due to e.g. the Health Check.[13]

Furthermore, an "initial" and a "main" baseline scenario allowed the calibration of the latter using "real-world data" for the years 2001 to 2007 (e.g. agricultural prices, demographics, regional GDP, etc.).

As regards the Alternative Scenarios, both the numbers and the scope of these required consideration. "Scope" here refers to both the range of policies (or market and other conditions leading to policy change) to be incorporated in one or more of these scenarios, and to their extent, i.e. how "realistic" or "extreme" should be the difference between the Baseline and Alternative specifications.

Given the focus of the TOP-MARD project on rural development as a whole, a wide range of options was preferred, including (e.g.) tourism developments as well as further internal CAP reforms, e.g. within Pillar 2. As regards the extent of change in any one of these dimensions, a relatively conservative view was taken, i.e. avoiding "abolition of the CAP", or a huge expansion (or contraction) of tourism due to (e.g.) drastically altered world conditions.

Change in any one direction can of course be decided to a greater or lesser extent (1%, 10% or 100%), or reversed, e.g. a -10% change as well as +10% one. However, multiple levels of the same type of change would have greatly increased the number of Alternative Scenarios (or sub-Scenarios). An even greater increase would have resulted from combining two or more dimensions of change: N dimensions, each with one level, offers 2^N single or combined

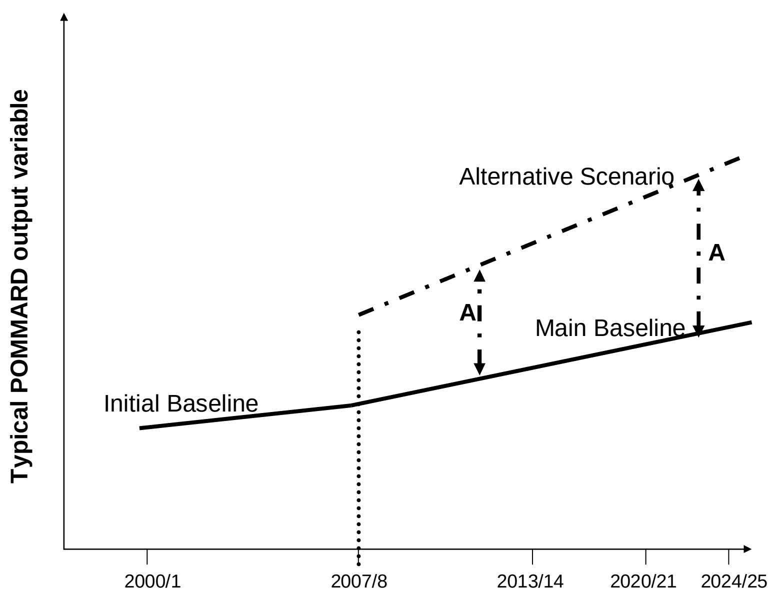
[13] Norway, as a non-EU Member State, has different policy time-frames, involving annual deliberations. However, the Norwegian TOP-MARD partner agreed to conform to the time frames and horizons.

scenarios. Thus it was decided to adopt "single-dimension" scenarios, each at a single (changed) level of the relevant policy variable(s).

These considerations, along with a study of scenarios adopted within other research projects (e.g. DORA, RESTRIM, MULTIAGRI, FORESCENE, SENSOR, LUPIS, ATLAS MATISSE, SEAMLESS, MEA-SCOPE), led to a mid-project decision to specify six (6) Alternative Scenarios for POMMARD simulation. However, towards the end of the project, external commentators suggested two further alternative scenarios, which are included here (see below). Each of these Alternatives involved changes from conditions specified in the 2007-based Main Baseline Scenario, in most cases as a "shock" imposed in that year (2007) and continued into all future years out into the next decade and beyond, i.e. disregarding possible further policy changes beyond 2013.

For comparative analysis, for any Output variable, the difference between the "Main Baseline Scenario" and the Alternative Scenario is of primary interest (see gaps A in Figure 7.1). Naturally, this difference (or Scenario "effect" or "impact") may change over time. Policy settings (and other input data) were in general be assumed constant over years, unless there was good reason (and data) to specify otherwise, e.g. rising EU Structural Fund investment spend over a programming period, or gradually introduced (or modulated) Single Farm Payments. However, the underlying dynamics of e.g. demographic change led to changing "impacts" over time, so that comparative analysis requires a future year to be chosen if complexity is to be avoided.

Figure 7.1 Impact Analysis of TOP-MARD Scenarios



7.3 Scenario Specifications

As explained above, the Main Baseline Scenario incorporates agricultural and structural policy changes since "2001" up to 2007. For old EU Member States (Hungary and Norway are different), these included (but others could be added by TOP-MARD teams, e.g. changed trend rates, changed tourist numbers):

1. the post-Mid-Term CAP Review switch to Single Payments (Pillar 1)
2. the adoption of new Rural Development Programme funding (Pillar 2)
3. changes in Structural Funds expenditure (may be positive or negative)
4. changes in farm commodity prices (e.g. doubled cereal prices in 2007).

All monetary values in the POMMARD modules (apart from the Tourism one) were expressed per year; thus "period" values (e.g. for RDPs 2007-2013) were annualised (in real terms; see next paragraph).

In monetary terms, POMMARD was run in real prices, i.e. all expenditures, prices, values, etc. were deflated to a single year (or inflated if earlier), usually 2001. An EU deflator index series is given in Table 7.1 below; teams using non-Euro currencies were able to use another deflator (and to assume a non-constant Euro exchange-rate series), if considered necessary.

Table 7.1: EU Price Deflators 2000 Onwards

Year	Index	Annual Rate	Deflator
2001	100.0		1.0000
2002	102.1	2.1	0.9794
2003	104.1	2.0	0.9606
2004	106.2	2.0	0.9416
2005	108.6	2.2	0.9208
2006	111.0	2.2	0.9009
2007 onwards	113.2	2.0	0.8834

Extracted and calculated from: http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,39140985&_dad=portal&_schema=PORTAL&screen=detailref&language=en&product=EU_MAIN_TREE&root=EU_MAIN_TREE/basic/strind/ecobac/eb040.

The eight Alternative Scenarios were specified as below at EU level; teams were required to apply these scenarios as appropriate to their country and region. For numerical illustration, Table 8.2 (see end of chapter) suggests values (some actual, some dummy for the years 2001 and 2007) which might have been inserted in order to specify the original six of the eight Alternatives identified.

A1. Direct (Single) Farm Payments Cut by 50%: a 50% cut in annual direct payments (DPs) to farmers (both rates and totals) starting in 2007, with no reallocation of funds e.g. to Pillar 2 or Structural Funds (and no change in farm commodity prices: see below).

Since the Main Baseline already assumed changed (2007) commodity prices, it was considered not necessary to specify further changes in these prices[14]. This corresponded to anticipating that DPs may be cut without being "balanced" by rises in farm commodity prices. Teams were asked to decide, for each agricultural production system type in their study area, the consequential changes (which may be zero, if none are expected as a result of the DP cut) in (at least) (a) land use/production, (b) annual farm incomes, (c) non-

[14] The World Bank has projected a further increase in commodity prices for 2008 and a decline from 2009 to 2020, while the latest FAO/OECD outlook projects slightly increasing prices over the same period. However, constant (real) prices seemed simplest, especially within Europe.

commodity outputs. These decisions were based on published results from models such as CAPRI, on local team expertise, or on key agent interviews.

In Table 7.2, it is assumed for simple illustration that during "2001"-2006 there was a trend loss (reflected in the Initial Baseline) of 100 ha per year in the land area used by the first Production System (PS1), and a corresponding gain in area used by PS2. From 2007 onwards, an accelerated trend of +/-150 ha per year is assumed. Since the POMMARD values are cumulative, the appropriate value for 2007 is 750 (6 years at 100 ha/yr, plus one at 150 ha) and this increases to 900, 1050, … for later years. If the 50% DP cut of Scenario A accelerates the above loss (and gain) by an additional 30 ha per year, then the appropriate Scenario A figures for 2007, 2008, 2009, … are 780 (as shown), 960, 1140, ….

The effect of the cut on household (including farm household) incomes is indicated as a non-cumulative reduction (to 1200) in the value (1600) which was used to specify the Main Baseline change in these incomes according to the change in payments between "2001" and 2007.

Also in Table 7.2, it is assumed that the change from Initial to Main Baseline, i.e. from "2001" to 2007 onwards, involves a change in Final Demand expenditure in certain economic sectors. These are illustrated here by values for (changes to)[15] Exogenous Expenditure and Income on the sectors Construction and Services, as 80:20 "targets" of Pillar 2 and ERDF spending, corresponding to values of 800 and 200 (thousand Euro) respectively[16]. It is assumed that these values are left unaltered in Scenario A.

Finally in this illustration, Household Income is changed by an amount less than in the Main Baseline (1200 rather than 1600), according to the drop in DPs.

A2. Direct (Single) Farm Payments Cut by 50%, with Modulation: a 50% cut in annual DPs to farmers (both rates and totals) starting in 2007, with reallocation of these funds to Pillar 2, in proportion to existing expenditure allocations across the Axes. This Alternative Scenario specification was suggested by participants at the final conference of the TOP-MARD project in Brussels in May 2008.

Its more detailed specification combines the features described above for scenario A1 with those described below for alternative scenarios B, C and Z, as appropriate for each Axis.

B. All Axis 2[17]: in this Alternative Scenario, spending on rural development (i.e. Pillar 2, in EU) in 2007-13 (and beyond) in the study area remained as in the EU budget but all[18] Pillar 2 spending was re-allocated to Axis 2, i.e. to agri-environmental land management (and none to Axis 1 farm development, nor to Axis 3 rural infrastructure and diversification). Pillar 1 spending stayed the same.

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[15] Unlike most POMMARD variables, these Exogenous (sectoral) Expenditure and (all-household) Income variables are changes from the core "2001" values, not new level values.

[16] Other ratios (and sectors, e.g. Education) could of course be suggested for policy "investment" spending.

[17] Originally, no "All Axis 1" Scenario was specified, since TOP-MARD is focussed on "public goods" associated with multifunctionality, rather than (private) competitiveness. However, as a result of suggestions made at the final TOP-MARD conference, an Axis 1 scenario was added, as Alternative Scenario Z (see below).

[18] i.e. 100% of Pillar 2 funds, not only the change (probably an increase) between "2001" and annual 2007-2013.

In Table 7.2, this Scenario is specified as involving an acceleration of the land use loss/gain described above of 50 ha/year relative to the Main Baseline trend of 150 ha/year from 2007 onwards, i.e. values of +/-800 ha for 2007, +/-1000 for 2008, +/-1200 for 2009,…. Moreover, Household Income has been increased by 400 above the value 1600 by the amount of the additional agri-environmental payments going to farmers[19], and the "Potential Annual Tourists" value has been raised, to reflect more attractive countryside[20].

C. All Axis 3[17]: in this Alternative Scenario, rural development (i.e. Pillar 2, in EU) spending 2007-13 in the study area remained as in the EU budget but all[18] Pillar 2 spending is re-allocated to Axis 3, i.e. to rural infrastructure and diversification (and none to Axis 1 farm development, nor to Axis 2 agri-environmental land management). Pillar 1 spending stays the same.

   In Table 7.2, this Scenario is specified as involving the same land-use losses/gains and Household Income levels as in the Main Baseline. Final Demand values for Construction and Services have been raised, and also "Potential Annual Tourists", to reflect more attractive villages etc. Some teams also treated Axis 3 (and regional funding below) as an Investment measure, as opposed to a measure that would be consumed in the year it was received, as in the case of Axis 2 or Pillar 1. Investment has on-going impacts, e.g. on regional tourism capacity, labour productivity, etc. Where such impacts could be measured or estimated using, for example, sectoral capital-output ratios, these were entered into the appropriate model input data for subsequent years, for example, in the case of increased tourism capacity, as increased tourism receipts (exogenous income).

D. 50% More Regional Funding: in this Alternative Scenario, annual regional policy spending (both EU Regional/Cohesion Funds, and national funds) in the study area during 2007-2013 was increased by 50%. "Regional policy" was interpreted as public spending on infrastructure investment (not maintenance) including trans-European rail networks, main roads, water and sewerage, special regional business support (grants, loans etc.), R&D, etc. It excluded any central government recurrent spending (local government operating expenses, health and education, social services, maintenance, etc.).

   In Table 7.2, this is reflected in substantial increases in Final Demand for certain sectors (here, for illustration, Construction and Services), and also in "Potential Annual Tourists", "Travel Capacity" and "Daily Arrival Capacity". Other values are as in the Main Baseline.

E. Doubled Energy Prices: this Alternative Scenario assumed a 100% increase in energy prices (due to market shortage and/or EU regulations, but excluding direct EU policy, e.g. minimum agricultural quotas for biocrops) from 2006 levels, i.e. from $60 to $120 per barrel[21]. Teams decided the impact on land uses and farm production systems, e.g. how (or whether) this increase would affect the study area's energy production system, and any other important regional impacts (e.g. on transport costs, or tourism), and implemented these via the appropriate convertors and bio-energy production system in POMMARD.

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[19] This assumes that such payments (like changes in mainstream direct payments) are "decoupled" from agriculture, i.e. are treated as (farm) household income. Some teams treated these payments differently, i.e. as changes in (intermediate) demand by Agriculture, although this seemed difficult to do in the structure of the core POMMARD model, in which Agriculture is not an element of the regional economy input-output table.

[20] A more effective alternative may be changing the non-commodity output production system and the Quality of Life Coefficients "converter" in POMMARD.

[21] Obviously, energy prices have been highly unstable, and have already reached well beyond $100. However, the above seemed a reasonable Alternative.

In Table 7.2 below, this has not been done, since there were no obvious impacts on land use etc. in the illustrative case study area in northern Scotland. Input-output analysis (as used within POMMARD) cannot directly handle pure price increases; if the Final Demand value for the Energy sector were doubled, this would generate unrealistic economic growth in other sectors.

F. More Tourism: this Alternative Scenario involved a gradual increase in tourism demand (i.e. tourist expenditures) from its 2006 (or the latest available year) level(s) to reach a 100% increase by 2013, and thereafter constant. Teams decided on the timing, seasonality and tourism type (e.g. day trippers and hikers, or "long stay" tourists/hunters/anglers), and implemented these via the appropriate convertors in POMMARD.

   In Table 7.2, this is illustrated by increased values for most Tourist variables, in particular an increase in "Tourism Growth Rate" for the period 2007-2013. Other values are as in the Main Baseline, since the Alternative did not involve increased policy spending[22].

Z. All Axis 1: in this Alternative Scenario, spending on rural development (i.e. Pillar 2, in EU) in 2007-13 (and beyond) in the study area remained as in the EU budget but all[23] Pillar 2 spending was re-allocated to Axis 1, i.e. to farm development investment (and none to Axis 2 environmental land management, nor to Axis 3 rural infrastructure and diversification). Pillar 1 spending stayed the same.

[22] It was noted at the Scottish NUG that this Alternative Scenario is the only one involving no policy trade-offs.

[23] See footnote 6.

Table 7.2 POMMARD Input Data for Initial Baseline, Main Baseline and Alternative Scenarios

Scenario	**Initial Base-line**	**Main Base-line**	**SFP -50%**	**All Axis 2**	**All Axis 3**	**Regional Funds +50%**	**Energy Prices +100%**	**Tour-ism +100%**
	I	**M**	**A1**	**B**	**C**	**D**	**E**	**F**
Years	"2001"	2007-	2007-	2007-	2007-	2007-	2007-	2007-
AGRICULTURE								
Ag Prices (normalised to 1 for 2001)								
Commodity 1 (e.g. cereals)	1	2	2	2	2	2	2	2
Commodity 5 (e.g. milk)	1	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Commodity 8 (e.g.Med.Pdts)	1	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Ag Income	1	1	1	1	1	1	1	1
*Change (*cumulative – so "↑" for higher post-2007 values*) in Land Use* (in ha/yr; must sum to zero)								
Production System 1	-100	-750↑	-780↑	-800↑	-700↑	-750↑	-750↑	-750↑
Production System 2	+100	+750↑	+780	+800↑	+700↑	+750↑	+750↑	+750↑
…								
ECONOMY								
(change in!) *Exogenous Expenditures* (excl. Agric. & For.) *and Income* (thousand Euro total)								
Sector 1	0	0	0	0	0	0	0	0
Construction	0	800	800	800	1000	1200	800	800
Services	0	200	200	200	300	400	200	200
Household Income	0	1600	1200	2000	1600	1600	1600	1600
TOURISM								
Average days of stay	14	14	14	14	14	14	14	20
Potential Annual Tourists	10000	11000	11000	12000	12000	12000	11000	20000
Related Daily Expenditures	50	55	55	55	55	55	55	55
Seasonal Peak	6	6	6	6	6	6	6	6
Seasonality Index	0	0	0	0	0	0	0	0
Tourism Growth Rate	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.10*
Travel Capacity	10000	12000	12000	12000	12000	15000	12000	12000
Daily Arrival Capacity	1000	1000	1000	1000	1000	1500	1000	1000

* 10% per year for 2007 to 2013 inclusive, thereafter reverting to 1% per year.

8. COMPARATIVE ANALYSIS OF POMMARD RESULTS USING THE ADAPTED MODELS

By Tibor Ferenczi, John Bryden, Krisztina Fodor and Attila Jambor

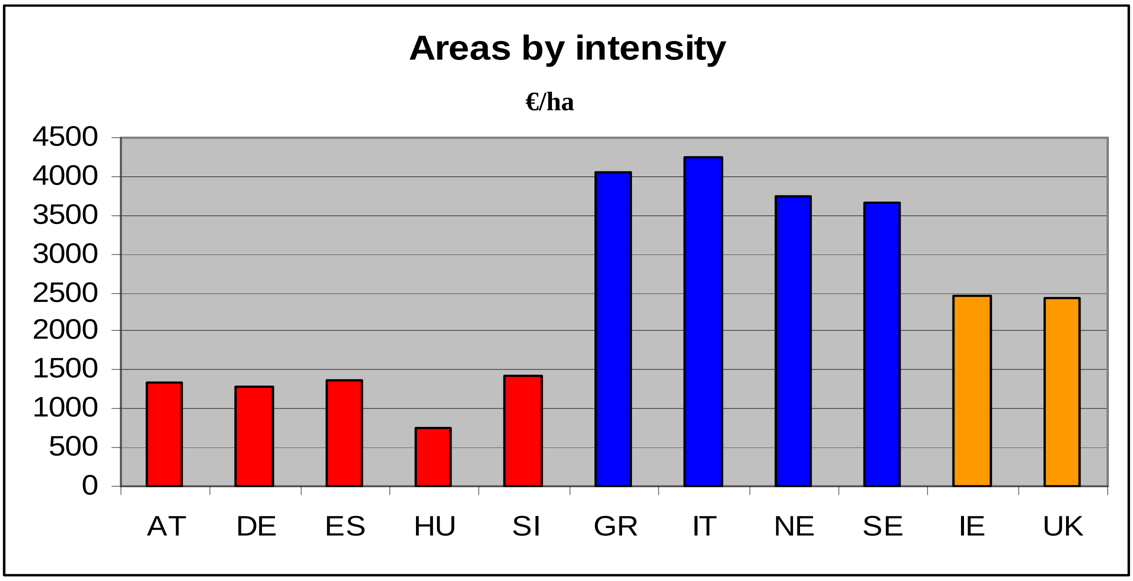
The output and outcome indicators of the model show the economic, social, demographic and environmental consequences of the various scenarios for the range of rural regions represented by our study areas. The reference years for analysing the model results are 2001, 2007, 2015 and 2025. As the study areas differ in physical, socio-economic and institutional and governance conditions, the parameters of the adapted POMMARD models necessarily vary. The outcome indicators will therefore be influenced not only by the model input data but also according to differences in the relevant parameters. In addition, these indicators will also be influenced by the existing (baseline) importance of each policy element examined (Pillar 1, Pillar 2, the three axes etc), which also varies between study areas.

8.1 Classification by intensity

The study areas have very different intensities of agricultural production. Three clusters can be distinguished: areas with relatively low gross value of agriculture in relation to land area, below 1500 €/ha; high, meaning over 3500 €/ha, and intermediate, around 2500 €/ha. Low intensity areas are Pinzgau/Pongau (AT), Wetteraukreis (DE), Berguedà (ES), Bács-Kiskun(HU) and Gorenjska (SI). Agriculture is highly intensive in Trikala (GR), Latina (IT), Hordaland (NO) and Västerbotten (SE). The Irish (Mayo) and Scottish (Caithness/Sutherland) study areas are in the intermediate position.

As intensity is a crucial indicator of the land use and environment, we make an overview of the POMMARD results by these clusters.

Figure 8.1 Areas by Intensity



8.1.1 Territorial development indicators

Areas where agricultural intensity is high or low are not simply richer or poorer due to the agricultural intensity, but among our richer study areas were also those with higher intensity.

For instance, the richest study areas are in the high intensive cluster, namely those in Norway and Sweden.

On average, population density is higher in the low intensity areas than in those with high intensity. This is partly because the share of the AUA is much higher (on average double), but mainly because of the strength of the non-agricultural economy in these areas.

In terms of demographic structures, the ratio of population cohort over 65 to the cohort below 19 years does not show great differences across intensity levels, and nor does the share of other age cohorts in total population. Later, in the projections from the scenario modelling, some significant differences will be presented.

As may be expected, the richer, high intensity, areas have a higher share of the population with tertiary education, a higher share of services in employment, and higher activity rates (share of cohorts from 20 to 65 in our simplified statistical approach). As these areas generally offer a higher quality of life to their population, they also have positive net migration, compared with a negative or zero net migration on average in the low intensity areas (in the study areas of HU and ES negative and just in balance in AT and SI).

Table 8.2 Indicators for Territorial Development and Regional Environment

Pre-2007 indicators	Cluster 1	Cluster 2	Cluster 3
Territorial development indicators			
GDP/capita	17.26	23.37	19.70
Per capita income	13.02	19.13	22.77
Population density, head/km2	100.06	87.92	12.96
Ageing index	0,64	0,68	0,64
Tertiary education share	0.149	0.177	0.189
Employment in active population	0.558	0.626	0.732
Tertiary sectors' share in employment	0.539	0.627	0.624
Tourism labour / 1000 inhabitants	4.03	3.41	1.86
Net migration to total population, ‰	1.66	9.25	3.63
Regional environment indicators			
Biodiversity, related to UAA	1.386	7.744	0.824
Shannon index	1.48	1.02	1.15
UAA/Total area	0.38	0.18	0.68
Mineral fertiliser/UAA	0.16	0.63	0.24
LU/UAA	0.54	0.32	0.96

Source: Own composition

8.1.2 Regional environment indicators

The biodiversity indicator measures the relative share of land use under low-input farming systems and the ratio of natural lands to utilised agricultural area. As previously discussed, high intensity countries have large natural areas, and so biodiversity is (on these indicators) much higher, with the exception of Lazio (IT). The Swedish area has the highest biodiversity and it is also very high in the Norwegian and Greek study areas. Low intensity areas have relatively low indicators of biodiversity.

The Shannon index is an entropy measure of land use diversity in agriculture. It is higher in Cluster 1, where intensity is low, especially in DE, HU and ES study areas, and relatively low in high intensity areas like the NO, SE and GR areas.

8.1.3 Agriculture and land use indicators

As previously mentioned, low intensity countries have a relatively high share of agricultural land use, e.g. study areas of HU, AT, ES and DE (40-70%) and areas of high intensity (e.g. in SE, NO and GR) have a very low share of UAA in the total land area. The high intensity is supported by a high mineral fertiliser use (especially in the Greek and Swedish study area). In low intensity areas (e.g. AT and ES) the mineral fertiliser use is also low. However, livestock density does not go together with the intensity levels: all clusters have a relatively low livestock density.

The share of agricultural in total employment in high intensity areas is on average double that in the low intensity cluster, and especially high in the Greek, Norwegian and Italian areas. At the other end of the scale, the German, Slovenian and Hungarian areas have the lowest rates of agricultural employment.

High intensity areas have much higher regional per capita income, and *vice-versa*. However tourism, including agri-tourism, is more evident in low intensity areas, although this is mainly due to outstanding areas, especially in Austria and, to a lesser extent, in Slovenia. The relative proportion of forestry does not show significant difference between clusters.

Table 8.3 Indicators of Agriculture and Land use

Pre-2007 indicators	Cluster 1	Cluster 2	Cluster 3
Agriculture and land use indicators			
GVoA/UAA €/ha	1236	3931	2446
Ag labour / 1000 inhabitants	18.40	44.25	73.50
Forestry land use share	0.38	0.37	0.09

Source: Own composition

8.2 Scenario analysis

Apart the baseline projections, eight scenarios were built up, each of them different policy approaches and market situations. The following discussion will overview the changes in model results mostly by the first and second clusters; and in relevant cases will be confronted trends with national results. In most of the cases changes of outcome indicators from 2007 to 2025 are analysed in each scenario.

8.2.1. Scenario A1

The assumption of this scenario is that direct payments would be cut by 50 per cent, and no modulation would be applied.

The effect of these policy changes will have a significant, if differential, impact on the territorial development indicators in the study areas. For instance, total population increases by 10 per cent in high density areas from 2007 to 2025 and only slightly (3%) in low intensity areas. The main source of that increase is in-migration. In-migration is much higher in high intensity areas, especially in Trikala (GR) and Västerbotten (SE), but also significant in the low intensity Pinzgau/Pongau (AT) and Berguedà (ES). Non-agricultural employment increases by 14% and 11% respectively, while per capita income grows by 6% and 2% respectively.

As to agricultural and land use indicators, in low intensity areas there will be a slight decrease of the utilised agricultural area (e.g. AT, DE, HU and SI). In high intensity areas the reduction in UAA will be much greater, especially in the Swedish and the Italian areas. The gross agricultural value, agricultural employment and biodiversity will decrease slightly in the low intensity areas and more significantly in high intensity areas, e.g. IT, SE and GR. However, production would fall much less than agricultural area in high intensity areas, where intensity would therefore increase further.

Agricultural employment will decrease slightly in low intensity areas (-1%), and more strongly in high intensity areas (-12%). Labour/land ratio will not change in low intensity areas, while in high intensity areas it will fall.

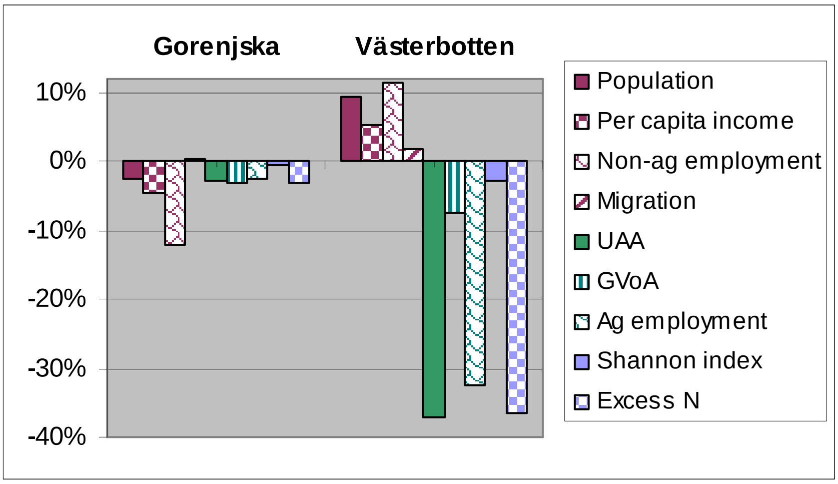
There will be more significant changes in the product mix, especially in high intensity areas. There will be almost no change in cereal production in low intensity areas, but a significant decline will take place in the high intensity areas. Milk and beef production will not change significantly in low intensity areas, but a substantial decline will occur in high intensity areas.

As to environmental issues, the application of mineral fertilisers will increase slightly in low intensity areas, but decrease in high intensity areas. The Shannon index would remain unchanged in low intensity areas, but would decrease in high intensity areas, especially in Latina (IT) and Västerbotten (SE).

Whilst it may seem contradictory that a cut on Direct Payments could over the medium term examined here lead to an increase in regional income and employment, this arises in regional economies where non-agricultural employment has been growing strongly and where non-agricultural jobs are relatively well paid. A clear case is that of Hordaland, Norway, for example, where the city of Bergen and the oil-related employment along the western coast and Fjords, has a major influence. In this and other cases, it is the regional cities and their commuting hinterlands that benefit most from the change, while the more peripheral rural areas within the region suffer most from the loss of Direct Payments, even if some agricultural labour moves from low to high productivity (and wage) employment.

The typical changes of this scenario can be well illustrated by the examples of Gorenjska (SI) as low intensity area on the one hand and Västerbotten (SE) as high intensity area on the other (Figure 8.2).

Figure 8.1 Typical Changes of Scenario A1



Source: 4_Output_comparison.xls

8.2.1 Scenario A2

In this scenario, the cut of direct payments is combined with modulation.

This scenario would not have a significant impact on the regional economy. Population change would be similar as the previous one, and slight changes would occur in the migration balance. The growth of per capita income would be a little higher in this scenario in low intensity areas. Non-agricultural employment will grow a little lower in both clusters when compared to the previous scenario.

This policy change would cause a 5% lower decline in UAA (-12%) in the high intensity areas compared with scenario A1. Little change would follow in production value; thus the intensity of the production would be increased. The impact on the agricultural employment will be similar to that in scenario A1.

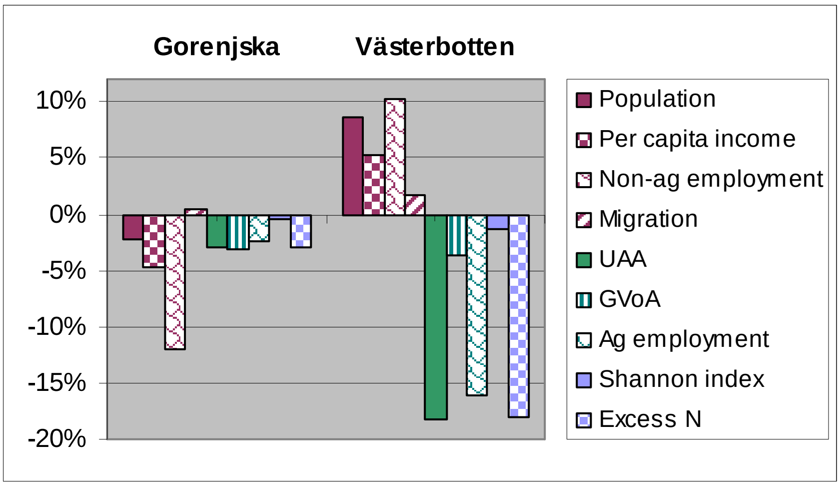
Modulation causes a slight decrease in cereal production. In high intensity areas, modulation would cause a lower decline in cereal production than in scenario A1. In A2 there is a slight increase in milk production in low intensity areas, compared with a slight decline in A1. In high intensity areas modulation causes a significant fall in milk production. In beef production similar changes and differences are revealed. In high intensity conditions, beef production will decline much less.

Fertiliser application will not be effected in this scenario. Shannon index, which is unchanged in scenario A1, tends to increase slightly in low intensity areas, but does not change in high intensity areas. The introduction of modulation does not cause any change in the share of agricultural area in the total. Excess Nitrogen emission is decreased by a slightly lower amount in this scenario.

As compared with a straightforward cut in Direct Payments, modulation 'softens the blow' on agriculture, and in so doing reduces the positive impact on high growth regional economies somewhat, while also helping the more peripheral rural areas. These results reveal the contradictory impacts of policies within rural regions and in terms of regional economic performance.

The example of Gorenjska (Slovenia) and Västerbotten (Sweden) illustrate that the introduction of modulation does not cause many changes in low intensity areas, but has much larger impacts in high intensity areas (Figure 8.3).

Figure 8.2 Typical Changes of Scenario A2



Source: 4_Output_comparison.xls

8.2.2 Scenario B

In this scenario, all Pillar-2 support is transferred to Axis 2. Little change would result from this scenario, especially in the low intensity areas. However, greater impacts are observed in high intensity areas.

Population increases by 5% in low intensity areas in this scenario, while in high intensity areas, it is the same as the previous scenarios, at 10%. Net in-migration is lower in Pinzgau/Pongau (AT) as in previous scenarios but higher in Gorenjska (SI) and low intensity areas. There is almost no differences in high intensity areas. Non-agricultural employment grows more significantly (17%) in low than it does in high intensity areas (13%). The growth of per capita income is lower in this scenario than in the previous scenario (3% and 5%, respectively), because relatively more people remain in low-productivity and low wage agricultural employment.

The agricultural area falls slightly in low intensity areas (-0.5%), but more significantly in high intensity areas (9.7%), however it is the lowest decline of all scenarios. Agricultural output is maintained in low intensity areas, which is consistent with the slight decrease of agricultural land, and there is therefore little change in intensity. The same applies to the high intensity areas except Latina (IT), where the utilised agricultural area declines much more than the agricultural production. It follows that the high level of intensity is increased further in that area. Another example is Trikala (GR), where the agricultural production is declining as in Latina, but in this case the utilised agricultural area is maintained.

Cereal production remains the same in low intensity areas, but significant changes occur in some of the high intensity areas: in Trikala there is a considerable expansion of cereal production, although it falls significantly in Latina. Milk production does not decrease much in low intensity areas, but there is a decline in high intensity areas, mainly accounted for by Latina. Beef production will be more stable in low intensity areas, but declines in high intensity areas, again largely accounted for by Latina.

Agricultural employment will not fall much in low intensity areas, but there is a significant decline in high intensity areas. However, in both cases the decline is less than in the previous scenarios.

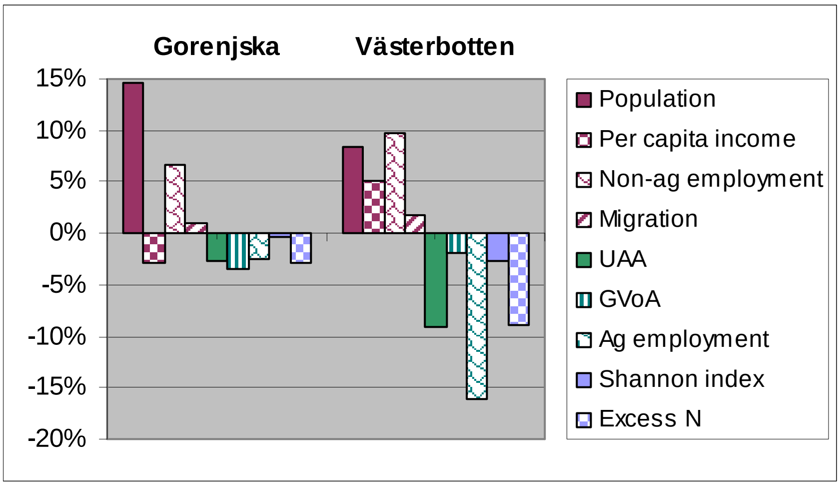
Changes in the product mix lead to a slight increase in biodiversity in low intensity countries, where the highest increase will be in Bacs-Kiskun (HU) and Gorenjska (SI). More significant increase in biodiversity is experienced by the high intensity areas, especially in Västerbotten (SE).

There will be little change in mineral fertiliser use in low intensity areas, but a decline in high density areas. Two study areas have a significant fall, notably Trikala (GR) and Latina (IT).

In conclusion, Scenario B will have its greatest impact in the high intensity areas. The agricultural land use and agricultural employment will decrease there, and the labour/land ratio will decline. The relative spending on Axis 2 is higher in low intensity regions, so that a re-allocation from Axis 1 and 3 has a greater positive impact here.

The following diagram illustrates the changes in Gorenjska and Västerbotten (Figure 8.3).

Figure 8.3 Typical Changes of Scenario B



Source: 4_Output_comparison.xls

8.2.3 Scenario C

Scenario C assumes that all Pillar-2 payments will be utilised in Axis 3. Changes are compared with those in scenario B in what follows.

In this scenario, total population is increasing at a lower rate than scenario B but still by 9% in high intensity areas, and by 4% in low intensity areas by 4%. Net in-migration is slightly higher in low intensity areas, which is 2.58‰ (compared to 2.45‰ in scenario B), while in high intensity areas it is 5.99‰ (compared to 6.10‰ in scenario B). Non agricultural employment increases much more in low intensity areas, by 21% and in high intensity areas only by 12%. Per capita income increase is 4% and 5%, respectively.

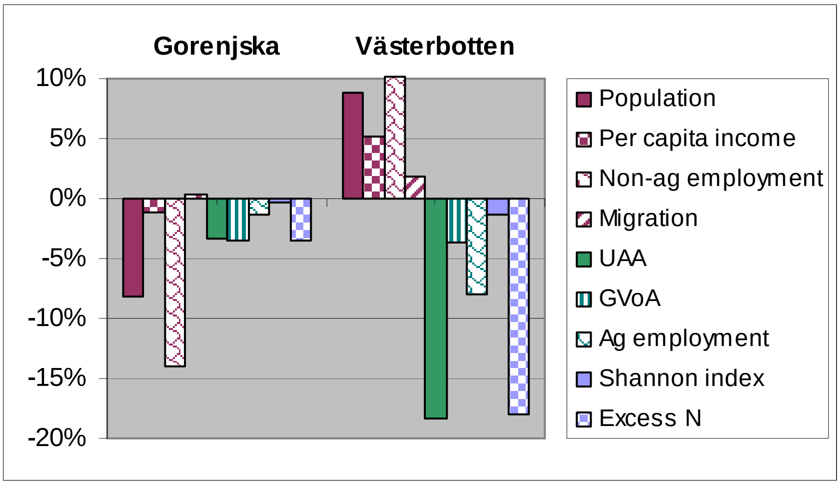
This scenario results in a slight fall in UAA in low intensity regions and a more significant decline in high intensity areas, nevertheless moderated by Latina (IT) and Västerbotten (SE). Gross agricultural production remains unchanged in low intensity areas while there is a significant decline in high intensity areas. Intensity increases, even in the high intensity areas.

Agricultural employment will fall slightly in low intensity areas, but more significantly in high intensity areas, especially in Latina and Västerbotten. There will be a significant change in the product mix. Cereal production will fall in low intensity areas, especially in Gorenjska (SL) and Bács-Kiskun (HU). High intensity areas experience increasing production, particularly in Västerbotten (+30%). Milk production declines in low intensity areas, but grows in Bács-Kiskun and Berguedà (ES). In high intensity areas it falls significantly but mostly due to Västerbotten; other areas are stagnating (as Trikala and the Hordaland) or even growing as in Latina (+9%)! Beef production follows the same tendencies as the dairy sector.

There is a slight increase in biodiversity in low intensity areas, where Pinzgau/Pongau (AT) and Bács-Kiskun (HU) are the leading areas. There is a more significant increase in biodiversity in high intensity areas, especially Latina and Västerbotten. The Shannon index slightly increases in low density and decreases in high density areas. Excess Nitrogen emission falls. The share of agricultural land slightly decreases in low intensity areas, and more significantly decreases in high intensity areas.

Fertiliser use increases slightly in low intensity areas, but decreases the most of all scenarios, in high intensity areas. Trikala and Västerbotten have the greatest reduction in fertiliser use. The various changes in this scenario are illustrated in the following diagram of Gorenjska and Västerbotten (Figure 8.4).

Figure 8.4 Typical Changes of Scenario C



Source: 4_Output_comparison.xls

Summarising the main effects from Scenario C, intensity will grow, due to a major decrease of UAA and proportionately lesser decline in production. Agricultural employment will fall less than UAA; thus the labour/land ratio will fall in high intensity areas. Biodiversity will increase, mainly in high intensity areas. Due to the changes in the regional economy, a slight out-migration would emerge in low intensity areas, and a more notable out-migration in high intensity areas.

8.2.5. Scenario D

Scenario D provides for a 50% increase in regional funding in each study area.

In this scenario, population trends do not change much: as low intensity areas grow by 5% and high intensity areas by 9%. Per capita incomes are increasing by 3% and 5% respectively.

Non agricultural employment growth in low intensity areas is still higher in this scenario than in high intensity areas (16% and 12% respectively).

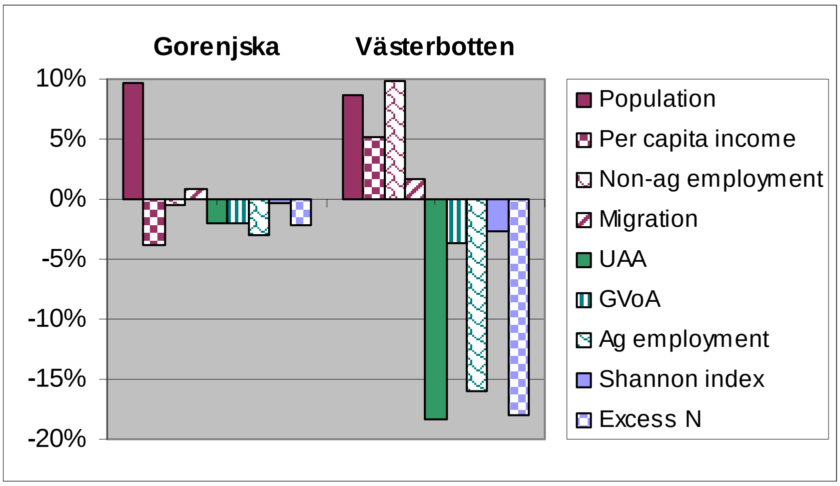
In low intensity areas UAA will decrease slightly, but in high intensity areas the fall is more significant even if it comes from two study areas, Latina and Västerbotten.

In low intensity areas there will also be a slight decrease in gross agricultural production, and again the decline is more significant in high intensity areas. The level of intensity grows in Latina and Västerbotten, because their UAA decline falls more than the production. Trikala is a special case, because here the UAA remains the same while production falls significantly, leading to decreasing intensity.

Agricultural employment remains practically unchanged in low intensity areas but will fall in high intensity areas, especially in Latina (24%) and in Västerbotten (-16%). Considering the changes in UAA and employment together, the labour/land ratio will fall with the exception of Hordaland; most of this fall being in the Italian and Swedish study areas. In low intensity areas, little change in the product mix is projected. In cereal and milk production there is almost no change, and only a slight decrease in beef production. More changes are projected in high intensity areas. Cereal production will decline, but the fall is uneven; the decline is greatest in Västerbotten followed by Latina. In contrast with these areas, Trikala has the opposite change in product mix with increasing cereal production. Milk production will decrease significantly in high intensity areas, especially Latina and Västerbotten. Beef production will also fall, pulled down by Latina and Västerbotten.

More details are given in the following diagram (Figure 8.5).

Figure 8.5 Typical Changes of Scenario D



Source: 4_Output_comparison.xls

Summarising the effect of a 50% increase in regional, the responses are normally greatest in high intensity areas. UAA and agricultural employment would fall significantly, biodiversity increase and there would be significant in-migration.

8.2.6. Scenario E

The assumption of this scenario is that energy prices will double.

The total population will grow by 4% in low intensity and 9% in high intensity areas. Non agricultural employment will grow only by 15% and 12% respectively, which means that low intensity areas are still in a better situation, however per capita income grows in those areas only by 1.6%.

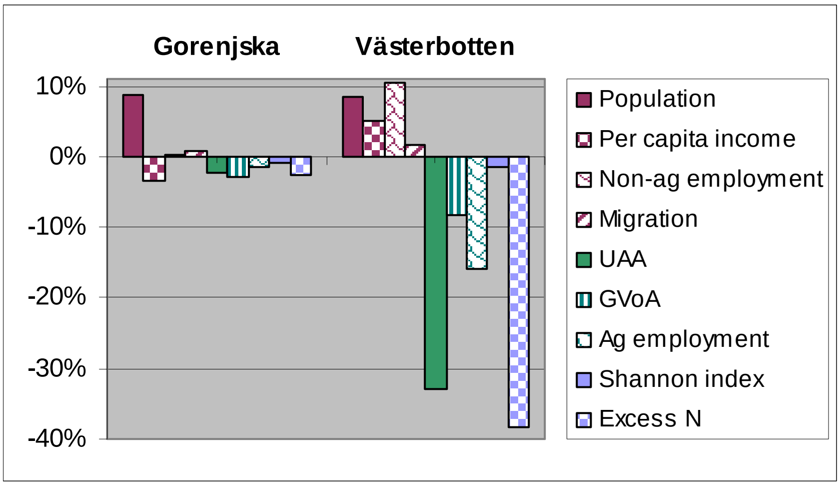
Low intensity areas will see almost no change in UAA, but there will be a significant decline in UAA in high intensity areas, which is the greatest decline of all scenarios (-16%). Västerbotten (SE) would lose a third of its utilised agricultural area, and Latina a fifth, while Trikala (GR) and Hordaland (NO) would have no changes.

Gross agricultural production will be almost unchanged in low intensity areas, but it will decline by 6% in high intensity areas. In Västerbotten (SE) and in Latina (IT), the decline in production is much lower than that in UAA, leading to increasing intensity.

Agricultural employment remains almost unchanged in low intensity areas but as there is a slight decline in UAA, the labour/land ratio increases. However, there are more significant changes in agricultural employment in high intensity areas, especially in Västerbotten (SE) and Latina (IT). Changes in the product mix are more significant in high intensity areas. In low intensity areas, no change is projected for cereal or milk production, but there is some decline in beef production. High intensity areas will have a downward trend in cereal production (with a fall as in Västerbotten and Latina). Trikala is once more a contrast with this as cereal production increases). There is a decrease in milk production, especially in Västerbotten and Latina and a similar trend is anticipated for beef production.

Increasing energy prices will make fertilisers more expensive, which will decrease the demand for them. Diminishing fertiliser use would be more typical in high intensity areas. In particular, excess Nitrogen will decrease. The impact of such an 'energy shock' is typified by areas of Gorenjska and Västerbotten (Figure 8.6).

Figure 8.6 Typical Changes of Scenario E



Source: 4_Output_comparison.xls

Summarising the impacts of scenario E, we can highlight the finding that agriculture in high intensity areas are more sensitive. Farmers in these areas reduce UAA, but at the same time try to increase intensity, which may increase their energy-dependence. Biodiversity would increase, but only in Västerbotten and Latina.

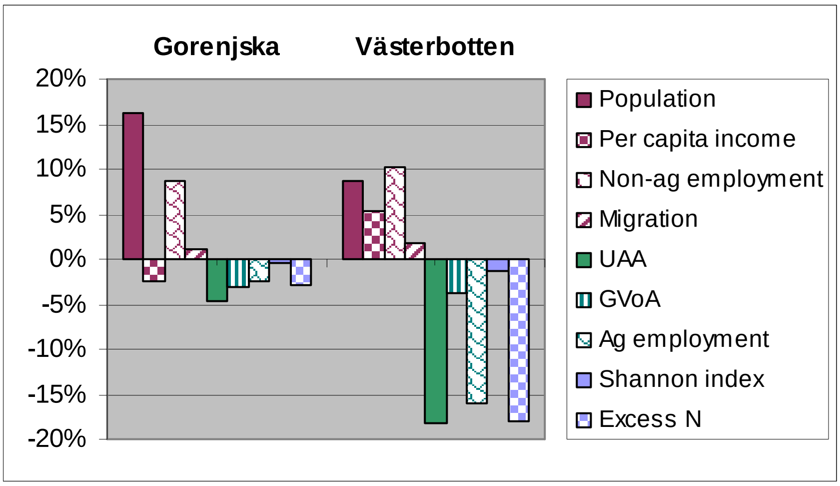
8.2.7. Scenario F

The assumption of this scenario is that Tourism demand would double over the period to 2013.

This scenario would provide the highest population growth in low intensity areas (11%); the same rate of increase as the high intensity areas. In both areas it is the highest population growth of all scenarios. The net in-migration is also the highest in this scenario for both clusters (5‰ and 8‰ respectively). Per capita income will grow more significantly in low intensity areas where the 6% increase is the highest among scenarios. This is the only scenario where growth of per capita income in low intensity areas exceeds that of high intensity areas. Non agricultural employment growth in low intensity areas is also highest by far (24%), compared with only 14% in high intensity areas even if this is also greater than in the other scenarios.

UAA will decrease slightly in low intensity areas and more significantly in high intensity areas. At the same time, the gross agricultural production will not change in low intensity areas and will fall in high intensity areas. This means that intensity will increase in both high and low intensity areas. Significant changes in agricultural employment will take place only in high intensity areas, again especially in Västerbotten and Latina. Tourism demand will reduce farmers' interest in agricultural activities and thus cause some fall in agricultural indicators in both Gorenjska and Västerbotten (Figure 8.7).

Figure 8.7 Typical changes of Scenario F



Source: 4_Output_comparison.xls

In Scenario F, limited changes in the product mix will occur in low intensity areas, and while changes in high intensity areas would be more evident, they would still be less than in several other scenarios. However, per capita income would increase in low intensity areas and also in high intensity areas, if to a lesser extent. There would be a more significant increase in biodiversity. Mineral fertiliser use will increase slightly in low intensity areas and decrease in high intensity areas. Shannon index will change similarly. The share of agriculture in total area decreases slightly in low intensity and significantly in high intensity areas.

8.2.8. Scenario Z

In this scenario, all Pillar-2 payments will be re-allocated to Axis 1.

This scenario would not change the population trends significantly in the study areas. Total population would grow by 2% in low intensity and by 9% by high intensity areas. These are the lowest growth rates of all scenarios. Non-agricultural employment will expand much more in low intensity areas (33%!). This is by far the greatest increase and originates from labour intensive sectors which have poorly remunerated jobs. This is why per capita income will grow only by 2% in low intensity areas (and 5% in the 2^{nd} cluster).

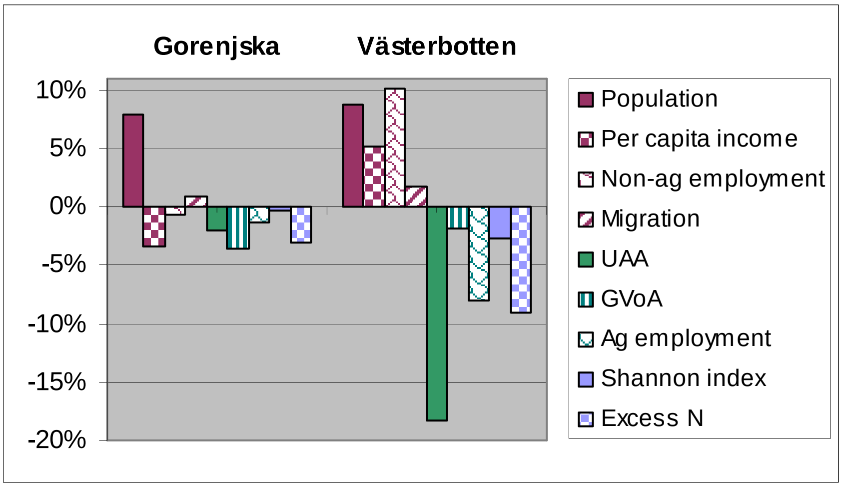
Agriculture in low intensity areas will be little changed, in contrast to the high intensity areas. UAA will fall, especially in Latina and Västerbotten. Nevertheless, gross agricultural production will fall less, leading to a significant increase of intensity in these two study areas (in contrast to Trikala, where intensity will fall).

Agricultural employment will fall, causing a slight increase of the labour/land ratio. There will be important changes in the product mix. Cereal production will usually fall, the main exception being Trikala where it is projected to increase. Milk and beef production will fall significantly in high intensity areas, especially in Latina and Västerbotten.

Mineral fertiliser use would slightly diminish by 3% in high intensity areas. The Shannon index would fall slightly. The share of agriculture in total area will diminish by 14%. Changes in low intensity areas are more limited.

Typical changes are illustrated by Figure 8.8 with the examples of Gorenjska and Västerbotten.

Figure 8.8 Typical changes of Scenario Z



Source: 4_Output_comparison.xls

To conclude, a switch to Axis 1 does not seem to lead to maintenance of production of many critical products, or of agricultural employment, especially in high intensity areas.

We have 3 scenarios where Pillar 2 payments are shifted to different axes: in scenario B, to Axis-2, in scenario C, to Axis-3 and in scenario Z, to Axis 1. The different outcomes of these three policy options are summarised in Table 8.3.

In fact we note rather small differences between these scenarios. Looking first at territorial development indicators, the most favourable scenario for population growth in both low and high intensity areas is B, where all Pillar-2 is shifted to Axis 2. This scenario provides better quality of life conditions, which is reflected in higher relative net in-migration in high intensity areas. Non-agricultural employment is expanding in low intensity areas in Scenario Z, when Pillar-2 payments are shifted to Axis-1, but due to poorly remunerated labour intensive sectors, per capita income grows slowest. In high intensity areas the differences in non-agricultural employment and per capita income are very limited, but the greatest non-Agricultural labour demand arises in scenario B.

Agricultural indicators are difficult to evaluate, because the highest growth or the least decline is not necessarily favourable for the region.

Indicators for the regional environment also do not offer a clear choice for the 'best' scenario. From the point of the least mineral fertiliser use, scenario C is the most favourable for the high intensity areas, but scenario B is best for the low intensity areas. The situation is just reverse for the excess Nitrogen use.

Table 8.3 Comparison of Policy Scenarios on Reallocation of Pillar-2

Indicators, changes from 2007 to 2025	**B**	**C**	**Z**	**B**	**C**	**Z**
	Cluster 1			**Cluster 2**		
Territorial development indicators						
Total population, %	**5.1**	3.6	1.5	**9.7**	9.5	9.2
Net migration on population, ‰	2.45	**2.58**	-0.13	**6.10**	5.99	6.02
Per capita income, %	2.8	**3.9**	2.5	5.3	**5.4**	5.29
Non-agricultural employment	17.2	21.2	**33.2**	**12.8**	12.2	12.0
Agriculture and land use indicators						
UAA, %	-0.5	-1.8	**-0.2**	**-9.7**	-12.3	-12.2
GVoA, %	-0.2	**0.2**	0.1	-5.6	-5.2	**-5.1**
Ag employment, %	**-0.3**	-0.8	-0.4	-12.2	-11.4	**-11.3**
GVoA/Ag employment, €/head	61,189	61,472	**67,183**	31,172	31,012	**31,305**
Regional environment indicators						
Shannon index, %	0.48	**0.50**	0.44	-3.40	-3.36	**-3.33**
UAA/Total area, %	-1.5	**-2.3**	-0.8	-14.2	**-14.3**	-14.2
Mineral fertiliser/UAA , %	**0.5**	0.6	0.8	-3.2	**-6.8**	-3.2
Excess N/UAA, %	-1.1	**-2.2**	-0.6	**-10.3**	-6.1	-6.0

Source: Own composition

8.2.9. Conclusions

Agricultural policy changes have their most significant impacts in high intensity areas, where the situation is more sensitive. However, these areas, thanks to the behaviour of other regional actors, commonly provide better condition for alternative work and income generation even if agriculture may have an important position.

Policy interventions risk leading to further intensification. However, higher intensity does not necessarily contradict environmental goals, especially if the increase is caused by more valuable (for example organic) products.

With respect to agricultural employment, some changes are emerging which contrast with the experiences of recent decades. Nowadays employment seems to stop decreasing in low intensity areas, while high intensity areas may experience a further decrease of 10-12%.

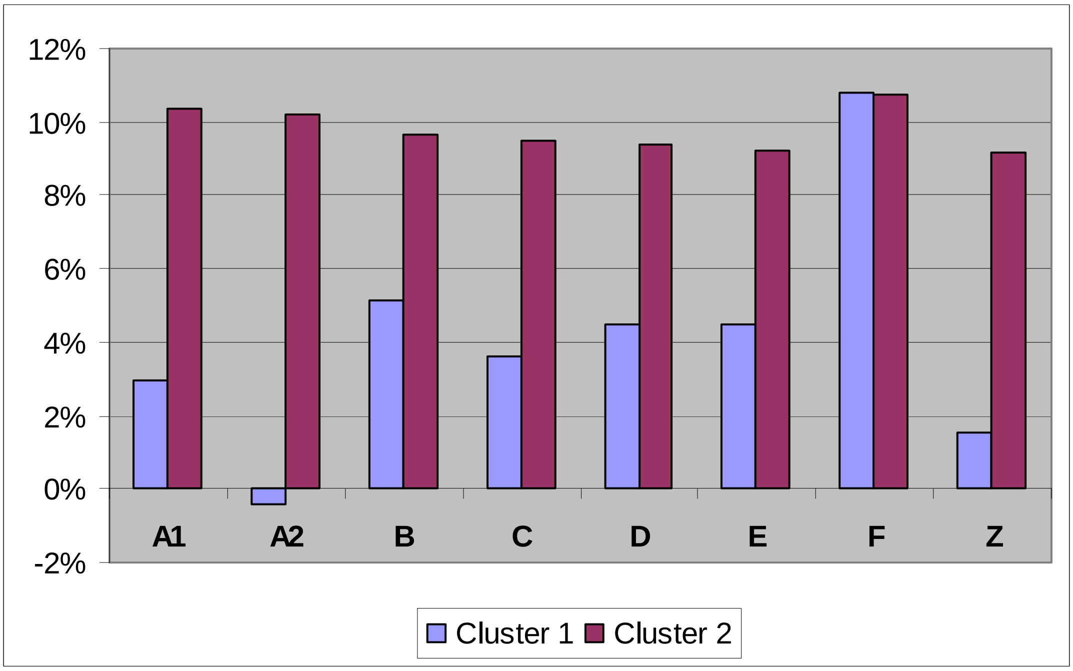
Product mix is adjusting to the employment situation; and considerable changes can be expected. The model has demonstrated that the critical products of the European Union can undergo deep changes, especially in high intensity areas. The product mix is more stable in low intensity areas, but response to significant price changes can be more dramatic here.

In terms of 'critical' products, cereal supplies can be more stable in future, but in high intensity areas a downward trend is likely. Milk and beef sectors are more vulnerable, especially in the high intensity areas, where a significant fall can be expected.

Per capita GDP may nevertheless strongly increase in rural areas due to better and more innovative use of other rural assets and resources including those for innovative renewable energies, tourism, and manufacturing.. In-migration can be a likely trend in rural areas.

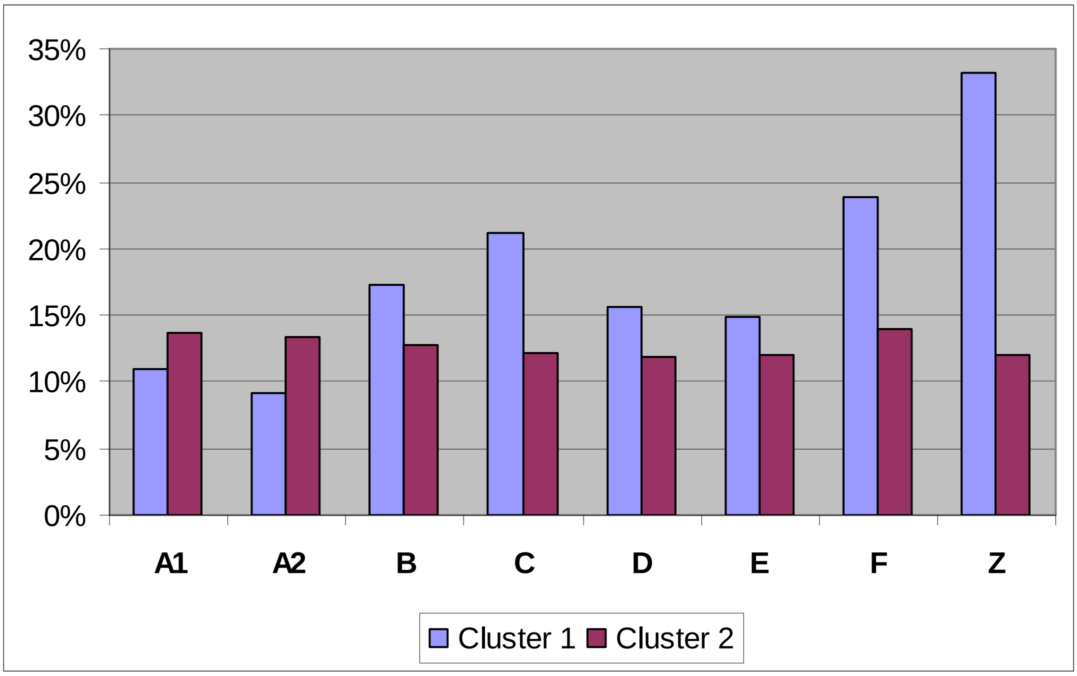
However, agricultural and other policy changes and other market changes we analysed may also have significant impacts on the regional economy, society and environment. The most significant impacts are often on population growth, as shown in Figure 8.9.

Figure 8.9 Change of Total Population by Scenarios



High intensity areas are less sensitive in this respect to different policy scenarios: they have an average 9-10% increase in all scenarios. However, different scenaiors have a significant impact on the population of low intensity areas: here the change may vary from -0.5% to 11%! As mentioned before the highest population increases are caused by the expansion of tourism demand (F), and a slight decrease results from the cut of direct payment with modulation (A2).

Figure 8.10 Change of Non-agricultural employment by scenarios



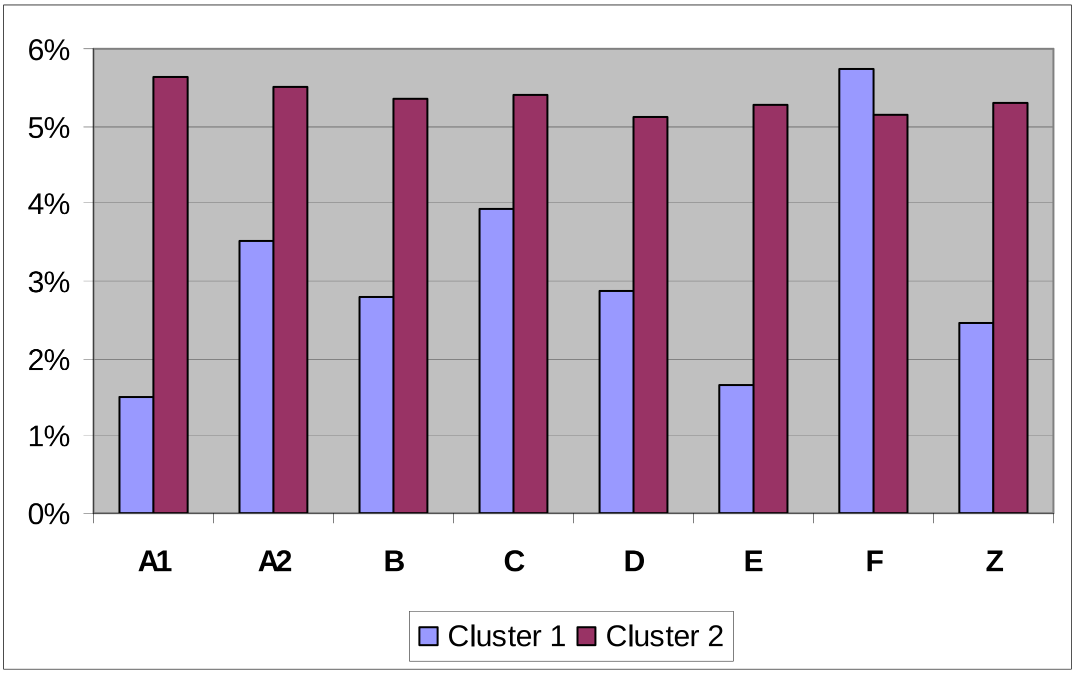
The increase of Non-agricultural employment is quite uniform in high intensity areas where it varies only from 12 to 15%, but quite varied in low intensity areas, where it ranges from nearly 10% to 34%. As with population change, the smallest change in Non-agricultural employment is projected for the cut of direct payments with modulation (A2) and the highest in scenario Z. The reasons of these differences can be considered after analysing the changes of income situation in Figure 8.11.

It is also striking here that high intensity areas have more uniform growth of income. The variation of per capita income in these areas is only from 5.1 to 5.6%, in contrast to low intensity areas, which vary from 1.5 to 5.7%.

Unlike the agriculture/land use and regional environment indicators, territorial development indicators are more uniform in high intensity areas and more varied in low intensity areas. Agriculture either may occupy a smaller part of the regional economy and land area and this is the reason for high intensity, or land, labour supply and local food demand is more favourable for agricultural use, so encouraging a higher intensity. For whatever reason, the rest of the economy has become more stable in these areas, and more resistant to significant changes in agricultural policy.

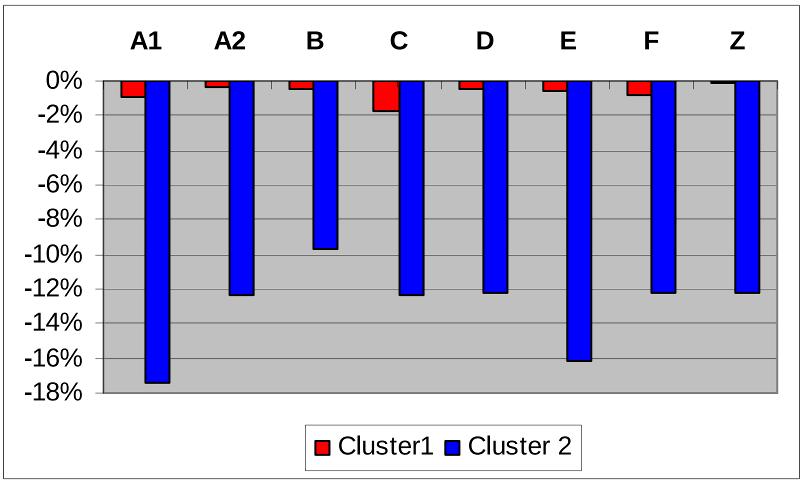
Low intensity areas can be very different with respect to the availability of labour and food demand. Some of them have a low density of population, and large distance to major markets; this is why they have a low intensity of farming. They may also have weak non-agricultural sectors and employment. Such weak and sparsely populated areas do not attract many migrants; rather there is a tendency for out-migration.

Figure 8.11 Change of Per capita income by scenarios



As low intensity areas are more vulnerable, they may generate labour demand in very different sectors. A high proportion of labour demand can be generated in low wage sectors, which results in very limited increases in per capita income, as was the case in some scenarios.

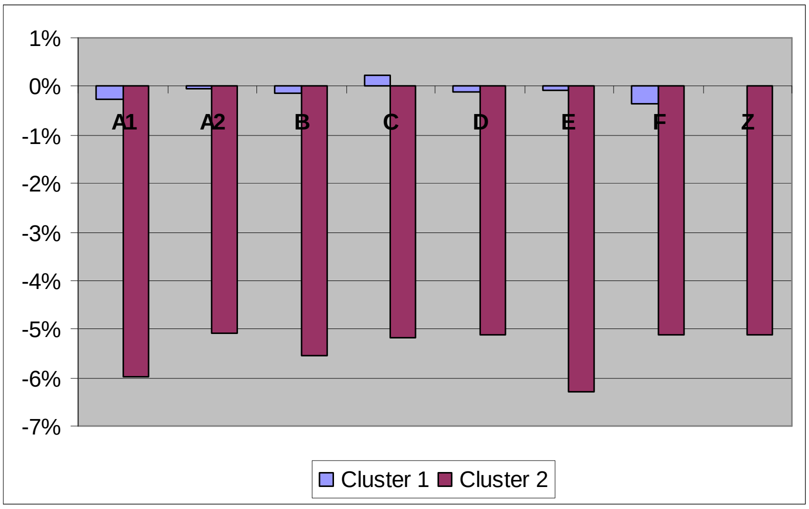
Figure 8.12 Change of UAA by Scenarios



Source: 4_Output_comparison.xls

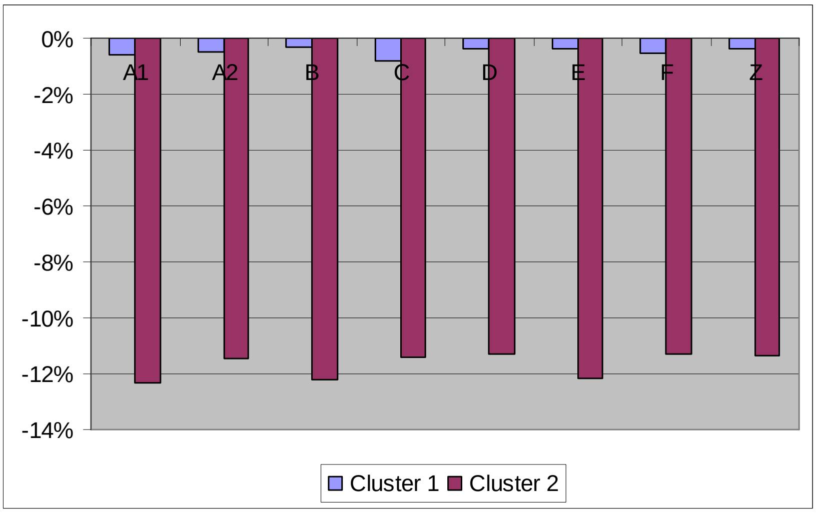
The agricultural and land use indicators are more uniform in low intensity areas. In the high intensity areas, there is a greater decline. For instance, UAA falls by 10-18% in the scenarios (Figure 8.12), and the Gross value of agricultural production also declines by 5-6% (Figure 8.13), which provides a further increase in intensity in most scenarios.

Table 8.13 Change of GVoA by Scenarios



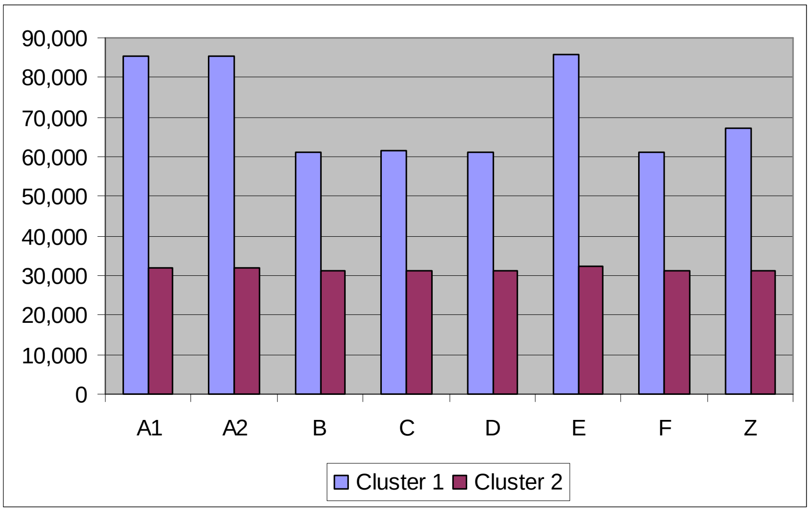
Agricultural employment is falling by 11-12% in high intensity areas, but by only 0.5-1.0% in low intensity areas (Figure 8.14).

Figure 8.14 Agricultural Employment Change by Scenarios



Labour productivity (€/head) is much higher in low intensity areas. However, the changes are much more significant here, and the deviation is also much higher. The high intensity areas have an almost unchanged level of productivity (Figure 8. 15).

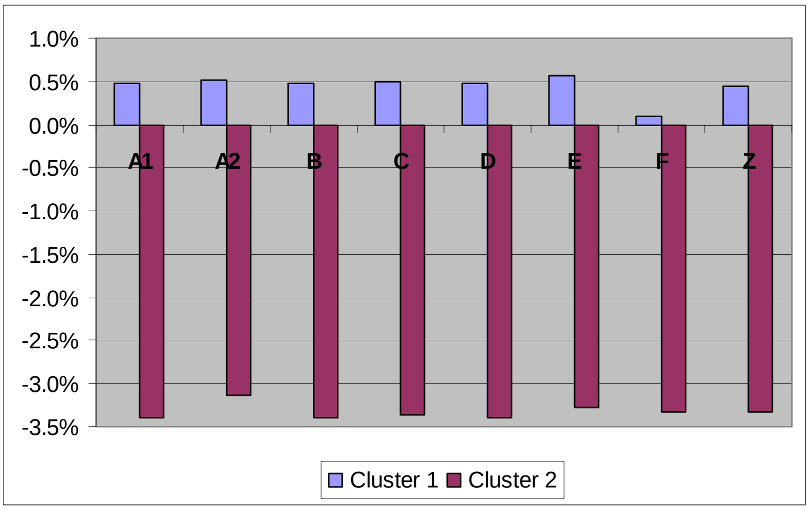
Figure 8.15 Labour Productivity (€/head) by Scenarios



Indicators of regional environment are also more uniform in low intensity areas. Most indicators have a slight increase in low intensity areas, but a significant decline in high intensity areas. This is connected with the fact that high intensity areas have a more sensitive environmental situation.

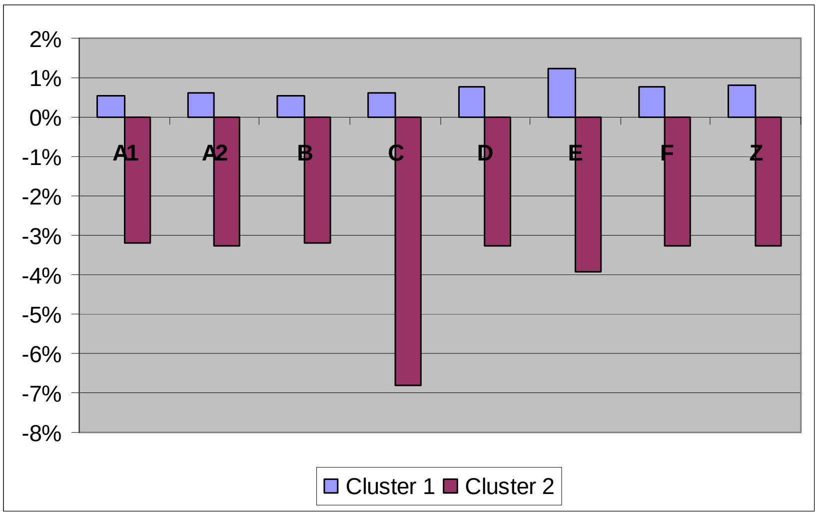
The Shannon index also changed in different directions: a slight increase (up to 0.6%) in low intensity areas, and a decrease of 3-3.5% in high intensity areas (Figure 8.16)

Figure 8.16 Shannon Index Change by Scenarios



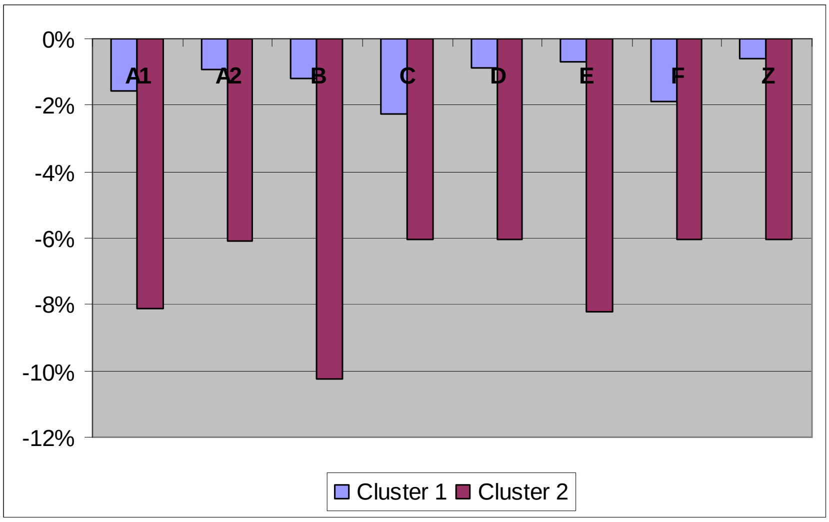
Similar changes were noted in mineral fertiliser use: increases in low intensity areas (max. by 1.1%) and decreases in high intensity areas (3-7%), as indicated in Figure 8.17. The lowest decline is projected by scenario C (Pillar-2 to Axis 3) and scenario E (energy prices doubled).

Figure 8.17 Mineral Fertiliser Use per UAA Changes



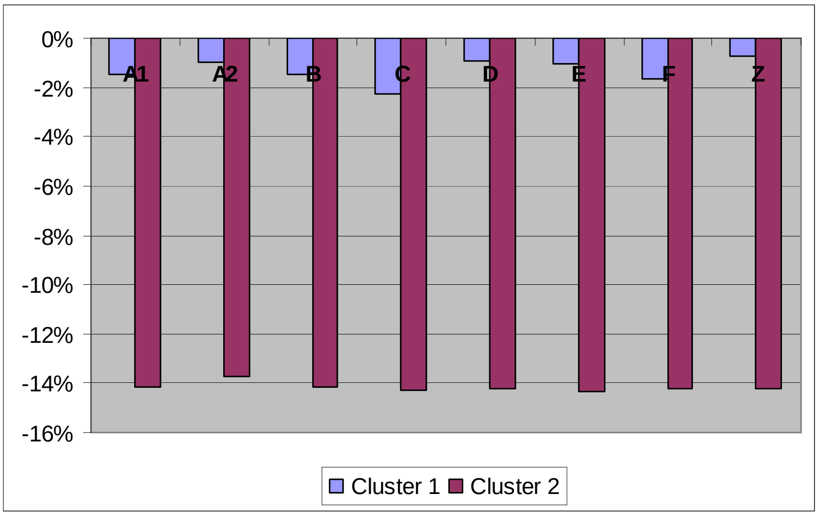
Excess Nitrogen is projected to decline in both low and high intensity areas. In low intensityr areas, a decrease of between 0.5 and 2.2% is projected compared with a decline of between 6 and 10% in high intensity areas (Figure 8.18).

Figure 8.18 Excess N per UAA by Scenarios



There is a decrease in agriculturally utilised land – slight in low intensity areas (1-2%), and more significantly in high intensity areas (about 14%). In the high intensity areas the differences between scenarios are small.

Figure 8.19 UAA per Total Area by Scenarios



8.3 Ranking of study areas by Policy efficiency

Data Envelopment Analysis (DEA) is a powerful service management and benchmarking technique originally developed within operations research by Chames, Cooper and Rhodes (1978) to evaluate non-profit and public sector organizations. DEA has since proved more helpful than other techniques in identifying ways to improve services.

DEA compares regions considering all resources used and services provided as inputs, and compares these with outputs measured from outcome indicators (including NCOs). Undesirable output indicators, which have negative impact on outcomes (e.g. mineral fertiliser applications or high livestock density which reduce NCOs), comprise part of the inputs. The different inputs and outputs are commonly weighted. Branches of organisations, or different implementations of a policy regime, can be compared, those with the highest ratio of output to input providing a 'benchmark' against which others can be judged.

Efficiency is simply defined as the ratio of output to input. The more output per unit of input, the greater the efficiency. If the greatest possible output per unit of input is achieved, a state of absolute or optimum efficiency has been achieved and it is not possible to become more efficient without new technology or other changes in the production process. The main problems with the DEA approach, and which need to be considered when interpreting the results, are:-

1. the choice of input and output indicators;
2. the weights to be applied to each of these indicators (in this case we use an implicit weight of 1 for each);
3. that many other forces determine the effectiveness and efficiency of any policy or 'branches' than the variables used, in our case policy expenditure.

In this analysis, we considered *NCOs*, measured by Biodiversity change and Shannon index, mineral fertiliser use per hectare and livestock units per hectare; *tourism* measured by the labour employed in Hotels & Catering; and *per capita income* as output indicators. They are various and sometimes contradicting indicators; the only common in them, which are intended to impact by rural development policies. Biodiversity and Shannon index should be increased; fertiliser use and livestock density decreased by farming, sectors like tourism should be grown, also by farm tourism.

Axis 1, Axis 2, Axis 3 and Leader payments are inputs of the model. From technical point of view, (as they create undesirable outputs) fertiliser use and livestock density also comprise part of the input variables.

This comparative analysis was made for two periods: the 2000-2006 and 2007-2013 EU programming periods. For the inputs, rural development payments were available as the annual average payments for both the first period and the second period.

Output indicators were taken from the baseline results, 2007 for the first period, and 2015 for the second (Table 8.4).

Table 8.4 Output Indicators of DEA Model

2007 Outputs		**AT**	**DE**	**ES**	**GR**	**HU**	**IE**
-Fertiliser/UAA	kg/ha	11,5	131,1	23,2	1814,6	191,4	128,7
-LU/UAA	LU/ha	0,170	0,347	0,738	0,280	0,041	0,962
Shannon index	index	1,073	2,774	1,188	1,070	1,254	0,403
Biodiversity change 2007/2001	2007/2001	1,005	1,002	0,980	1,003	1,000	1,000
Labour_Hotel&catering change	2007/2001	1,055	1,005	1,120	1,161	1,038	0,993
p.c. income	ths €/head	22,88	9,71	15,98	10,39	12,83	38,54

Cont.		**IT**	**NO**	**SE**	**SI**	**UK**
-Fertiliser/UAA	kg/ha	281,6	551,1	415,2	479,9	93,3
-LU/UAA	LU/ha	0,313	0,127	0,010	1,168	0,226
Shannon index	index	1,308	0,744	0,730	1,011	1,377
Biodiversity change 2007/2001	2007/2001	1,024	1,069	1,030	1,005	1,004
Labour_Hotel&catering change	2007/2001	1,114	1,040	1,016	1,208	1,123
p.c. income	ths €/head	22,85	20,20	28,92	10,62	12,21

2015 Outputs		**AT**	**DE**	**ES**	**GR**	**HU**	**IE**
-Fertiliser/UAA	kg/ha	11,4	133,2	23,2	1722,9	191,4	128,7
-LU/UAA	LU/ha	0,168	0,337	0,738	0,280	0,041	0,962
Shannon index	index	1,074	2,789	1,188	1,070	1,256	0,403
Biodiversity change 2015/2007	2015/2007	1,007	1,003	1,000	1,006	1,001	1,000
Labour_Hotel&catering change	2015/2007	1,037	1,001	1,071	1,025	1,100	1,099
p.c. income	ths €/head	22,604	9,800	16,588	10,460	12,509	39,211

Cont.		IT	NO	SE	SI	UK
-Fertiliser/UAA	kg/ha	277,1	551,1	415,7	480,7	93,3
-LU/UAA	LU/ha	0,248	0,127	0,010	1,166	0,226
Shannon index	index	1,252	0,744	0,730	1,008	1,377
Biodiversity change 2015/2007	2015/2007	1,024	1,000	1,092	1,006	1,005
Labour_Hotel&catering change	2015/2007	1,088	1,023	1,111	0,998	0,894
p.c. income	ths €/head	23,992	20,533	30,360	10,281	11,661

The input variables are indicated in Table 8.5.

Table 8.5 Input Variables of DEA Model

2000-2006 INPUTS		**AT**	**DE**	**ES**	**GR**	**HU**	**IE**
A1 - annual payments	mio €	2,89	0,53	1,07	19,02	2,42	5,61
A2 - annual payments	mio €	37,06	1,81	0,80	8,26	14,53	0,84
A3+Leader a. payments	mio €	0,74	0,49	0,64	3,33	0,59	0,24

Cont.		**IT**	**NO**	**SE**	**SI**	**UK**
A1 - annual payments	mio €	9,02	143,57	29,37	0,89	0,00
A2 - annual payments	mio €	2,88	18,37	288,14	4,24	9,56
A3+Leader a. payments	mio €	1,90	113,63	25,74	0,24	0,36

2007-2013 INPUTS		**AT**	**DE**	**ES**	**GR**	**HU**	**IE**
A1 - annual payments	mio €	5,70	0,71	1,46	18,29	96,65	3,76
A2 - annual payments	mio €	35,57	1,36	1,38	8,12	71,61	27,24
A3+Leader a.payments	mio €	4,33	0,39	0,94	4,97	20,27	3,22

Cont.		**IT**	**NO**	**SE**	**SI**	**UK**
A1 - annual payments	mio €	11,27	..	4,25	7,07	11,74
A2 - annual payments	mio €	1,98	..	0,54	10,38	31,43
A3+Leader a. payments	mio €	2,26	..	3,38	2,33	0,56

The calculations were made by DEAFrontier software, and provided the following results in Table 8.6.

Table 8.6 Results of DEA Model

Region No.	Region Name	Input-Oriented CRS Efficiency	2000-2006 □□	Benchmarks			
1	AT	1,00000	1,000	1,000	AT		
2	DE	1,00000	1,000	1,000	DE		
3	ES	1,00000	1,000	1,000	ES		
4	GR	0,85686	1,066	0,344	HU	0,722	IT
5	HU	1,00000	1,000	1,000	HU		
6	IE	1,00000	1,000	1,000	IE		
7	IT	1,00000	1,000	1,000	IT		
8	NO	0,95059	1,390	1,155	HU	0,236	IT
9	SE	1,00000	1,000	1,000	SE		
10	SI	1,00000	1,000	1,000	SI		
11	UK	1,00000	1,000	1,000	UK		

DMU No.	DMU Name	Input-Oriented θ Efficiency	2007-2013 □□	Benchmarks							
1	AT	1,00000	1,000	1,000	AT						
2	DE	1,00000	1,000	1,000	DE						
3	ES	1,00000	1,000	1,000	ES						
4	GR	0,22954	0,997	0,166	DE	0,831	SE				
5	HU	1,00000	1,000	1,000	HU						
6	IE	1,00000	1,000	1,000	IE						
7	IT	0,98343	1,029	0,030	AT	0,187	DE	0,230	ES	0,582	SE
8	NO	..	..	..							
9	SE	1,00000	1,000	1,000	SE						
10	SI	0,27738	1,001	0,045	AT	0,937	DE	0,019	SE		
11	UK	0,81266	0,992	0,686	AT	0,200	DE	0,011	HU	0,094	SE

The interpretation of DEA results is as follows:

1. The efficiency ratings are generated by the model. Units that are efficient (θ = 1) are relatively, and not absolutely, efficient. That is, no other region is obviously utilising the RD measures more efficiently than these regions, but it is possible that all regions, including those deemed relatively efficient, can be operated more efficiently. Therefore, the efficient regions represent the best existing (but not necessarily the best possible) treatment of RD resources with respect to NCO production, Tourism growth and per capita income, provided that these are all equally valued.

2. Inefficient regions are identified by an efficiency rating of θ < 1. These regions are inefficient (with respect to the selected NCO generation) compared to all other regions.

3. The efficiency reference regions indicate the relatively efficient regions against which the inefficient regions were most clearly determined to be inefficient. Table 8.6 summarises the magnitude of the identified inefficiencies by comparing the inefficient region with its efficiency reference set of regions.

4. The reference inputs and outputs are multiplied by the weights derived by DEA. These are then added together to create a composite „region" that provides as much or more NCO services as the inefficient region, while also using less inputs that this latter one. These reference weights are generally referred to as Lambda - λ - values in the DEA models.

According to these considerations the following main comparisons can be drawn based on the results:

1. In the 2000-2006 period, there are only two 'inefficient' regions Trikala (GR) and the Hordaland (NO). In both, there appears to be too much RD support in relation to NCOs, per capita income and Tourism growth. The inefficiency lag can be measured by the indicators of Bács-Kiskun (HU) and Latina (IT).

2. For the current projected period (2007-2013) the picture is more interesting: for some outputs certain regions will be less efficient than the others. Trikala is inefficient measured by the Wetteraukreis (DE) and Västerbotten (SW), and Latina also joins the inefficient regions measured by Pinzgau/Pungau (AT), Wetteraukreis, Berguedà (ES) and Västerbotten (SW). Gorenjska (SL) has also become inefficient compared with Pinzgau/Pungau, Wetteraukreis and Västerbotten. Caithness and Sutherland (UK) has also become inefficient.

Naturally, this ranking is established for NCO production, tourism and per capita income in parallel, under the current structure. Certainly, central, regional and local governments may and certainly do have different preferences (weights) about these three and other indicators, which would yield other results. In addition, as mentioned previously, changes in tourism and per capita income are the consequence of much more than the second Pillar of the CAP and its equivalent in Norway! Therefore this analysis must be viewed with caution.

9. IMPLICATIONS FOR POLICY

Ken Thomson and John Bryden

9.1 Introduction

The policy implications of the results of the TOP-MARD project – as derived from both its survey and modelling elements – can be drawn at a number of levels, from farms or farm households, through regions and countries, to EU level (or EU-affected, in the case of Norway). Similarly, implications can be analysed in economic, social (e.g. demographics, education), or environmental terms, taking into account the various actual or potential policy instruments available in these areas. It is however fundamental to the approach of the project that future policy should be considered in a more "territorial" (i.e. regional) sense; in some cases, this may suggest more "integration" of existing policy design and implementation, whereas in other cases more fundamental changes in government structures and in governance may be involved.

This chapter explores some general implications for EU policy-making that can be based on the findings of the TOP-MARD analysis, whether from its survey work (Chapter 5), or its modelling analysis of policy scenarios (Chapter 8).

9.2 Multifunctionality

Multifunctionality in agriculture is generally considered as the joint production of both a physical commodity such as wheat or beef, and of a non-commodity output (NCO) such as landscape or wildlife. The lack of a market for NCOs (or at least a direct one for most of them; tourism, and to some extent desired in-migration, clearly rely openly on such NCOs) poses a problem for policy makers in deciding whether and how far to modify commodity policy instruments such as production subsidies to take account of NCOs, or whether to design and implement two separate sets of instruments, on the Tinbergen principle of matching the number of instruments to the number of "targets".

For the Common Agricultural Policy (CAP), the issue has changed its nature since the introduction and now domination of the CAP's Pillar 1 by decoupled direct payments to farmers; whatever the formula used for such payments (which varies considerably from country to country, and region to region), these have altered the market conditions for commodities, although a significant degree of non-subsidy support remains, especially for some farm commodities. Moreover, the single payments have allowed the introduction of "cross-compliance" as a CAP principle, i.e. the production of NCOs can – at least to a limited degree – be made a condition of payment eligibility, and so some "multi-functions" can be ensured, or at least greatly encouraged, in this way.

However, this approach, though attractive in its scope (most EU farmers, especially the larger ones, depend heavily on direct payments), has its limitations, primarily its crudeness. Cross-compliance requirements can be tailored to some extent, e.g. by country or region, but not by farm type or environmental quality. The CAP's Less Favoured Area payments scheme offers a more targeted basic instrument, but over time has shown itself too general, which is why some current proposals for LFA reform are suggesting a much more targeted environmental basis for these payments.

The Tinbergen approach suggests that a separate set of instruments, such as those in Pillar 2 and its Axes, should be used to focus public expenditure on specific "public goods" (i.e. NCOs), either directly, as in payments for environmentally friendly land management, or indirectly, e.g. by supporting farm and rural diversification activities which will themselves enhance the commercial value of NCOs.

Again, however, the complexity of and variations in agricultural multifunctionality, both on the commodity (or land use) side, and in the NCOs involved, mitigate against any simple solutions for the EU as a whole.

9.3 Non-Commodities

Some NCOs are evidently important for territorial development and “quality of life” (QoL), but these vary, and their importance varies, from place to place. They are not always 'joint' *sensus strictus* with any particular commodity output production, but more with the presence of a viable farming family (i.e. one with reproduction and succession possibilities). This means that as we move from production subsidies through income payments to Pillar 2, variation at national and sub-national levels is important. The means by which EU-national-local articulation of policies takes place, and the outcomes related to that articulation, therefore becomes a much greater focus than previously when the focus was on the “common markets” in commodity outputs.

The impact of policy changes is varied and depends not only on regional production structures, commodities etc., but also on regional economic structures, labour markets, demographics and migration, education, and other factors. Thus in some cases, notably where non-agricultural labour markets are growing, and there are relatively high wages, a reduction in direct Pillar 1 type payments can be more than compensated for by a shift of labour into higher earning local employment in other sectors. A good example here (but not the only one) amongst the TOP-MARD case study areas is Hordaland. This is because wages and productivity are so much higher in the sectors of growing labour demand. Again, it suggests that policies need to be tailored to local conditions. This is more possible with Pillar 2 than with Pillar 1.

Low-intensity agricultural areas are to some extent 'buffer zones' in the face of rapidly changing food and energy prices. They have more capacity to adjust without collateral damage. This appears to be the case both for renewable energy forms (bio-energy, wind energy, etc) as well as for food production. In the case of high food prices, there is less scope to increase production without undesirable environmental consequences in those regions that are already intensively farmed, while a combination of high energy and food prices may in certain circumstances mean an increasing advantage of local production and consumption[24].

In attempting to evaluate policy impacts (see the DEA analysis in Chapter 8), a continuing problem is that many changes are not mainly, or even significantly, the result of policies: other driving forces are more powerful. For example, because of its generally low, and declining, share of regional GDP, the CAP has little impact on regional economic growth, or perhaps on overall regional QoL *per se*, depending on what weight is given to QoL components related mainly to farming, such as landscape. Another case is where a significant non-agricultural economic driver (such as the long-term closure of a major industrial site in the Scottish case study area of Caithness & Sutherland) is affecting the region. And, of course, farming is subject to the perennial effects of climatic variations and technological change. This means that while one can estimate the effects of agricultural policy on farming

[24] Although we did not model this combination explicitly. Because of the dominance of supermarkets in modern nation-wide and globalised food systems, the overall reaction to the combination of high energy and food prices is not very obvious.

income and agriculture itself, one cannot measure the effects on regional environment, economy and QoL so easily.

9.4 Policy Changes

As discussed briefly in Section 9.2 above, there are choices to be made between Pillar 1 and Pillar 2, between Pillar 2 Axes, and the sub-instruments of modulation, capping etc. While our work informs these choices, it gives no quick-fix answer at the EU level, because of the different and even contradictory impacts in different contexts. The 'behaviour' or 'performance' of other elements or sectors in these contexts becomes much more important in a 'rural development policy' than in an agricultural policy.

The results of the Scenario A1 analysis suggests that reduction of Pillar 1 payments, whether modulated or not, will have greater effects – in terms of farm incomes, employment, land use and commodity production - in extensively farmed regions than in more intensive ones. This suggests that this type of policy reform should not be undertaken in a “horizontal” fashion, although the problems of defining different agricultural regions or territories are not under-estimated, nor the difficulties of budgetary adjustment that will be posed as countries and regions experience net gains or losses.

Focus on Axis 2, i.e. payments for environmentally friendly land management, seems promising in terms of continuing support for farming in extensive regions, but the implications for more intensive regions are mixed. Some proportion of such areas would benefit, e.g. from organic methods or transfer of farmland to desirable forestry and nature reserves, but there might be (further) intensification on the remaining farmland area. It is not clear if or how a “territorial” approach would meet these challenges, although the farm-level (or field-level) consideration that would be necessary might be easier to operate, and be more acceptable, from a relatively low administrative level.

Similar effects seem observable if funding is shifted to Axis 3 or to general regional support, e.g. for agriculture, although no doubt the situation in extensive areas will depend on whether their farms will be maintained alongside the new types of financial assistance that would then be possible in the effort to promote diversification.

The implications for policy arising from a doubling of energy prices (treating this rise as a non-policy shock, and as non-temporary) again require consideration in terms of farming intensity. The greater adjustment enforced on higher-intensity farming areas (see Chapter 9) would need a balance between the need to accept such adjustment to the increased cost of an essential input, and the consequences for food supplies both within the EU and elsewhere.

The above discussion of policy implications have focussed on agriculture itself, following the results shown in Chapter 8; nevertheless, the TOP-MARD approach suggests that multifunctionality should be treated as extending to both environmental and social spheres. In the latter sphere, one complexity is that some of the changes considered would have direct effects on the economic and perhaps other behaviour of regional residents, e.g. if energy prices, or tourism levels, doubled, or support for regional economic diversification was highly effective. In such circumstances, the overall effects on the QoL and the general and relative prosperity in a rural region would be hard to assess, and certainly other policies, both EU and national/regional, would be brought to bear. Nevertheless, the enduring importance of agriculture and its non-commodity externalities suggests that a broad range of impacts should be taken into account in considering specific funding for rural development.

The contextually specific impacts and outcomes of different policy measures suggests that agricultural policy should perhaps increasingly become a part of territorial policy, and so adopt the concerns of territorial policy for social and economic cohesion. Agricultural policy now has a mandate not only to deal with traditional concerns of food security, food quality, and reasonable prices to consumers but also to deal with other functions, especially functions in relation to the environment and territorial (regional, sub-national) development and quality of life. As such, it seems necessary to deal with agriculture as one of several sectors within a territorial policy for rural regions, rather than dealing with policy for such regions as a subsidiary part of agricultural policy.

10. POMMARD - IMPLICATIONS FOR FUTURE RESEARCH

Luka Juvančič

POMMARD Vs. other integrative modelling approaches for analysing impacts of multifunctional agriculture

10.1 Introduction

This chapter attempts to provide a comparative analysis of the POMMARD modelling framework with other integrated models assessing impacts of multifunctional agriculture. The aim of this review is to systematically compare the modelling approach and research scope of POMMARD with its counterparts. By doing so, merits and potential drawbacks of alternative modelling approaches can be discussed and future improvements/extensions of POMMARD can be suggested.

In their exhaustive review of modelling work that integrate disciplinary knowledge for analysing impacts of multifunctional agriculture, Rossing et al. (2007) developed analytical framework for comparison of various modelling approaches. The framework originally consists of eight categories of information. We see this analytical framework very useful also as a useful starting point for this comparative analysis. The list of categories and elements used in comparative analysis of POMMARD therefore derives from Rossing et al. (2007) and has been only slightly adapted (Table 1).

Table 10.1 Categories and Elements of Models Analysing Impacts of Multifunctional Agriculture

Category	**Element**
1. General description	
2. Major objective of modelling	- Methodology development, - Answering specific questions commissioned by clients - policy evaluation (Ex-ante, Ex-post).
3. Intended user groups	- Policymakers - Farmers - General population (ie. consumers, taxpayers) - Scholars, scientists
4. Modelling approach	- Regression based - Optimisation models (eg. linear programming) - Simulation models
5. System definition	- Spatial scale - Temporal scale/time horizon - Objects describing the system - Type of results
6. Categories of multifunctionality indicators and method of quantification	- Environmental (abiotic, biotic, landscape) - Economic (costs, gross margins, utility, investments, rate of return, liquidity, rate of return on factors,etc.) - Social (demography, labour, etc.)

The 'General description' category includes a brief description of the purpose of the model. In 'Major objectives of modelling', we distinguish between two (not necessarily exclusive) modelling objectives – methoodological and applicative. The 'Intended user groups' category describes the target groups of actual and potential users. Another category used in comparison has to do with the chosen modelling approach. The 'System definition' category is given in terms of the spatial and temporal scales, the objects that characterize the model and the type of results presented. The review concludes by a review of categories of multifunctionality accomodated by the model.

10.2 General description of the models

Based on an analysis of three European countries with a track record in quantitative system modelling on multifunctional agriculture (Germany, France and the Netherlands), Rossing et al. (2007) identify 15 integrative models. Some of them comprised ‘schools of thought’ and included several studies in which similar approaches were used. Some typical cases of such ‘families of models’ were: (i) multi-agent simulation approaches; (ii) farm optimisation using LP and various ecological evaluation tools; (iii) prediction of land-use change based on regression analysis and (iv) spatially explicit and multiple scale optimisation methods. The common denominator of the reviewed modelling approaches is that they all have been built to assess the consequences of alternative land uses. Impacts were modelled at various territorial scales - from a single-farm to a regional scale.

In this sense, POMMARD does not deviate significantly from modelling practices described above. Impacts are modelled at the regional scale (in most cases NUTS 3 regions). Likewise, place-based assets (especially land and natural characteristics) are considered key to rural region performance. However in terms of the scope and the contents, POMMARD is more complex than most of the previous modelling work on multifunctionality. Accommodating new dimensions of multifunctionality to the modelling framework, the system consists of eleven inter-related modules.[25] The region is treated as a system (land, people, economy, commodities / non-commodities, policies, quality of life), and relationships between them are identified and quantified. It can be therefore seen as a modelling tool for analysing multiple functions in rural regions.

10.3 Modelling objectives

With the exception of two approaches – RAUMIS developed in Germany as a policy evaluation tool aggregating regional farm models (FAL, 1996) and Nature Planner developed in The Netherlands for assessment of the state of nature and environment (eg. Oostermeyer and van Swaay, 1998) – the focus of the modelling analysed by Rossing *et al* (*op cit*) was in methodology development. Most approaches aimed at ex-ante evaluation and decision support, and in a number of biophysical models, results were used also for ex-post evaluations. Nevertheless, since impact evaluation was usually absent in the approaches towards modelling different multiple functions of agriculture so far attempted of, their use for policy evaluation and policy development has so far been rather limited.

In contrast, POMMARD has a clear ambition to accommodate various policy and market scenarios. It is build to assist evaluating the impacts of changes in policy or market conditions, on both agriculture and regional development in different rural contexts and conditions. Impacts of policy changes (relating mainly to agricultural, rural development and regional policies) are modelled in the ‘agriculture’ and ‘region’ modules of POMMARD, while the ‘policy’ module accommodates changes in initial conditions and in the optional sector (tourism). With its intuitive (icon-based) structure, the model is relatively easy to

[25] The scientific approach towards modelling and the structure of POMMARD are described in a greater detail in Chapters 3 and 6 of this volume.

explain to clients, which is advantageous for its use as a policy planning tool. Also in terms of data supply, the model is quite straightforward and not too demanding. But adaptation of the model to characteristics of a chosen region requires a skilled modeller and reliable background information to assess behavioural or response coefficients and the attribute coefficients (e.g. the landscape characteristics of arable farmland). One can therefore speak about a large gap between intuitive understanding and qualified application. For analysing impacts of various market or policy conditions, which is one of the main potential uses of the model, an experienced modeller is needed to deal with scenario building.

10.4 Intended user groups

Among the groups of intended users of information generated by the approaches described in Rossing *et al* (2007), policy makers and scientists were mentioned most frequently. The same can be argued in the case of POMMARD. It is designed to evaluate and – where possible – to measure the nature and degree of inter-relationships between private and public goods used or produced within rural economies, and their influence on quality of life of rural residents. It analyses the factors influencing or determining use of local resources, the performance of agriculture, other segments of local economy, a range of public goods, demographic trends and synthetic indicators of the quality of life. A special emphasis is placed on modelling the influence of a range of different EU, national and regional policies (especially EU CAP Pillar 1 Direct Payments, and CAP Pillar 2 measures promoting Rural Development). Beyond the stated aims of the TOP-MARD project discussed in Chapter 2, the use of POMMARD as a tool for a more qualified policy planning and decision-making has been pointed out.

There are however other fields of interest where use of POMMARD could prove beneficial and which yet have to be developed. One of the immediate potential uses of the model stems from its layout which is intuitive and relatively easy to understand. Although the rural economy is by all measures a ‘complex system’, its elements and relationships are presented in an almost self-explanatory manner. This virtue could be beneficially transferred to the teaching and/or training process, as it can be used to demonstrate modelling of complex systems. In this sense, two characteristics of the model seem particularly interesting: (i) each of the module components can be used as stand-alone models and therefore help students to understand how these components function; (ii) the POMMARD platform can be used for further modifications or enhancements. Due to its pedagogic potentials discussed in Chapter 3, POMMARD could be beneficially used also for training of policy practitioners and/or stakeholders involved in rural development policy. It is useful to present the complexity of relationships within the local economies and - even more so - to demonstrate the complexity of impacts that various policies can have on local economies.

Within the TOP-MARD research project, POMMARD was relatively easily and effectively adapted to eleven very different rural economies throughout Europe. It is therefore a tool which is relatively easily adaptable to different regional contexts, and which can accommodate a range of impact analyses in dynamic settings. Due to its complexity (region is treated not just an economic, but also as a social, environmental, and a land use system), it is more data demanding than the ‘mainstream’ economic modelling tools (eg. Input-output, SAM, partial or general equilibrium models). This opens another dimension of potential future uses of POMMARD as a policy evaluation tool. Providing the necessary amendments to the model (which are more thoroughly discussed later in this chapter), it could prove useful for analysing indirect, non-tangible impacts of policies, which cannot be grasped without such modelling. Its ability to accommodate various policy assumptions and to compare their outcomes could prove useful for (usually contestable) segments of policy evaluation, such as counterfactual analysis, or analysis of deadweight effects or displacement effects.

10.5 Modelling approach

Within integrated models of multifunctional agriculture, various optimisation methods (such as linear programming, positive quadratic programming, heuristics) have prevailed. Apart from numeric datasets, the newer policy models have often used spatial (GIS) databases.

POMMARD deviates from the ‘conventional’ modelling approaches in analysing multifunctional agriculture. It has adopted a ‘system dynamics‘approach, which is a new approach towards modelling of rural policies. This approach has been utilised in order to explore complex and dynamic relationships between various components of rural economies. Having said this, it has to be stressed that the primary focus (and the main virtue) of POMMARD is its ability to integrate various components of rural economies to a workable system model, whereas projections of sectoral, macroeconomic and/or spatial impacts have remained at a rather crude level. The modelling tools specialized on one or few components of the rural economy (eg. land use, agricultural price and revenue projections) provide more detailed results. Upgrading of POMMARD by enabling its compatibility with ‘conventional’ spatial[26], environmental and sectoral models is worth considering as one of the future improvements of the model.

POMMARD has also initiated some novel aspects of modelling. This applies especially to the ‘quality of life’ component of the model. Five capitals have been identified and analysed within the ‘Quality of life’ component: natural, material, human, social and cultural capital, and the model also makes explicit linkages between these capitals and migration behaviour. Coefficients for each of the capitals have been estimated but were only deemed reliable for natural and material capital, even though the model structure accommodates all five. Larger scale surveys are needed in future to improve the calibration and estimation of all the capitals and their relationships to migration, entrepreneurial decisions and attractiveness for tourism. Moreover, in developing the ‘capitals’ more attention should be paid to the tricky questions of ‘investment’ and ‘depreciation’ involved in each form of capital – not an easy issue in theoretical or practical terms. Integration of non-commodities in the model can be pointed out as another novelty aspect, even though this needs further background research to improve their functional relationships. Also the demographic stratification of impacts and the inclusion of a migration module are important novel aspects of POMMARD not previously applied with reference to multifunctional agriculture and rural development issues.

Finally POMMARD has the ability to model the dynamic impacts of policy changes after 2013, and also to represent very long run developments. Various policies affecting economic, social or environmental welfare of a chosen region are treated as a separate model component and can be adapted. Linkages between policies and their impacts on the region have been identified through an innovative approach of a ‘Policy-Function Matrix’ (described in greater detail in Chapter 8 of this report). This approach enables a relatively easy and straightforward adaptation of policy impact analysis for each particular region.

[26] A new version of the STELLA™ software, issued after our main modelling work was completed, allows more refined handling of the spatial dimension and distances.

10.6 System definition

The modelling approaches differ in terms of spatial scales. Decision on the spatial scale depends primarily from the purpose of the models developed. Most frequently, the integrated models of multifunctional agriculture tackled the dynamics of land use and/or cropping systems. This is why optimisation models usually start at the scale of one or a few hectares, denoted as field or landscape element forming a homogenous land use unit. Results at micro scale are then scaled up – from a single farm to the regional level (Rossing *et al*., 2007). POMMARD belongs to the second group of the models that take larger areas as starting points, in this case defined by the administrative or statistical NUTS 3 territorial units. While these approaches enable rapid analyses at the macro (in the case of POMMARD regional) level, the consequence of ignoring the household / farm / enterprise as a decision making unit, is that some questions such as farm level decisions cannot be analysed appropriately. This is the negative, but unfortunately inevitable trade-off of the models analysing multiple functions of agriculture at 'macro' level'. On the other hand, a territorial approach is essential when the focus of policy shifts to sustainable rural development, including social, economic and environmental issues, and where it is the sum of all micro-behaviours that matters (Daly, 2007).

In terms of time horizon, POMMARD does not deviate significantly from other approaches to modelling of multifunctional agriculture, which mainly accommodate both short- and long-term impacts. For the time being, the smallest temporal scale of POMMARD is chosen by the analyst, and in our case was monthly for the seasonality component of the tourism module, while impact analysis extended over a relatively long time-scale (20 years). But the system dynamics approach towards modelling makes POMMARD relatively easily adaptable to various (shorter or longer) time scales of analysis.

The number of components forming a modelling system in POMMARD is more complex and diverse than most of its counterparts. Likewise, compared to other modelling approaches, POMMARD builds on place-based assets (particularly land use and natural characteristics) as keys to rural region performance. But in contrast to most of the modelling approaches that treat land use changes endogenously, *ie* as the main model outputs, POMMARD treats these changes exogenously as a key driver of change in a region. Land use change acts in combination with variables describing human behaviour (migration, education, labour force participation), and with policy variables influencing place-based assets. The POMMARD outputs therefore go far beyond the usual model outputs dealing with land-use types and changes in land management practices; they deal also with demographic trends, labour market and economic performance indicators, and indicators revealing change in capitals depicting life quality.

10.7 Categories of multifunctionality indicators and method of quantification

One of the benefits of system models, including POMMARD, is that we can choose between many different kinds of indicator depending on the analytical objectives.

In terms of goals and their indicators, integrative modelling approaches have so far focused primarily on environmental and economic indicators, while social goals and indicators have been far less represented (Rossing *et al*., 2007). This reflects the prevailing notion of (environmental and spatial) multifunctionality in public discourse.

Among the environmental indicators, indicators of the abiotic environment were more abundant than biotic and landscape indicators. This is true also in the case of POMMARD, where the biotic environment enters into the model as the Shannon biodiversity converter. The Shannon index is a relatively crude and blunt measure of biodiversity. If regions are 'branded' (for purposes of marketing tourism or food, to take common examples) by a particular form of flora, fauna, or landscape then an indicator of this particular "local" feature would be useful in order to assess policy or other impacts.

As regards the economic indicators, POMMARD deviates from the standard neo-classical micro-economic approaches, based on eg. marginal and/or utility theory, including indicators such as costs, gross margins, rates of return etc. Explicitly, economic indicators enter the model within the 'Regional economy' module with a dynamic social accounting matrix (SAM). Implicitly, economic indicators are entering the model within most of the remaining modules of POMMARD (with the sole exception of the 'Land' module). Nevertheless, POMMARD is a regional model, and the outcome indicators include net farm income, regional per capita income and other indicators including regional population which are common in regional economic modelling.

A relatively strongly developed social component is again one of the qualities of POMMARD. By inserting human resources as one of the main components of the model and by including human, social and cultural capital to the quality of life module, POMMARD can be seen as a successful attempt to bring social goals of multifunctionality from the public discourse to the modelling context. There is potential for further development by incorporating more detail on particular social groups of interest (young farmers, successors, rural residents, youth, retirees, etc).

10.8 Future research – empirical and data gaps to be filled

Two issues are worth mentioning when discussing about empirical research on such an elusive concept as multifunctional agriculture. The first one concerns the difficulties in defining social goals and the values that the society attributes to various non-market functions of agriculture. Here, disciplines from social and natural sciences have a role to play by jointly investigating needs of society and elucidating potential provision by agriculture (Mattison and Norris, 2005). This is even more relevant in the current situation, where the importance of EU Rural Development Policy is growing and the policy is increasingly argued by externalities and public goods provided by multifunctional agriculture. In contrast to the frequently expressed declarative policy goals, empirical evidence putting physical or money values on multiple outputs of agriculture remains rather weak in some aspects, as for example in the case of social functions of agriculture.

More empirical work is therefore needed in the field of quantification of impacts of rural policies on public goods. So far, research focused mainly on 'Standard' (OECD-definition) elements of multifunctional agriculture, such as eg. spatial impacts, impacts on soil and water quality, balance of nutritive substances (for instance, relationships between specific land use changes and a range of 'non-commodities' both biophysical and social in nature).

More empirical work yet has to be done also on elements of multifunctional agriculture related with human capital or non-tangible impacts. One example arising from TOP-MARD is the complex measurement of quality of life, how changes in a range of non-commodities impact on those, and how such changes impact on other elements of thesystem, including the regional economy, migration and population.

Another set of issues that limits empirical research on multiple roles of agriculture derives from absent or inconsistent data. Solving this problem would require clear-cut and quantified policy objectives and a better developed monitoring and evaluation system concerning economic, environmental and social impacts of agricultural and rural policies. Knickel and Renting (2000) have suggested extending monitoring networks to include new indicators as well as new actors such as inhabitants and part-time users of rural areas.

The above described improvements in the definition of policy objectives and in data availability on multifunctional agriculture and rural development could help towards more elaborate and policy-relevant models. This is also the case for future elaboration and development of POMMARD. Notwithstanding its complexity, the structure of the model is quite intuitive and potentially relevant for policy evaluation and policy planning purposes. Improvements in terms of empirical upgrading, better data quality and availability would only improve its applicative potentials.

10.9 Potential uses of POMMARD – future challenges

As described earlier, POMMARD can accommodate a wide range of different market and policy scenarios. The analytical potentials for scenario analysis cannot be fully exploited within a three-year research project. Within the TOP-MARD research project, the main policies under empirical scrutiny were the EU Rural Development and (only to a certain extent) EU Cohesion policy. Four policy scenarios (addressing mainly different modalities on Rural Development public expenditure) and two market scenarios (increased tourist demand and increased energy prices) were tested in the first instance. POMMARD might prove beneficial for testing some additional scenarios, relevant for the policy and market discourse in the near future. For example, outcomes of the CAP Health Check or the likely outcomes of the debate on EU budget would be worth testing. Although additional two scenarios were added after the final conference with policymakers in Brussels, it was not possible to test these in all study areas before the project end-date.

As seen from the comparison of POMMARD with its modelling counterparts (see section 1 of this chapter), the modelling approach of POMMARD deviates from the previous modelling works on multifunctional agriculture. Despite this, POMMARD should not be regarded as a competition to other modelling approaches. The main comparative strength of POMMARD lies in its ability to accommodate complex interactions between actors and processes influencing rural economies. On the other hand, modelling tools specialized on one or few components of the rural economy (eg. land use, agricultural price and revenue projections) provide more accurate and detailed results. There is an obvious room for improvements of the current model by accommodating ‘conventional’ (sectoral, macroeconomic or spatial…) models into the POMMARD framework. This could be done relatively simply by using the outcomes of the specialized models (eg. agricultural prices, agricultural policy variables, macroeconomic indicators, changes in land use, demographic and/or labour market indicators, nutrient balances, models for linking agricultural practices with their impact on soil, water, biodiversity and the ecosystem in general, etc.) as data inputs for POMMARD. Results could be mutually beneficial.

One of the potential uses of POMMARD is its application as a rural development policy evaluation tool. Due to its dynamic character and ability to provide long-term projections, it could be particularly useful to explore its capabilities for ex-ante evaluation or medium-to-long-term projections of policy impacts. Obviously, this would require certain amendments to the current model. It would need adaptation to integrate with the Rural Development Policy CMEF (Common Monitoring and Evaluation Framework) system. The relevance of POMMARD as a policy planning/evaluation tool would increase also by Territorial up-scaling of POMMARD to the level of a programming region (NUTS 2). This would be beneficial also in terms of data-availability and resource-efficiency. However, as NUTS 2 regions are usually dominated by the influence of larger cities, the policy relevance of the model would on the other hand result in an inevitable trade-off in terms of a loss of information on impacts on rural regions of NUTS 3 or lower levels.

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11. CONCLUSIONS

By John Bryden

Rural areas everywhere are distinguished by the relative importance of a range of public and quasi-public (including club) goods[27] for people's livelihoods, work, and quality of life. They add to, complement, and act as externalities for, the production of a wide range of private goods and services. They are for rural regions the equivalent of agglomeration economies in city regions, and they are mostly distinguished by their association not with agglomeration, but with space. One of the characteristics of innovative and successful rural economies is that they are adept at transforming these into new activities and higher income earning opportunities. This transformation is sometimes done by farmers themselves, and sometimes by entrepreneurs, or even community organisations or NGOs who are not involved in farming. Policies can be more, or less, successful or effective in encouraging such transformation, depending in part upon the institutional structures and modes of governance at regional levels.

Agriculture, and those concerned with practising it, farm households, both 'produce' and utilise such NCOs, and we can treat production as a positive and utilisation as a negative NCO. The range of private goods and NCOs combine in the concept and practice of 'multifunctionality', and we identified both the functions and their multiple combinations at farm and regional level during TOP-MARD.

We also identified the ways in which commodities produced by agriculture as well as NCOs associated with both farming and the activities of farm households are utilised by non-farming businesses and non-agricultural enterprise on farms to create new forms of market goods and services. The most typical medium for transformation of commodities is the processing of food and raw materials. The most usual medium for the transformation of NCOs is tourism, but this is partly because it is the most recognised and discussed in academic and professional literature, and in policy measures directed at rural regions. The other economic activities utilising commodity and non-commodity inputs add to the regional economy and directly to regional material welfare or 'capital'.

NCOs also affect the quality of life of residents in a number of other ways – through their impact on the less tangible 'capitals' increasingly recognised as significant for rural development: natural, cultural, social and human. And, especially important for rural areas beyond the potentially shrinking commuter belt of larger towns and cities, NCOs affect the perceptions of potential migrants – younger people who are inclined to leave, those of child bearing age who may – but too often do not – return, new in-migrant groups, and older people who may return, in-migrate, or leave. More importantly for the future of rural regions, NCOs have been shown to influence decisions to migrate. Since the natural population in almost all rural regions in Europe beyond the commuting belt is at best static, the dynamics of population change are heavily dependent on migration decisions, and hence on NCOs as well as material conditions such as incomes and employment.

In TOP-MARD we consider the combination of material and less tangible capitals to comprise what we regard as 'quality of life', and this composite quality of life to be a major driver of rural sustainability. Whilst we were not able to measure to precise relationships between every 'capital' and decisions to migrate of different age, education and gender

[27] For present purposes we will lump all such goods together as NCOs or 'non-commodities', even if some of them may have a partial market reward. The point is that some or all of the value of such NCOs remains unaccounted for in the market price or its equivalent in fees etc.

groups, we were able to handle two important 'capitals' and to include the others within the model so that future empirical work can allow these to be calibrated and included.

As far as we have been able to discover, the integration of NCOs, quality of life, and demography (including migration) within a dynamic system model is unique to TOP-MARD and its core and adapted POMMARD models. True, there is more work to be done to develop the model, and to find – and make more precise - the relevant data and functional relationships. But to have built a complex model of this kind, and to have demonstrated its functionality and utility for policy analysis, is a crucial first step.

It may seem to those not engaged in this kind of endeavour a simple matter to develop a set of realistic and relevant policy scenarios, acceptable as such to policy-makers, and then to assess how these scenarios translate into on-the-ground policy measures, and action from farmers and other policy target groups in very different institutional, economic, social, geographical and environmental contexts. It is not! First of all, it is necessary to penetrate the often un-transparent realms of policy discourse – what the 'sub-rosa' groups, the lobbyists, the officials, the professionals, the ministers, believe should happen in future, and their discussion of the practical politics, economics, and finance involved. Secondly, it is necessary to reduce this rather large and diverse discourse to a manageable set of scenarios for the future. Then we need to convert these scenarios into policy measures in different contexts, and the measures into uptake and action by the social actors – farmers, agro-industry, SMEs, Leader groups and so on. And finally, we need to assess the first order consequences of that action – how will farmers change their production systems, commodity production, intensity, land use, employment etc. POMMARD does not do this. We use other models, such as CAPRI, and interviews with experts, to assess these first order effects. But once we have arrived at these, we use POMMARD to trace through the medium and long term dynamic impacts on the regional economy, quality of life, agriculture and environment.

Our analysis confirms that these impacts are not uniform or even in a consistent direction across our study areas. Whilst more conventional (comparative statics) analysis of agricultural policy changes involving reduced payment to farmers almost inevitably concludes that farm and regional incomes will decline, the POMMARD model results show how, and why, this is not necessarily so in an holistic and dynamic analysis of the territorial system as a whole. Thus, for example, a region that has a dynamic and relatively high productivity non-agricultural sector may benefit from a reduction in agricultural subsidies because it causes labour to shift from low productivity and low wage agriculture to significantly higher productivity and wage non-agricultural occupations. However, these occupations may not be located in the most 'rural' areas, and so there will be sub-regional implications which we do not usually consider. Moreover, different regions will have different labour market conditions. For these kinds of reasons, one of our major policy conclusions is that policy content and implementation must become ever more decentralised and devolved, leaving the overall goals and intent at central levels.

TOP-MARD has identified these and other relationships, issues and conundrums precisely because the systems modelling approach allows us to consider and explore them.

Further research is of course needed, and some of these needs have also been identified in Chapter 10. We always need better data, and better understanding of on-the-ground responses to policy and market changes. We need better knowledge of the economic, social and environmental impacts of different policy measures and 'axes' in different contexts. We need to integrate POMMARD with other models, engaged in optimisation, for example. We need to deepen our understanding of the constituents of quality of life for different groups of citizens (young, child-bearing, elderly, different gender and ethnic groups) and the relationship to migration behaviour. This is on-going work, important in and of itself, but also for the development of more complex, holistic and dynamic modelling of sustainable rural development, and for the improved understanding of the impacts of different policies and policy options.

Those involved will testify to the didactic value of POMMARD. Between the researchers and national user groups in 11 countries, well over 100 individuals were directly involved in the research effort. All concerned learned a great deal from the process of building a complex system dynamics model. This includes understanding the discipline-neutral language of system dynamics, deciding on the 'modules' or building blocks of the model, understanding how NCOs impacted on other sectors and the quality of life, how quality of life affects migration decisions, and how different policies affect actions of farmers, entrepreneurs and other 'on the ground'.

The work involved in TOP-MARD, in the background materials, in cooperation with other research projects like MEA-SCOPE or SEAMLESS, in building and adapting the model, undertaking analysis, working out policy and research conclusions, could not have been done without a large, multi-disciplinary, and expert team of researchers from all the participating countries and institutions, a highly skilled modeller (our consultant, Professor Tom Johnson) who guided us all through the complex and time-consuming process of building and adapting the POMMARD systems model, a well-known agricultural policy analyst who helped us with the policy scenarios (Professor Ken Thomson) and an interested and supportive group of (largely) non-academics in the national user groups and national and regional ministries, departments and agencies. Due credit must be given to all those involved, including the less obvious support staff dealing with the complex administrative and financial tasks involved in a Framework programme research project.

.

Appendix I to Chapter 6: The Policy Model for Multifunctional Agriculture and Rural Development (POMMARD): User's Manual 1.4.1

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Appendix I Table of Contents

Introduction

The paper is intended to both describe the technical aspects of the Policy Model for Multifunctional Agriculture and Rural Development (POMMARD) and to serve as a manual for entering data, running the model, and interpreting results.

There are 11 distinct but similar models (POMMARDs) one for each study-area. The model described herein is referred to as the core model. The core model is generic and includes the common elements of the 11 study area models, but corresponds to none of them. Most of the data in this model are hypothetical.

In this manual, we describe the elements, definitions, logic, structure, and the data entry process of the prototype model. The terms *structure* and *layout* used here are suggested and may be changed as the models evolve.

Model Structure

POMMARD is built with the Stella™ software. The overall structure of the model is shown in Chapter 6, Figure 6-1. The model contains 10 modules: Initial Conditions, Policy Controls, Indicators, Land, Non-Commodities, Agriculture, Quality of Life, Human Resources, Region, and Tourism.

Unlike many models of economic relationships, this model is **supply oriented**. This means that the model reflects an economy in which supply decisions (production technologies, input use, product mix) drive the economy more than demand decisions (consumption choices). Land use is the primary “engine” in this model. Land use determines agricultural production of commodities and non-commodities. It also determines the amount of labour employed in agriculture.

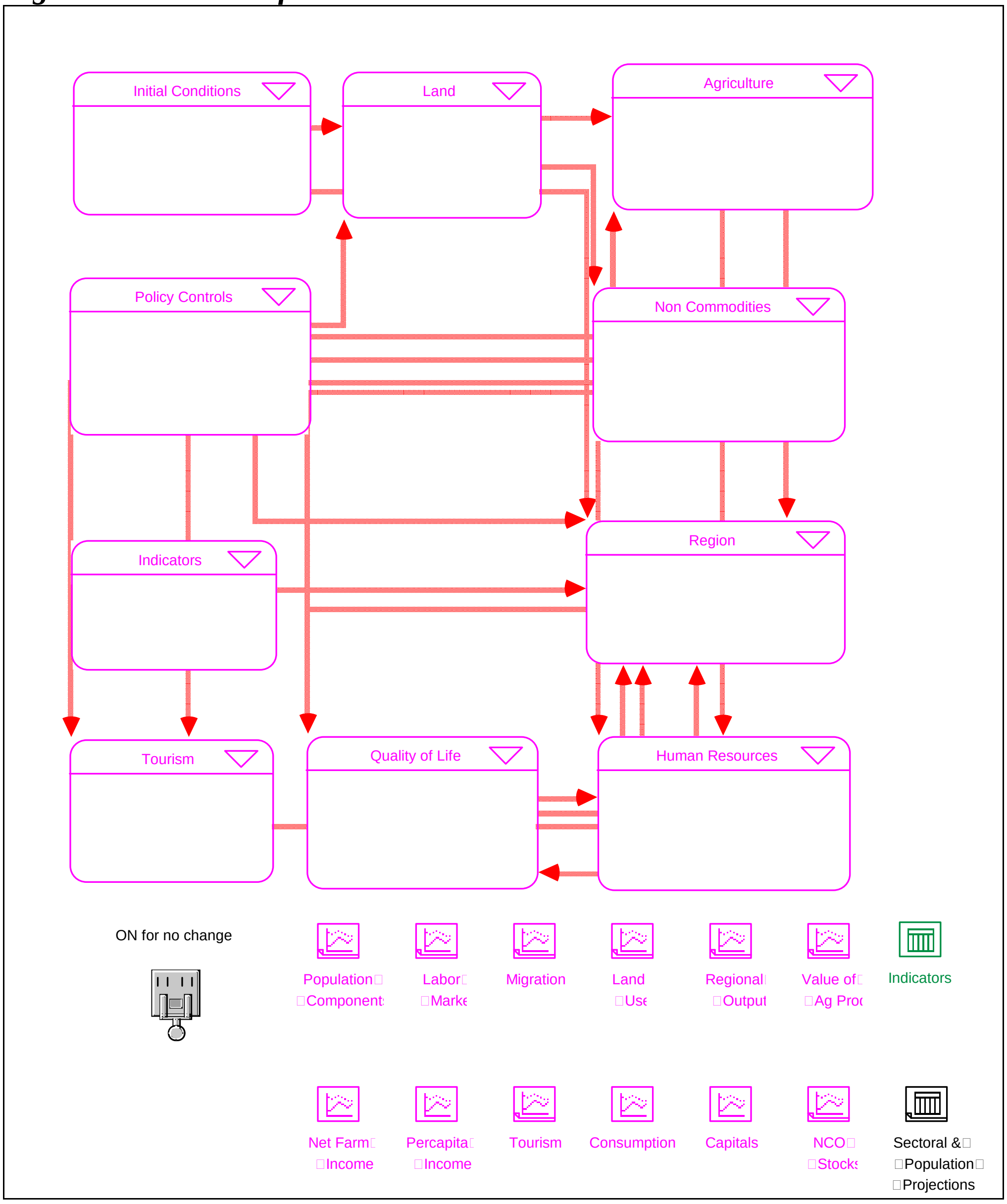
The regional economy is, in turn, driven by the supply-oriented agriculture module (and other special modules) as well as some demand drivers from the larger economy. The initial conditions and policy controls provide inputs to the model for scenario analysis. Finally, indicators allow the user to monitor changes in key variables.

Windows in the POMMARD Model

The POMMARD model contains several types of features that together lead to the dynamics in the model. The Stella software includes four windows or levels: interface, map, model and equation. All levels except the equation level contain optional devices for users to enter information and to see graphs and table results. In this section we describe the four windows.

Interface Window

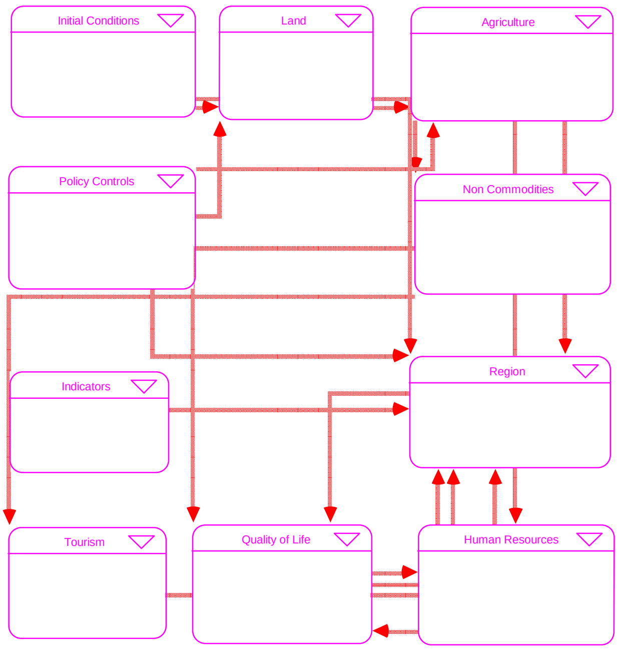
Figure A.2 The Interface Window



The Big Picture

The interface window shows the relationships among the modules. The bold arrows in this view indicate the direction of general information flows. No detail is displayed in this view.

Figure A.3 The Big Picture

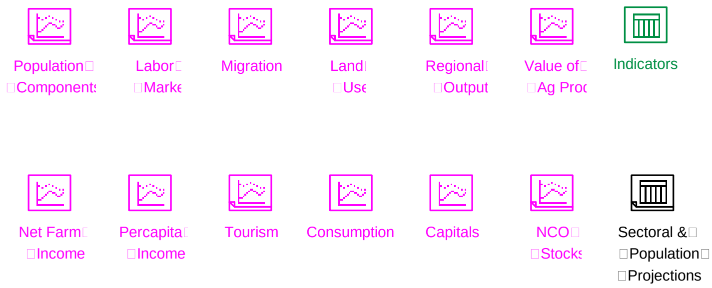


Graphs and Tables

Users may choose between several pre-built graphs to see the behaviour of the main variables or create graphs of their own. The pre-built graphs are accessed by clicking on the graph icons. There are 12 types of graphs and 2 tables available:

Figure 4 Graphs and Tables

1. Population Components
2. Labour Market
3. Migration
4. Land Use
5. Regional Output
6. Value of Ag Product
7. Net Farm Income
8. Precipitate Income
9. Tourism
10. Consumption
11. Capitals
12. NCO Stocks
13. Indicators (table)
14. Tabular Projections (table)



For each of these variables, one or more detailed graphs (or tables) are available. For instance, the Population Components presents six graphs: the total population, the education component youth, the education component working age, the education component older workers, the education component retirees, and the youth working QOL migrants.

The user may also build custom-designed graphs or customize the pre-built graphs. To learn how to build customized graphs, see "Graph Pad Surface Operations: Creating/ Moving/Resizing/Closing a Graph Pad" in the Stella manual. The same option is available for tables; see "Table Pad Surface Operations: Creating /Moving/ Resizing/ Closing a Table Pad."

Toggle Switch

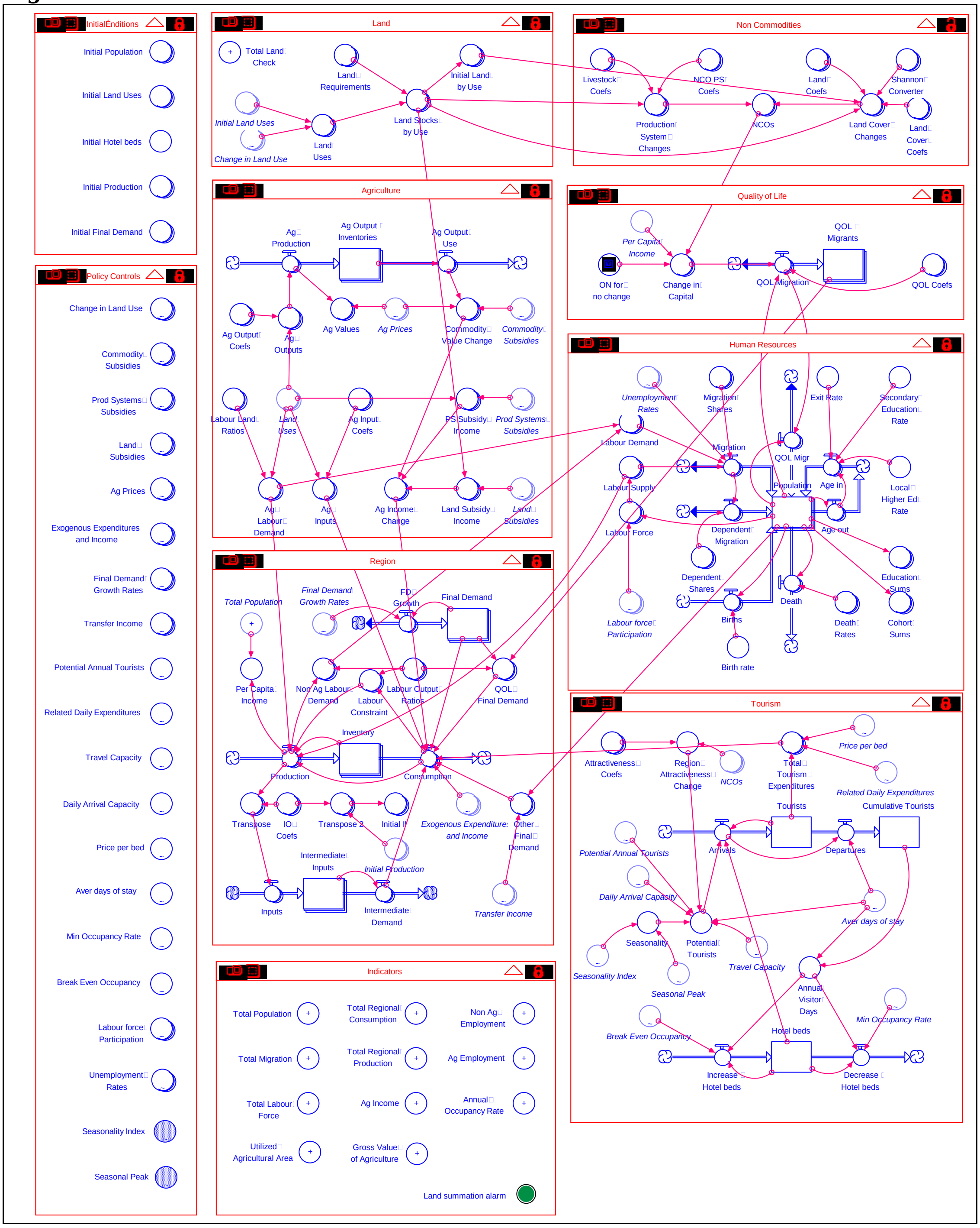
The interface window includes a toggle switch to make error testing and model calibration easier. The use of the ON for No Change toggle is explained in the section Quality of Life Module.

Map Window

The map window is nearly identical to the model window. The main difference is that the former does not remind the user when the model is incomplete. Its purpose is to allow model builders to think about the structure of the system as it is being built.

Model Window

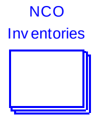
Figure A.5 The Model Window



The model window is where a majority of the work is done. It allows users to modify assumptions of the model, add or replace data, add output features, and so on. The model is built with building blocks that are described below.

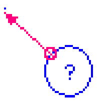
Model Building Blocks

Stocks



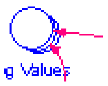
The role of stocks is to calculate and record the accumulated levels of flows. The levels of stocks are calculated by the model. Initial levels (at time = 0.0) could be required to start simulation near equilibrium or base year levels.

Converters



The role of converters is to transform data from one form to another (e.g., convert inputs into outputs or raw materials into assets). Converters can be used to calculate values, introduce data, combine data, convert units, and so on.

Converters that have only arrows pointing away from them and no arrows pointing toward them are exogenous data input sources. This type of converter almost always contains ratios or coefficients of some kind.

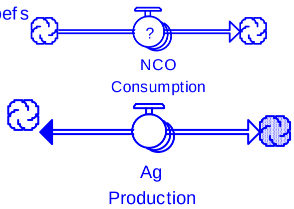


Converters that have one or more arrows pointing toward them either calculate, convert, or report data. As these are a programmed part of the simulation model, they do not require any data entry.

Converters with small lines at the bottom expect data inputs in a graphical format.

Converters with a plus sign are called “summers” and are used to obtain indicators. They do not require any data entry.

Flows



Flows describe the rate of increase or decrease in stocks. Users

are not required to enter data into them because they typically accept information from other model elements and use these to calculate rates of flow. Flows with one-direction arrows accept only positive values, whereas bi-flows accept any value.

Ghosts

Ghosts are replicas of flows, converters, or stocks that may be placed anywhere in the model, reducing the need for long connectors. Their role is to reduce the clutter in the model diagrams. Any changes incorporated in either the building block or the ghost affects both of them at the same time.

Equation Window

The equation window contains the differential equations and other relationships implied by the model structure. These equations may be edited directly, but it is best to change them indirectly by changing the model logic in the model window.

Categories (Elements) in the Core Model

This section describes the basic elements in each of the dimensions in the model:

Types of Land

There are ***l*** types of land. The core model includes five types:

	Types of Land	**Units**
1	Annual crop land	hectares
2	Permanent crop land	hectares
3	Grass land	hectares
4	Forest land	hectares
5	Other land (e.g. urbanized, water)	hectares

Non-commodities (NCOs)

11 non-commodities are identified in the core model:

	Variable	**Units**
1	Forest %	percentage point change
2	Arable Land %	percentage point change
3	Grass Land %	percentage point change
4	Permanent Crops %	percentage point change
5	Shannon Index	index, 0 to infinity
6	Mineral Fertilizer	kg/ha/year
7	Excess Nitrogen	kg/ha/year
8	Biodiversity	proportion, 0 to 1
9	Livestock Unit per Hectare	unit per ha
10	Land Cover Change	hectares
11	CO2 Balance	CO2/hectare

Production Systems

There are ***p*** types of production systems. In the core model, eight production systems are identified:

1. Mixed Livestock
2. Granivores
3. Beef Cattle
4. Sheep and Other
5. Other Ag Systems
6. Agro Forestry
7. Forestry
8. Other Systems

These are examples only. It is expected that individual study teams will change this list to reflect conditions in their case study areas. Production systems should include current production activities but also those that may be induced by policy changes (e.g., biomass production).

Levels of Education

There are ***e*** levels of education. The core model includes six:

1. In Primary (students)
2. Primary
3. In Secondary (students)
4. Secondary
5. In Tertiary (students)
6. Tertiary

Users should not change the number of categories, although they may change the age ranges of these groups. For example, if the typical age of primary, secondary, or tertiary students is different from those assumed here (14, 18, and 22 years, respectively), these may be changed. See the Age In and Age Out Flows section in the Human Resources Module for details.

Sectors

There are ***s*** sectors. The core model includes 23. The last sector should *always* be households. Households are treated as if they are a sector in order to "close the IO" coefficients matrix (the IO Coefficients Converter in the Region Module). The IO column for the household sector should be expenditure coefficients for the average household in the region. The IO row for the household sector is the payments to households (wages, salaries, profits, rents, dividends, and so on) by firms in each sector. The core model also contains recreation and tourism sectors to demonstrate how the tourism sector may be incorporated.

Commodities

There are ***c*** commodities in the models; eight are identified in the core model:
1. Cereals
2. Forage
3. Pigs
4. Milk
5. Beef
6. Sheep
7. Wood
8. Non-Conventional

Capital

There are ***k*** types of capital in the model; five are identified in the core model:
1. Natural Capital
2. Material Capital
3. Human Capital
4. Cultural Capital
5. Social Capital

Currently, only the *first two* capitals are used (see Chapter 3).

Cohorts

There are ***a*** types of cohorts in the model; four are identified in the core model:
1. Age 0-19
2. Age 20-39
3. Age 40-64
4. Age 65 plus

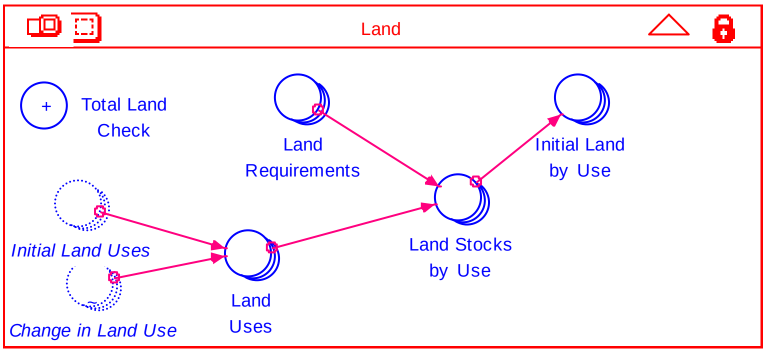
Users who want to add or change elements should refer to the section Adding/Changing Elements in the Categories.

The Logic of POMMARD

This section of the manual discusses the theory and assumptions underlying each of the model's modules. In the diagrams in this section, each module is isolated for simplicity, but the reader should note that there are additional inter-module linkages that are not shown in the diagrams. Furthermore, the mathematical descriptions of the logic are often simplified by suppressing the time variable. Time is depicted by t only when it is important to the expression. All variables in this model are a function of time.

The Land Module

Figure A.6: The Land Module



We start our discussion of POMMARD with the Land Module. We assume that agriculture is supply driven, subject to certain demand constraints and organized into alternative production systems. Land is the primary resource or capital affecting supply of agricultural commodities.

Allocation of land to production systems determines land use. Current land used in each production system is obtained as the sum of the Initial Land Use and the Change of Land Use from the Initial Conditions and Policy Controls Module, respectively. Land Uses, together with the Land Requirements, determine the land stocks used by each production system. Changes in land use and type affect the Agriculture, Human Resources, Non-Commodities, and Region Modules.

Land Requirements Converter (units: proportion)

This two-dimensional converter describes the amount of each land type (rows) required by one hectare unit of each production system (columns). Each value represents the proportion of total land required by each production system that comes from each land type. For instructions on entering this data, see the data entry section.

Land Uses Converter (unit: hectares)

This converter calculates the current land used in each production system. It is obtained as the sum of the Initial Land Use (from the Initial Conditions Module) and the Change in Land Use. Users are not required to provide any information.

$$LU_i = LU_i(0) + \Delta LU_i \qquad \text{for i=1}\ldots p$$

p is the total number of production systems

LU_i is the total land used for each production system

$LU_i(0)$ is the initial land used by each production system (this comes from the Initial Conditions Module)

ΔLU_i is the change in land use by each production system

Change in Land Use Converter (units: hectares)

This converter accepts changes in land use in all production systems over time. Together with the Initial Land Use (from the Initial Conditions Module) determine the Land Use variable that is used as input in many operations within the Agriculture Module. For instructions on entering this data, see the data entry section.

Land Stocks by Use Converter (units: hectares)

This two-dimensional converter (land types and production systems) distributes the total land use by type to production systems over time. Users do not enter data into the converter.

$$LSU_{i,j} = LR_{i,j} * LU_j \qquad \text{for} \qquad i=1\ldots l \qquad \& \qquad j=1\ldots p$$

l is the total number of types of land

p is the total number of production systems

$LSU_{i,j}$ is the land stocks by use by type of land and by production system

$LR_{i,j}$ is the land requirements by type of land and by production system

LU_j is the total land used for each production system

Initial Land by Use Converter (units: hectares)

This two-dimensional converter (land types and production systems) recaptures the initial levels of the Land Stocks by Use Converter. This information is used in the Non-Commodities Module. Users are not required to modify any values.

$$ILU_{i,j} = LSU_{i,j}(0)$$

l is total number of types of land

p is the total number of production systems

$ILU_{i,j}$ is the initial land by use, by type of land, and by production system

$LSU_{i,j}(0)$ is the initial land stock by use, by type of land, and by production system

Total Land Check Converter (units: hectares)

This converter is used as a check to ensure that total land does not decrease or increase. It is expected that the difference between the total Initial Land Use (from the Initial Conditions Module) and the Land Stocks by Use must be zero. If not, the land summation alarm indicators will turn red. Users are not required to modify any values.

$$TL = \sum_{i=1}^{p} LU_i(0) - \sum_{j=1}^{l}\sum_{i=1}^{p} LSU_{i,j} \qquad \text{for } i=1\ldots p \ \& \ j=1\ldots l$$

l is total number of types of land

p is the total production system

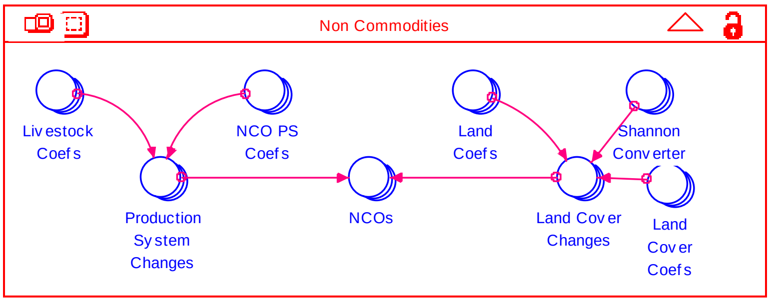
TL is total land change

$LSU_{i,j}$ is land stock by use, by type of land, and by production system

$LU_i(0)$ is the initial land used by production systems (this information comes from the Initial Conditions Module)

The Non-Commodities Module

Figure A.7 The Non-Commodities Module



This module is an important link to Quality of Life Module due to the migration it induces.
There are eleven types of non-commodity outputs included in this model. Some of these are related to land use and other to production systems. In order to keep the model as simple as possible but also to minimize the problems involved when adapting the model to particular study areas, we have only one dimension for non-commodity outputs (NCO) and divide the contributing sources of change into four types: land use related NCO change, land cover related change, Shannon index of diversity, and production system related NCO changes. As a consequence, there is significant redundancy in the converters. Converters contain zeros for all unrelated elements.

The eleven NCO categories (elements) are as follows:

12. Forest % (percentage point change): cumulative change in area devoted to forests
13. Arable Land % (percentage point change): cumulative change in area devoted to arable land
14. Grass Land % (percentage point change): cumulative change in area devoted to grass land
15. Permanent Crops % (percentage point change): cumulative change in area devoted to permanent crops
16. Shannon Index (index, 0 to infinity): entropy measure of land use diversity
17. Mineral Fertilizer (kilograms/year) : total mineral fertilizer applied per year
18. Excess Nitrogen (kilograms/year): total surplus of nitrogen applied over that used by plants applied per year
19. Biodiversity: total utilized agricultural land under low-input farming systems
20. Livestock Unit per Hectare: total number of livestock units per hectare
21. Land Cover Change (hectares): total negative change in cropland
22. CO_2 Balance: total net emissions of CO_2

The first four non-commodities are related to land changes.

The fifth NCO type is the Shannon Index. This index is calculated from the amounts of land of each type.

Next is the NCO production system array (non-commodities and production systems), which includes categories 6, 7, 8 and 11. This array is the total amount of each non-commodity, produced by on one hectare of each production system.

NCO 9 is the livestock unit per hectare which is calculated by dividing the total number of livestock units in each production system by the number of hectares in each production system.

NCO 10 is land cover change. Land cover change is equal to the negative of annual change in the stock of annual cropland. Because cropland is generally a less desirable land use than other farm uses, increases are recorded as negative changes.

NCOs Converter (units vary)

This converter aggregates the contributions of NCO Production Systems Changes and NCO Land Cover Changes in order to obtain the total production of non-commodities. Users are not required to make any changes here.

$$NCOs_i = \sum_{j=1}^{p} NCOPSCh_{i,j} + \sum_{h=1}^{l} NCOLCh_{i,h}$$

for i= 1…*nco*, j=1…*p* & h=1…*l*

l	is the total number of types of land
p	is the total number of production systems
nco	is the total number of non-commodities
$NCOPSCh_{i,j}$	is the NCO PS Changes by non-commodity and production systems
$NCOLCh_{i,h}$	is the NCO Land Cover Changes by non-commodity and land types

NCO Production Systems Changes Converter (units vary)

This two-dimensional converter (non-commodity and production systems) represents the part of the total production of non-commodities related to production systems:

1) NCO Types 6, 7, 8 and 11: NCO Produced by Production Systems (units vary)

The NCO Production System Changes converter calculates the amount of each non-commodity produced with one hectare of each production system.

$$NCOPSCh_{\min eral\_fertilizer,j} = NCOPSC_{\min eral\_fertilizer,j} * \sum_{h=1}^{l} LSU_{h,j}$$

$$NCOPSCh_{excess\_nitrogen,j} = NCOPSC_{excess\_nitrogen,j} * \sum_{h=1}^{l} LSU_{h,j}$$

$$NCOPSCh_{biodiversity,j} = NCOPSC_{biodiversity,j} * \sum_{h=1}^{l} LSU_{h,j}$$

$$NCOPSCh_{CO2\_balance,j} = NCOPSC_{C02\_balance,j} * \sum_{h=1}^{l} LSU_{h,j}$$

for j=1…*p* & h= 1…*l*

l	is the total number of types of land
p	is the total number of production systems

$NCOPSC_{h,j}$	is the coefficients for the production system related changes in NCOs (NCO PS Coefficients). It includes the change in each non-commodity by one hectare of each production system
$LSU_{h,j}$	is the land stock by use, by type of land, and by production system (this comes from the Land Module)

2) NCO Type 9: Livestock Units per Hectare (units: livestock units/hectare)

$$NCOPSCh_{livestock\_unit\_per\_ha,j} = LSC_{livestock\_unit\_per\_ha,j} * \frac{\sum_{h=1}^{l} LSU_{h,j}}{\sum_{j=1}^{p}\sum_{h=1}^{l} LSU_{h,j}}$$

for h= 1…*l* & j=1…*p*

l	is the total number of types of land
p	is the total number of production systems
$LSC_{livestock\_unit\_per\_ha,j}$	is the livestock coefficient by non-commodity and production system
$LSU_{h,j}$	is land stock by use, by type of land, and by production system (this comes from the Land Module)

Users are not required to enter any information into this converter.

NCO Production System Coefficients Converter (units vary)

This two-array converter (non-commodities and production systems) contains the quantities of non-commodities produced on one hectare of each production system. Users can enter values for their production systems. For instructions on entering this data, see the data entry section.

Livestock Coefficients Converter (units vary)

This two-dimensional array converter (non-commodities and production systems) contains the quantities of livestock units per hectare of each production system. Users enter values for their production systems. For instructions on entering this data, see the data entry section.

NCO Land Cover Changes Converter (units vary)

This two-dimensional converter (non-commodity and land types) represents the part of non-commodities related to land types.

1) NCO Types 1 through 4: Land Changes (units: percentage point change)

   These NCO Land Changes represent the change in types of land in percentage. Note that the percentages calculated are not percentage changes but *percentage point changes*. Thus, an increase from 10% to 15% is a 50% increase but only of 5 percentage points.

$$NCOLCh_{forest\_\%,h} = 100 * LC_{forest\_\%,h} * \frac{\sum_{j=1}^{p} LSU_{h,j} - \sum_{j=1}^{p} ILU_{h,j}}{\sum_{j=1}^{p}\sum_{h=1}^{l} LSU_{h,j}}$$

$$NCOLCh_{arable\_land\_\%,h} = 100 * LC_{arable\_land\_\%,h} * \frac{\sum_{j=1}^{p} LSU_{h,j} - \sum_{j=1}^{p} ILU_{h,j}}{\sum_{j=1}^{p}\sum_{h=1}^{l} LSU_{h,j}}$$

$$NCOLCh_{grass\_land\_\%,h} = 100 * LC_{grass\_land\_\%,h} * \frac{\sum_{=1}^{p} LSU_{h,j} - \sum_{h=1}^{p} ILU_{h,j}}{\sum_{j=1}^{p}\sum_{h=1}^{l} LSU_{h,j}}$$

$$NCOLCh_{permanent\_crops\_\%,h} = 100 * LC_{permanent\_crops\_\%,h} * \frac{\sum_{j=1}^{p} LSU_{h,j} - \sum_{j=1}^{p} ILU_{h,j}}{\sum_{h=1}^{p}\sum_{j=1}^{l} LSU_{h,j}}$$

for h= 1…*l* & j=1…*p*

l	is the total number of types of land
p	is the total number of production systems

$LC_{i,j}$	is the land coefficients by non-commodities and type of land
$LSU_{h,j}$	is the land stock by use, by type of land, and by production system (this comes from the Land Module)
$ILU_{h,j}$	is the initial land by use by type of land and by production system (this comes from the Land Module)

2) NCO Type 5th: Shannon Index (units: index)

This converter calculates the Shannon Index.

$$NCOLCh_{shannon\_converter,h} = SC_{shannon\_converter,h} * (\frac{\sum_{j=1}^{p} LSU_{h,j}}{\sum_{j=1}^{p}\sum_{h=1}^{l} LSU_{h,j}} * Log(\frac{\sum_{j=1}^{p} LSU_{h,j}}{\sum_{j=1}^{p}\sum_{h=1}^{l} LSU_{h,j}}))$$

for h= 1…*l* & j=1…*p*

l	is the total number of types of land
p	is the total number of production systems
$SC_{shannon\_converter,h}$	is the Shannon Converter Coefficient
$LSU_{h,j}$	is the land stock by use by type of land and by production system (this comes from the Land Module)

3) NCO Type 10: Land Cover Change (units: hectares)

This NCO Land Change records the change in cropland stock through the use of the Land Cover Coefficient Converter. Because cropland generally is a less desirable land use than other farm uses, increases are recorded as negative changes.

$$NCOLCh_{land\_cover\_change,h} = LCC_{land\_cover\_change,h} * (\sum_{j=1}^{p} LSU_{h,j} - \sum_{j=1}^{p} ILU_{h,j})$$

for i= 1…*l* & j=1…p

l	is the total number of types of land
p	is the total number of production systems
$LCC_{land\_cover\_change,i}$	is the land cover coefficient by non-commodities and land type
$LSU_{i,j}$	is the land stock by use by type of land and by production system (this comes from the Land Module)
$ILU_{i,j}$	is the initial amount of land of each land use and by production system (this comes from the Land Module)

Users are not required to enter any information to this converter.

Shannon Coefficient Converter (units: 0, 1)

This two-dimensional converter (non-commodities and land types) is used to calculate the NCO Land Change Type Shannon Converter. No data entry is necessary.

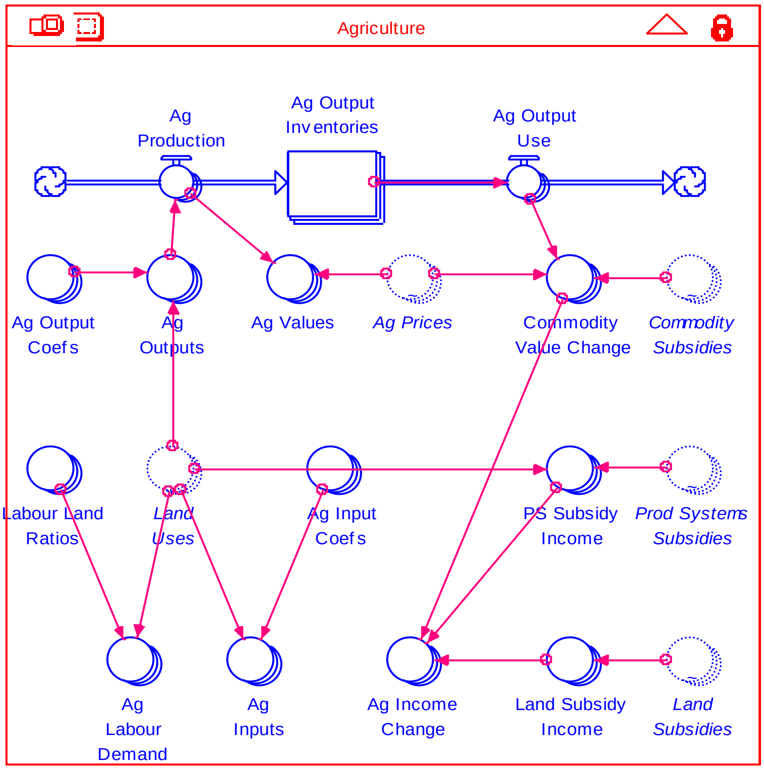
Land Coefficients Converter (units: 0, 1)

This two-dimensional converter (non-commodities and land types) is used in the calculation of the NCO Land Cover Change. This array simply maps land types (e.g., forest, annual cropland) onto NCOs (e.g., forest %, arable land %). Users do not need to modify this converter.

Land Cover Coefficients Converter (units: 0, 1)

This two-dimensional converter (non-commodities and land types) simply maps changes in annual cropland onto the Land Cover Change NCO. Users do not have to modify this converter.

The Agriculture Module
Figure A.8 The Agriculture Module



The Agriculture Module is our central concern in POMMARD. Agriculture is assumed to be supply-oriented and is organized into alternative production systems in order to produce commodities.

Agriculture purchases of inputs (including payments to households for labour and ownership inputs) depend on land use and agricultural input coefficients for each production system. These input purchases augment demand for production elsewhere in the regional economy. Land use, together with the labour-land ratios, determines the agriculture demand for labour.

Agricultural production, determined by the amount of land allocated to each production system and the agriculture output coefficients, add to the agriculture output inventories. The rate of outflow of these inventories is equal to the agriculture commodity use. The dynamic stock of agricultural commodities is then calculated by integrating the net of inflows and outflows over time.

Ag Output Inventories (units vary)

This is the stock of agricultural commodities calculated by integrating the net of inflows and outflows.

$$AOI_i(t) = AOI_i(0) + \int_0^t (AP_i(t) - AOU_i(t))dt \qquad \text{for i=1...}c$$

c is the total number of commodities

t is time

$AOI_i(t)$ is the inventory of agricultural commodities at time t

$AOI_i(0)$ is the initial level of agricultural commodities in inventory

$AP_i(t)$ is the rate of additions to inventory (inflow), that is, the rate of production of commodity

$AOU_i(t)$ is the rate of sales or consumption (outflow) of commodities

For this stock, it is not necessary to enter initial values because the model begins with values equal to 0.

Ag Production Inflow (units vary)

This inflow is the sum of the total output (commodity) produced in each production system. Users are not required to provide information to this flow.

$$AP_i = \sum_{j=1}^{p} AgO_{i,j} \qquad \text{for } i=1\ldots c \ \& \ j=1\ldots p$$

c is the total number of commodities

p is the total number of production systems

AP_i is the agricultural production of each commodity

$AgO_{i,j}$ is the agricultural output of each commodity produced by each production system

Ag Output Use Outflow (units vary)

This flow calculates the outflow from the Ag Output Inventories. It is assumed that all inventories are consumed so it is equal to the inventories. As those values are calculated, users do not need to change any of these values.

Ag Input Coefficients Converter (unit: thousands of euros/ hectare)

This converter is a two-dimensional array (agricultural inputs [i.e., sectors] and production systems). The coefficients represent the purchase of inputs per hectare in each production system. Values must be modified to reflect local production systems. For instructions on entering this data, see the data entry section.

Ag Inputs Converter (unit: thousands of euros)

This two-dimensional converter (sectors and production systems) calculates the agriculture sector's expenditure on each input (sector) by production system. *For the case of households* (sector 23 in the core model), this converter represents the payments to operators, owners, and labourers. Users are not required to provide any information.

$$AInp_{i,j} = AIC_{i,j} * LU_j \qquad \text{for i=1…}s \text{ \& j=1…}p$$

s	is the total number of sectors
p	is the total number of production systems
$AInp_{i,j}$	is the agricultural input purchased from each sector by production system
$AIC_{i,j}$	is the agricultural input coefficients for each production system and sector
LU_j	is the land use of each production system (this comes from the Land Module)

Labour Land Ratios Converter (unit: persons/hectare)

This two-dimensional array converter (education and production systems) represents the person-years of labour (measured in full-time equivalents or FTE[28]) required from each education level per hectare of each production system. Users must modify these ratios to reflect the labour usage patterns in their region. For instructions on entering this data, see the data entry section.

[28] Full-time-equivalents (FTE) here should be interpreted as the total number of years that the person works. For example, a person working one quarter of the year and two days of each five-day week would be counted as .25*.40=.1 FTEs.

Ag Labour Demand Converter (unit: persons)

This two-dimensional converter (education and production systems) represents the total number of workers (measured in FTE) required in each production system. Users are not required to provide any information.

$$ALD_{i,j} = LLR_{i,j} * LU_j \qquad \text{for i=1…}e \text{ \& j=1…}p$$

e is the total number of education levels
p is the total number of production systems
$ALD_{i,j}$ is each production system's labour demand by level of education
$LLR_{i,j}$ is the labour land ratio by education level and by each production system
LU_j is the land use of each production system (this comes from the Land Module)

Ag Output Coefficients Converter (units: units vary/hectare)

This converter is a two-dimensional array that contains the yield of each agricultural commodity (rows) from each production system (column). Yields can be represented by ton, livestock units, cubic meters, euros, or hectare of land, depending on the commodity. Data must be entered by the user to reflect the yield from production systems in his/her region. For instructions on entering this data, see the data entry section.

Ag Outputs Converter (units vary)

This converter is the total output produced (commodities) in each production system. This array is calculated by multiplying the Ag Output Coefficients by the Land Use. Users do not require completing any information.

$$AgO_{i,j} = AOC_{i,j} * LU_j \qquad \text{for i=1…}c \text{ \& j=1…}p$$

c is the total number of commodities
p is the total number of production systems
$AgO_{i,j}$ is the output of each agricultural commodity by each production system
$AOC_{i,j}$ is the coefficient array containing agricultural output of each commodity by each production system
LU_j is the land use of each production system (this comes from the Land Module)

Ag Prices Converter (units: euros)

This converter accepts the agricultural commodity prices farmers receive for their commodities. These are used together with Ag Production to determine Ag Values. For instructions on entering this data, see the data entry section.

Ag Values Converter (units: euros)

This one-dimensional array calculates the total value of agricultural commodities produced. Users do not need to change these values.

$$AV_i = AP_i * CP_i \qquad \text{for i=1…}c$$

c	is the total number of commodities
AV_i	is the value of each commodity
AP_i	is the total production of each commodity
CP_i	is the local price of each commodity

Commodity Subsidies Converter (units: euros)

This converter permits the introduction of subsidies paid to farmers for the production of specific agricultural commodities. For instructions on entering this data, see the data entry section.

Commodity Value Change Converter (units: euros)

This one-dimensional array calculates the change in value of agricultural commodities due to changes in farm level prices (relative to the initial prices) and subsidies. Users do not need to change these values.

$$CVC_i = (CP_i - CP(0)_i) * AOU_i + CS_i * AOU_i \qquad \text{for i=1}\ldots c$$

c	is the total number of commodities
CVC_i	is the value of each commodity
CP_i	is the price of each commodity
$CP_i(0)$	is the initial price of each commodity
CS_i	is the subsidies of each commodity
AOU_i	is the consumption of the agricultural commodity

Production System Subsidies Converter (units: euros)

This converter allows the payment of subsidies to farmers for particular production systems. These subsidies are constant values per hectare of a particular production system. For instructions on entering this data, see the data entry section.

Production System Subsidy Income Converter (units: euros)

This converter calculates the total income from the subsidies based on hectares in each production system. Users do not need to change these values.

$$PSSI_i = PSS_i * LU_i \quad \text{for i=1}\ldots p$$

p is the number of production systems
$PSSI_i$ is the production systems subsidies received
PSS_i is the subsidy received per hectare of production system
LU_i is the land use of each production system (this comes from the Land Module)

Land Subsidies Converter (units: euros)

This converter allows the introduction of subsidies paid to farmers for each hectare in each land type. These subsidies are constant values per hectare. For instructions on entering this data, see the data entry section.

Land Subsidy Income Converter (units: euros)

This converter calculates the total income received for subsidies based on land types. Users do not need to change these values.

$$LSI_i = LS_i * \sum_{j=1}^{p} LSU_{i,j} \qquad \text{for i=1}\ldots l \text{ \& j=1}\ldots p$$

p is the number of production systems
l is the number of land types
LSI_i is the total land subsidy received by land type
LS_i is the subsidy received per hectare of land type
$LSU_{i,j}$ is the land stock by use by land type and production system (this comes from the Land Module)

Ag Income Change Converter (units: euros)

This one-dimensional array calculates the change in agricultural income received by farm households due to price changes and land and production system subsidies. Users do not need to change these values.

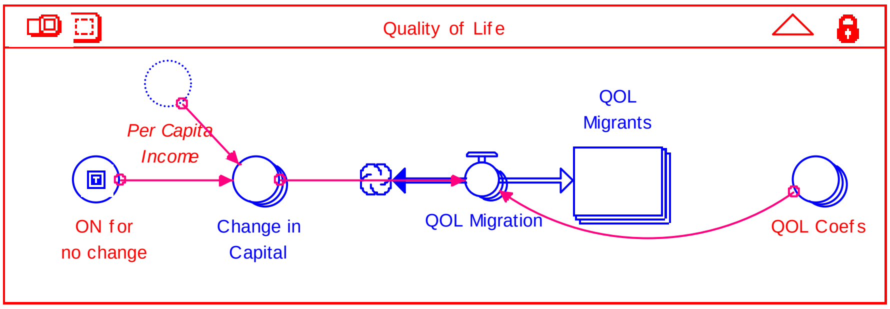
$$AICh_{households} = \sum_{i=1}^{c} CVC_i + \sum_{j=1}^{l} LSI_j + \sum_{h=1}^{p} PSSI_h \qquad \text{for i=1}\ldots c\text{ , j=1}\ldots l \text{ \& h=1}\ldots p$$

c is the number of commodities
l is the number of land types
p is the number of production systems
$AICh_{households}$ is the change in agricultural income earned by farm households due to all price changes and subsidies
CVC_i is the change in value of each commodity due to price changes

LSI_j	is the land subsidy income received
$PSSI_h$	is the production systems subsidy income received

The Quality of Life Module

Figure A.9 The Quality of Life Module



Changes in quality of life (QOL) create a supply-driven migration that is in addition to the demand-driven migration (i.e., migration to fill vacant jobs). We assume that each autonomous in-migrant creates demand for his or her job.

QOL Migrants Stock (units: persons)

This stock records the cumulative number of in- and out- migrants due to changes in quality of life. Initial conditions are assumed to be zero because only changes are of interest. Users do not need to change any of those values.

$$QOLMS_i(t) = QOLMS_i(0) + \int_0^t (QOLM_i(t))dt \qquad \text{for i=1..}a$$

a	is the total number of cohorts
t	is time
$QOLMS_i(t)$	is the QOL inventory of migrants for cohorts at time t
$QOLMS_i(0)$	is the initial level of QOL inventory of migrants by cohort
$QOLM_i(t)$	is the rate of QOL migration flow by cohort at time t

QOL Migration Flow (units: persons)

This bi-flow calculates migration (*in* or *out*) by cohort level based on changes in natural, material, human, social, and cultural capital.[29] The actual calculation incorporates a third-order exponential smoothing function with a delay of two years. The effect of this delay is to spread the response to changes over a two-year period. No data entry is needed.

$$QOLM_i = \sum_{j=1}^{n} (\Delta C_j * QOLC_{j,i} * \sum_{h=1}^{e} P_{i,h}) \qquad \text{for i=1..}a\text{, j=1…}n\text{ \& h=1…}e$$

a	is the total number of cohorts
n	is the total number of possible capitals
e	is the total number of education levels
$QOLM_i$	is the total QOL migration for each cohort
ΔC_j	is the change in capital
$QOLC_{j,i}$	is the QOL coefficients of each cohort and capital
$P_{i,h}$	is the population cohort by education level (this information comes from the Human Resources Module)

It is important to note that changes in quality of life induce three types of migrations (in or out) depending on the age of the migrant. The first category is youth (age 0 to 19) with secondary education but who do not have dependents. The second category includes those who are active in the labour market (age 20 to 64) but who migrate (in or out) without direct relationship to job opportunities. This group is accompanied by their dependents. The third group includes retirees (age 65 plus) who migrate without the incentive of employment.

People in the second group are assumed to join the labour force and to add to the regional production proportionately to their numbers, creating a QOL Final Demand (from the Region Module). This new final demand leads to more demand for workers (through the Non Ag Labour Demand from the Region Module), and thus more migration (they and their dependents). By contrast, the first and the third groups join or leave the labour force, which changes the demographics and income of the region but does not affect the labour market directly. All groups also add consumption in the economy because of the change in household income, which induces Other Final Demand (from the Region Module).

QOL Coefficients Converter (units: proportion)

These coefficients (or *elasticities*) represent the proportion of net migration (in migration – out migration) of each cohort due to changes in each type of capital. Only natural and material capitals are being used at this time. The QOL elasticities are based on regression analysis of data collected in the study areas. In general, these values should not be altered by users, but for instructions on modifying those values, see the data entry section.

ON for No Change Converter

This converter is used to disable the QOL changes in order to test the stability of the model and to determine the equilibrium levels of other variables. This converter is associated with a

[29] At this time only coefficients for natural and material capital have been estimated.

toggle switch on the interface level. When the toggle switch is green (ON), changes are disabled.

Change in Capital Converter (units vary)

This converter calculates the change in each capital. Different calculations are used for each of the five capitals. In the natural capital calculation, the rate of change in NCO forest % is divided by 1.1 based on empirical estimates of this variable's contribution to natural capital. Similarly, in the case of material capital, the change in per capita income is divided by its coefficient, 1.767. No additional data is required from the user.

$$\Delta C_{natural\_capital} = \frac{\dot{NCOs}_{forest\_\%}(t)}{1.1} * (1 - ONC)$$

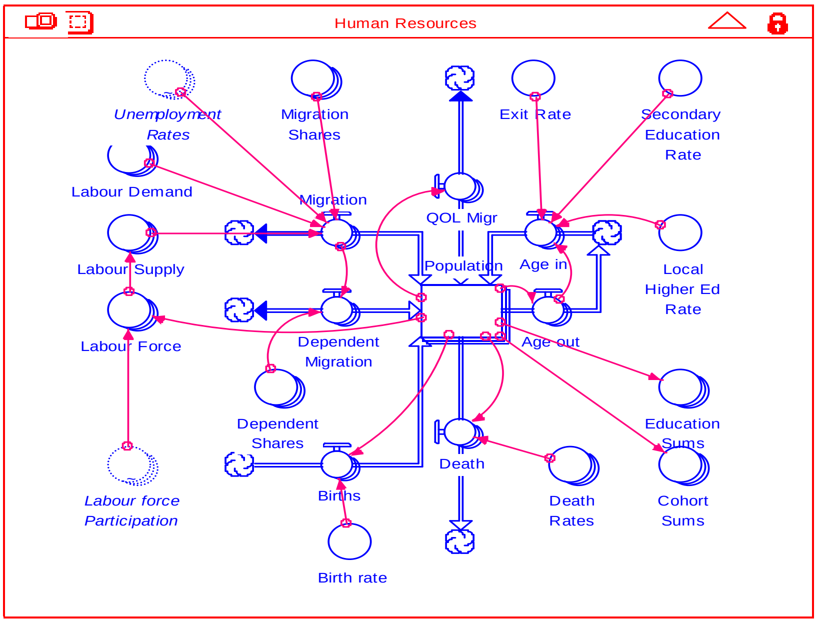
$$\Delta C_{material\_capital} = \frac{\dot{PCI}(t)}{1.767} * (1 - ONC)$$

t	is time
$\Delta C_{natural\_capital}$	is the change in natural capital
$\Delta C_{material\_capital}$	is the change in material capital
$\dot{NCOs}_{forest\_\%}(t)$	is the time derivative of the production of the non-commodity Forest_% (this information comes from the Non-Commodities Module)
$\dot{PCI}(t)$	is the time derivative of per capita income (this information comes from the Region Module)
ONC	is ON for no change

The Human Resources Module

Land use determines the agricultural labour needs. Demand and other internal and external changes determine the non-agricultural labour needs. This module calculates the total labour demand, in and out migration, and the typical demographic processes (births, deaths, and aging). This module also deals with the educational changes in the population. In addition, it uses information from the Region and Quality of Life Modules and generates values that are subsequently used in the Region Module.

Figure A.10 The Human Resources Module



Population Stock (units: persons)

This is the stock of people in each age-education category obtained after integrating inflows and outflows.

$$P_{i,j}(t) = P_{i,j}(0) + \int_0^t (B_{i,j}(t) + AI_{i,j}(t) + M_{i,j}(t) + DM_{i,j}(t) + QOLMg_{i,j}(t) - AO_{i,j}(t) - D_{i,j}(t))dt$$

for i=1…*a* & j=1…*e*

a	is the total number of cohorts
e	is the total number of education levels
t	is time
$P_{i,j}(t)$	is the population by cohort and education level at time *t*
$P_{i,j}(0)$	is the initial population by cohort and education level (this comes from the Initial Population Converter in the Initial Conditions Module)
$B_{i,j}(t)$	is the births at time *t* (all newborns are added to the 0-19 in-primary category)
$AI_{i,j}(t)$	is the rate of transition of the population into an older cohort by cohort and education level at time *t*
$M_{i,j}(t)$	is the migration rate of worker by cohorts and education level at time *t*
$DM_{i,j}(t)$	is the rate of dependent migration by cohorts and education level at time *t*
$AO_{i,j}(t)$	is the rate of transition of the population out of each cohort by cohort and education level at time *t*
$QOLMg_{i,j}(t)$	is the quality of life migration rate for elderly and youth who are not able to work at time *t*
$D_{i,j}(t)$	is the death rate by cohort and education level at time *t*

Initial values of population groups must be incorporated. This information will be incorporated in the Initial Population Converter in the Initial Conditions Module. For instructions for entering this data, see the data entry section.

QOL Migration Flow (units: persons)

This bi-flow represents people that migrate due to changes in quality of life but do not directly increase the labour demand. This group includes those aged 65 and over without dependents, and secondary youth (ages 0 to 19 without dependents) but who are not part of the working age population (see more detail in the QOL Migration Flow from the Quality of Life Module). No data entry is necessary.

$$QOLMg_{0-19,secondary} = QOLM_{0-19}$$

$$QOLMg_{65\_plus,j} = QOLM_{65\_plus} * \frac{P_{65\_plus,j}}{\sum_{h=1}^{e} P_{65\_plus,h}}$$

for j=primary, secondary, tertiary & h=1…*e*

e	is the number of educational categories
$QOLMg_{0-19,secondary}$	is the quality of life migration (positive or negative) for secondary youth who are not members of the labour force
$QOLMg_{65\_plus,j}$	is the quality of life migration (positive or negative) for elderly who are not members of the labour force
$QOLM_{0-19}$	is the quality of life migration flow for youth (this information comes from the Quality of Life Module)
$P_{65\_plus,j}$	is the elderly population by education level

Migration Flow (units: persons)

This bi-flow calculates the rate of in- or out-migration of workers. This flow is based on the labour requirements of the region relative to the labour supply. It should generate flows only for the 0 to 19, 20 to 39 and 40 to 64 age groups and only for the primary, secondary, and tertiary education groups. No data entry is necessary.

$$M_{i,j} = MS_{i,j} * (LD_j - LSp_j * (1 - UR_j)) \qquad \text{for i=1…}a \text{ \& j=1…}e$$

a	is the number of cohorts
e	is the number of education levels
$M_{i,j}$	is the migration flow (positive or negative) by cohort and education level
$MS_{i,j}$	is the migration share by cohorts and education level
LD_j	is the labour demand by education level
LSp_j	is the labour supply by education level
UR_j	is the unemployment rate by education level

Migration Shares Converter (units: proportion, 0 to 1)

This two-dimensional array converter (cohorts and education level) controls the total migration (in and out) of working age people in response to changes in regional labour demand and quality of life. Because this population will often migrate with their family members—both youth and elderly—who are assumed to work, it is important to determine these values together with the Dependents Converter. This array should have non-zero values only for the 0 to 19, 20 to 39, and 40 to 64 age groups and for the primary, secondary and tertiary education groups. Values must be entered by the user. For instructions for entering this data, see the data entry section.

Labour Demand Converter (units: persons)

This converter aggregates labour demanded in the agriculture and non-agriculture sectors. No data entry is necessary.

$$LD_i = \sum_{j=1}^{p} ALD_{i,j} + \sum_{h=1}^{s} NALD_{i,h} \qquad \text{for i=1}\ldots e\text{, j=1}\ldots p \text{ \& h=1}\ldots s$$

e	is the number of education levels
p	is the number of production systems
s	is the number of sectors
LD_i	is the total labour demand by education level from the agriculture and non-agriculture sectors
ALD_i	is the total labour demand by education level from the agriculture sector (this information comes from the Agriculture Module)
$NALD_i$	is the total labour demand by education level from the non-agriculture sector, which in this is case comes from the Region Module

Labour Supply Converter (units: persons)

This converter calculates labour supply by education level. No data entry is necessary.

$$LSp_{primary} = \sum_{j=1}^{a} LF_{j,in\_primary} + \sum_{j}^{a} LF_{j,primary} + \sum_{j}^{a} LF_{j,in\_secondary}$$

$$LSp_{secondary} = \sum_{j=1}^{a} LF_{j,secondary} + \sum_{j}^{a} LF_{j,in\_tertiary}$$

$$LSp_{tertiary} = \sum_{j=1}^{a} LF_{j,tertiary}$$

a	is the number of cohorts
LSp_i	is the labour supply by education level
$LF_{j,i}$	is the labour force participation by cohort and education level

Labour Force Converter (units: persons)

This converter calculates the labour force by cohort and education level based on the labour participation rate and the population. No data entry is necessary.

$$LF_{i,j} = LFP_{i,j} * P_{i,j} \qquad \text{for i=1}\ldots a \text{ \& j=1}\ldots e$$

a	is the number of cohorts
e	is the number of education levels
$LF_{j,i}$	is the labour force participation by cohort and education level

$LFP_{i,j}$ is the rate of labour force participation by cohort and education level

$P_{j,i}$ is the population by cohort and education level

Labour Force Participation Converter (units: proportion, 0 to 1)

This two-dimensional array converter (cohorts and education level) represents the proportion of the population in each cohort and education group that is active in the labour market. It is assumed that students are not part of the labour force. For instructions for entering this data, see the data entry section.

Unemployment Rate Converter (units: proportion, 0 to 1)

This represents the unemployment rate per education level. For instructions for entering this data, see the data entry section.

Dependent Migration Flow (units: persons)

This bi-flow calculates the rate of in or out migration of dependents of workers. This flow is based on the migration rates of workers and the dependent:worker ratios. This flow variable generates flows of dependents only for the 0 to 19 in-primary and in-secondary school groups and possibly over 65 age groups for the primary, secondary and tertiary education categories. It is assumed here that the pattern of dependents is similar for both the age 20 to 39 and age 40 to 64 groups. While this is not likely in practice, the error caused by this assumption will be small if the dependent:worker ratios are an average for workers aged 20 to 64. No data entry is necessary.

$$DM_{i,j} = De_{i,j} * (M_{20-39,j} + M_{40-64,j}) \quad \text{for i=1}\ldots a \text{ \& j=1}\ldots e$$

a	is the number of cohorts
e	is the number of education levels
$DM_{i,j}$	is the rate of migration of dependents (positive or negative) by cohorts and education level
$M_{20-39,j}$	is the migration rate of workers by age 20 to 39 and education level
$M_{40-64,j}$	is the migration rate of workers by age 40 to 64 and education level
$De_{i,j}$	is the ratio of dependents by cohorts to workers with education level

Dependents Shares Converter (units: proportion, 0 to 1)

This two-dimensional array converter (cohorts and education level) contains the ratios of dependents to labour force members, both by cohort and by education level. For each worker with primary, secondary, and tertiary education, this array gives the number of dependents aged 0 to 19 in primary and in secondary school, and possibly retirees with primary, secondary, or tertiary education. The only non-zero elements should be in the primary, secondary, and tertiary education 20- to 39- and 40- to 65-year-olds and the primary and secondary educated 0- to 19-year-olds. Values must be entered by the user. For instructions for entering this data, see the data entry section.

Births Inflow (units: persons)

This flow calculates the total amount of people born. It is assumed that infants are born only to adults aged 20 to 39. No data entry is necessary.

$$B_{0-19,in\_primary} = BR * \sum_{h=1}^{e} P_{20-39,h} \quad \text{for h=1}\ldots e$$

e	is the total number of education levels
$B_{0-19,in\_primary}$	is the births of the 0 to 19 cohort
$P_{20-39,h}$	is the population of age 20 to 39 by education level
BR	is the birth rate

Birth Rates Converter (units: proportion, 0 to 1)

This converter is a constant value that represents an estimate of the annual rate of birth among families ages 20 to 39. User should provide this value for their study area. For instructions for entering this value, see the data entry section.

Death Outflow (units: persons)

This flow represents the total number of people who die. It is calculated by multiplying the total population by cohorts and education level by the rate of death of the cohort population. No data entry is necessary.

$$D_{i,j} = P_{i,j} * DR_i \qquad \text{for i=1}\ldots a \text{ \& j=1}\ldots e$$

a	is the total number of cohorts
e	is the total number of education levels
$D_{i,j}$	is the population death by cohort and education level
$P_{i,j}$	is the total population by cohort and education level
DR_i	is the death rate by cohort

Death Rates Converter (units: proportion, 0 to 1)

These constant values represent the annual mortality rate of members of each cohort. Users should provide these values for their study area. For instructions for entering these data, see the data entry section.

Age Out Inflow (unit: persons)

This flow calculates the total number of people who because of age leave each age cohort to join the next older age cohort. No data entry is necessary.

Age Out		Education level (j)					
		In Primary	Primary	In Secondary	Secondary	In Tertiary	Tertiary
Cohorts (i)	Age 0-19	$\frac{P_{0-19,in\_primary}}{14}$	$\frac{P_{0-19,primary}}{6}$	$\frac{P_{0-19,in\_secondary}}{4}$	$\frac{P_{0-19,secondary}}{2}$	$\frac{P_{0-19,in\_tertiary}}{2}$	0
	Age20-39	0	$\frac{P_{20-39,in\_secondary}}{20}$	0	$\frac{P_{20-39,secondary}}{20}$	$\frac{P_{20-39,in\_tertiary}}{2}$	$\frac{P_{20-39,tertiary}}{18}$
	Age 40-64	0	$\frac{P_{40-64,in\_secondary}}{25}$	0	$\frac{P_{40-64,secondary}}{25}$	0	$\frac{P_{40-64,tertiary}}{25}$
	Age 65 plus	0	0	0	0	0	0

Note: If the standard age of graduation out of primary, secondary, and tertiary school is not 14, 18, and 22, respectively, then the first and second rows of formulae must be changed. Furthermore, if the mandatory retirement age is earlier or later than 65 then the third row of formulae must be changed.

Age In Inflow (units: persons)

This flow represents the aging of the population from cohort to cohort and through the levels of education. No data entry is necessary.

The in-primary education level includes all individuals from birth to the completion of primary school, which is assumed to happen at the age of 14 (this may be changed to match the educational system of particular regions). No one ages into the in-primary level. New members of this group are either born or migrate in.

At 14 years, individuals age-out of the in-primary group and either go into the primary educated category (1-Secondary Education Rate), or into the in-secondary category (Secondary Education Rate).

At 18 years, individuals age-out of in-secondary and go into one of three categories: they go into the local labour market (1-Local Higher Education Rate-Exit Rate), they go into the in-tertiary (Local Higher Education Rate), or they exit the region (Exit Rate).

At the age of 20, individuals age-out of the three groups included in the 0 to 19 cohort: those in the 0 to 19, primary-educated group age into 20 to 39, primary-educated group; those in the 0 to 19, secondary-educated group age into the 20 to 39 secondary-educated group; and those in the 0 to 19 in-tertiary group age into the 20 to 39 in-tertiary group.

At 22 years the in-tertiary group ages into the 20 to 39 tertiary group.

At the age of 40 individuals age into the 40 to 64, primary, secondary, and tertiary-educated groups.

At the age of 65, individuals age into the 65 plus, primary, secondary, and tertiary-educated groups.

Age In			Education level (j)					
			In Primary	Primary	In Secondary	Secondary	In Tertiary	Tertiary
Cohorts (i)			1	2	3	4	5	6
	1	Age 0-19	0	$AO_{0-19,in\_primary} \times (1-SER)$	$AO_{0-19,in\_primary} \times SER$	$AO_{0-19,in\_secondary} \times (1-LHE-ER)$	$AO_{0-19,in\_secondary} \times LHE$	0
	2	Age20-39	0	$AO_{0-19,primary}$	0	$AO_{0-19,secondary}$	$AO_{0-19,in\_tertiary}$	$AO_{20-39,in\_tertiary}$
	3	Age 40-64	0	$AO_{20-39,primary}$	0	$AO_{20-39,secondary}$	0	$AO_{20-39,tertiary}$
	4	Age 65 plus	0	$AO_{40-64,primary}$	0	$AO_{40-64,secondary}$	0	$AO_{40-64,tertiary}$

$AO_{i,j}$ Age out by cohort and education level
SER Secondary Education Rate
LHE Local Higher Education Rate
ER Exit Rate

Note:
1. Those who go into the labour force are represented by (1-SER) and (1-LHE-ER) for those who finish primary school and secondary school, respectively.
2. Those who continue studying are represented by SER and LHE for those who go to secondary school and tertiary school, respectively.

Secondary Education Rate Converter (units: proportion, 0 to 1)

This converter is a constant value that represents the rate of participation in secondary education. It applies only to those students completing primary school. For instructions for entering these values, see the data entry section.

Exit Rate and Local Higher Education Rate Converters (units: proportion, 0 to 1)

These are constant values. The first represents the proportion of secondary school graduates that leave the region after completing secondary school whereas the second is the proportion of secondary school graduates that continue onto higher education (tertiary education) at a local institution. The remainder of graduates are assumed to join the local labour force (1-local higher education rate-exit rate). Users should provide this value for their study area. For instructions for entering these data, see the data entry section for the exit rate or for the local higher education rate converters.

Cohorts Sums Converter (units: persons)

This converter sums the population across education levels to get total numbers in each age cohort. Users are not required to modify any values.

$$CS_i = \sum_{j=1}^{e} P_{i,j} \quad \text{for i=1}\ldots a \text{ \& j=1}\ldots e$$

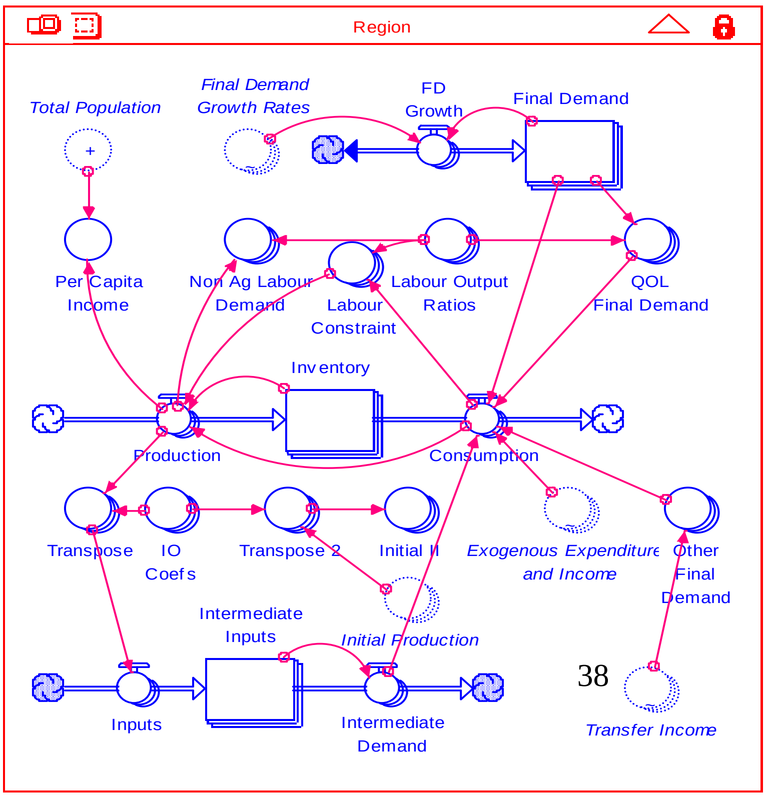
a is the total number of cohorts
e is the total number of education levels
CS_i is the sum of all education levels by cohort
$P_{i,j}$ is the population by cohort and education level

Education Sums Converter (units: persons)

This converter sums the population across age cohorts to get sums for each education level. Users are not required to modify any values.

$$ES_i = \sum_{j=1}^{a} P_{i,j} \quad \text{for i=1}\ldots e \text{ \& j=1}\ldots a$$

a is the total number of cohorts
e is the total number of education levels
ES_i is the sum of all cohorts by education level
$P_{i,j}$ is the population by cohort and education level



The Region Module

Figure A.11 The Region Module

The regional economy module is based on the dynamic macroeconomic model developed by Leontief and adapted by Johnson. These models are similar to the ecological or mass-balance system. In such systems, mass changes from one state to another as a function of the difference between its current level and its equilibrium level. In an economic system, production and consumption move toward equilibrium at a rate that depends on the difference between demand and supply, that is, as a function of the unplanned change in inventory. When production and consumption are equal, inventories are in equilibrium. When inventories are larger than ideal, then production will decline. When inventories are too small, production will increase.

We start with the equilibrium conditions:

$$ROUT_{i,1}^{E} = IO_{i,i} * ROUT_{i,1}^{E} + RFD_{i,1} + ADEM_{i,1} + INVEST_{i,1} + \dot{INVENT}_{i,1}^{E}$$

for i=1…*s*

where,

s	is the total number of sectors
E	is the superscript that indicates variables are at their equilibrium levels
$ROUT_{i,1}$	is the vector of production in each sector
$IO_{i,i}$	is the matrix of current account input-output coefficients
$RFD_{i,1}$	is the external final demand for regional output
$ADEM_{i,1}$	is the demand by the agriculture module for regional output
$INVEST_{i,1}$	is the local demand for commodities for investment purposes
$\dot{INVENT}_{i,1}$	is the planned change in inventory in each sector

The regional sectoral output ($ROUT_{i,1}$) is the sum of intermediate outputs (goods and services used as inputs by other sectors, $IO_{i,i} * ROUT_{i,1}$) and final demand ($RFD_{i,1} + ADEM_{i,1} + INVEST_{i,1} + \dot{INVENT}_{i,1}$). Final demand is disaggregated into external final demand or exports ($RFD_{i,1}$), agriculture demand ($ADEM_{i,1}$), investment demand ($INVEST_{i,1}$), and planned inventory change ($\dot{INVENT}_{i,1}$).

In general, the economy is not in equilibrium:

$$ROUT_{i,1} = IO_{i,i} * ROUT_{i,1} + RFD_{i,1} + ADEM_{i,1} + INVEST_{i,1} + \dot{INVENT}_{i,1}$$

for i=1…*s*

Because of unexpected changes in demand, there are unplanned changes in inventories of sector commodities, that is,

$$\dot{INVENT}_{i,1} = \dot{INVENT}^{E}{}_{i,1} + \dot{U}_{i,1} \qquad \text{for i=1…}s$$

where,

$\dot{U}_{i,1}$ is the unplanned rate of change in inventories.

The actual change in inventories is the difference between production and consumption:

$$\dot{INVENT}_{i,1} = ROUT_{i,1} - (IO_{i,i} * ROUT_{i,1} + RFD_{i,1} + ADEM_{i,1} + INVEST_{i,1})$$
for i=1…*s*

Like an ecological system, the change in production is a function of unplanned inventory change. The economy responds to the unplanned inventory change (the imbalance) by increasing or decreasing production in the opposite direction:

$$\dot{ROUT}_{i,1} = -v(\dot{U}_{i,1})$$
$$\dot{ROUT}_{i,1} = v(IO_{i,i} * ROUT_{i,1} + RFD_{i,1} + ADEM_{i,1} + INVEST_{i,1} + \dot{INVENT}^{E}_{i,1} - ROUT_{i,1})$$
for i=1…*s*

where,

v is the constant velocity of the production system.

$\dot{ROUT}_{i,1}$ is the vector of change in production of each sector

Because production is itself a rate, this is a second-order differential equation—inventories are stocks that are determined by the flow, inventory change, but the level of inventory change determines the change in the rate of output change. Thus, the rate of production is determined by changes in the rate of production, which requires a second-order differential system to solve the model. We do this by treating the production flow as a stock (annual production), which is related to a flow, the change in production.

In POMMARD, the primary driver of the regional economy, and the main linkage between agriculture, tourism, and the regional economy, is final demand for regionally produced goods and services. Consumption is also one of the more convenient places to introduce policy-related shocks to the model. Thus, total consumption is the sum of several categories of demand, including (1) intermediate demand by non-agriculture sectors; (2) intermediate demand by the agriculture sector; (3) final demand (including exogenous income to households but excluding the agriculture and tourism sectors)[30]; (4) tourism final demand; (5) exogenous final demand generated by quality of life induced migration; (6) other final demand derived from transfer of income to the regions residents; (7) agriculture income change due to commodity price changes and subsidies; and (8) changes in expenditure and income due to policy changes.

As explained above, rates of consumption and production are dynamically linked through changes in inventories. An increase in consumption draws down inventories but induces a production response equal to the new consumption plus the decline in inventories.[31]

[30] The final demand for the outputs of the household sector should be interpreted as the *income from* outside employment, investments, and government payments. This flow is distinguishable from the transfer payments and agricultural income because it is not related to the levels of migration.

[31] In the POMMARD model we assume that desired inventories are equal to 1.0 time consumption, which means that an increase in consumption induces a 2.0 time consumption production response until inventories recover and then attain the new desired level. Thus the dynamic response is 2.0 time consumption minus inventories. Typically dynamic IO models impose a capacity constraint on production by making production equal to the minimum of consumption requirements (including replenishment of inventories) and the capacity of each sector. In POMMARD this feature is ignored because of lack of information on sectoral capacity, capital purchase coefficients and fixed investment coefficients.

Exports are the region's external final demands. Capital demand is determined by applying the capital coefficients (demands per unit of sectoral capacity) to the desired investment levels (described below). Intermediate demand is the input-output coefficients multiplied by the level of sectoral output. Inventory change is proportionate to the difference between desired and actual inventories. Finally, agriculture demands for commodities are equal to the agriculture output times the sector's input coefficients.

Inventory Stock (units: thousands of euros)

This is the inventory stock that records the cumulative level of inventories for each sector as production increases it and consumption decreases it. Initial levels are estimated from the Initial Production Converter in the Initial Conditions Module. No data entry is required for this stock.

$$I_i(t) = I_i(0) + \int_0^t (SP_i(t) - C_i(t))dt \qquad \text{for i=1…}s$$

s	is the total number of sectors
t	is time
$I_i(t)$	is the inventory stock by sector at time t
$I_i(0)$	is the initial inventory stock level of sector (this is equal to the Initial Production Converter that comes from the Initial Conditions Module)
$SP_i(t)$	is the rate of production in each sector at time t
$C_i(t)$	is the rate of consumption in each sector at time t

Production Inflow (units: thousands of euros)

This flow is the value of the production by each sector. It is assumed ideal inventories are approximately equal to annual consumption. Because production levels equal current consumption plus needed inventory replenishment (consumption minus inventories), production is twice consumption minus inventories. This value is constrained when the labour supply is lower than the labour demand. Users do not have to modify this flow.

$$SP_i = Min(2*C_i - I_i, (2*C_i - I_i)*\frac{\sum_{j=1}^{e} LSp_j}{\sum_{i=1}^{s} LCo_i + \sum_{h=1}^{p}\sum_{j=1}^{e} ALD_{h,j}})$$

for i=1…s, j=1…e & h=1…p

s	is the number of sectors
e	is the number of education levels
p	is the number of production systems
SP_i	is the production in thousands of euros by sector
C_i	is the consumption in thousands of euros by sector
I_i	is the inventory in thousands of euros of inventory
LSp_i	is the labour supply by education level (this information comes from the Human Resources Module)
LCo_i	is the labour constraint by sectors

ALD_i is the total labour demand by education level from the agriculture sector (this information comes from the Agriculture Module)

Consumption Outflow (units: thousands of euros)

This flow represents the total consumption in the economy by each sector. Consumption is also one of the more convenient places to introduce policy-related shocks to the model. Thus, total consumption is the sum of several categories of demand including (1) intermediate demand by non-agriculture sectors; (2) intermediate demand by the agriculture sector; (3) final demand (including exogenous income to households but excluding the agriculture and tourism sectors)[32]; (4) tourism final demand; (5) exogenous final demands generated by quality of life induced migration; (6) other final demand derived from transfer of income to the regions residents; (7) agriculture income change due to commodity price changes and subsidies; and (8) changes in expenditure and income due to policy changes. Users do not have to modify this converter.

$$C_i = ID_i + \sum_{j=1}^{p} AInp_{i,j} + FD_i + \frac{TTE_i}{1000} + QOLFD_i + OFD_i + \frac{AICh_i}{1000} + EEI_i$$

for i=1…*s* & j=1…*p*

s	is the number of sectors
p	is the number of production systems
C_i	is the consumption of the production of each sector
ID_i	is the intermediate demand from each sector
$AInp_{i,j}$	is the agricultural inputs purchased from each sector (this information comes from the Agriculture Module)
FD_i	is the final demand of each sector
TTE_i	is the total tourism expenditures from each sector (this information comes from the Tourism Module)
$QOLFD_i$	is the quality of life final demand from each sector (this information comes from the Quality of Life Module)
OFD_i	is the other final demand from each sector
$AICh_i$	is the change in agricultural income earned by farm households due to all price changes (this information comes from the Agriculture Module)
EEI_i	is the total exogenous expenditures and income from each sector

Labour Constraint Converter (units: persons)

This converter calculates the total non agriculture labour that is required in order to fulfil current consumption. It is used to obtain the labour adjustment ratio in the production inflow. Users do not have to modify this converter.

[32] The final demand for the outputs of the household sector should be interpreted as the *income from* outside employment, investments, and government payments. This flow is distinguishable from the transfer payments and agricultural income because it is not related to the levels of migration.

$$LCo_i = \sum_{i=1}^{e} LOR_{i,j} * C_i$$

for i=1…*e* & j=1…*s*

s	is the number of sectors
e	is the total number of education levels
LCo_i	is the labour constraint by sectors
C_i	is the consumption of the production of each sector
$LOR_{i,j}$	is the labour output ratio by sector and education level

IO Coefficients Converter (units: proportion, 0 to 1)

This two-dimensional converter (sector by sector) represents the portion of total expenditures (in euros) by each column sector on inputs supplied (in euros) by the row sector. Note that *the column sum of these coefficients will always be less than 1.0* because of leakages in the economy. For instructions for entering this data, see the data entry section.

Transpose Converter (units: thousands of euros)

This two-dimensional array converter (sector by sector) is used for calculation purposes only. Due to the way that Stella calculates products of arrays and vectors, we must first create a square matrix of production that transposes the data before multiplying by the IO coefficients. This converter calculates the inputs (in thousands of euros) required by each sector. It is calculated by finding the product of the transposed production levels matrix and the input-output coefficients. Users do not have to modify this converter.

$$Tr_{i,j} = IOC_{i,j} * SP^{T}_{i,j}$$ for i & j=1…*s*

s	is the total number of sectors
$Tr_{i,j}$	is the inputs required by each sector
$IOC_{i,j}$	is the input-output coefficients
$SP^{T}_{i,j}$	is the square and transposed matrix of production levels

Intermediate Inputs Stocks (units: thousands of euros)

This is the stock of intermediate inputs required from each sector, net of inflows and outflows. The purpose of the stock is to allow a dynamic response in the economy. The initial levels of stocks are calculated at near equilibrium levels. Users do not have to modify this converter.

$$IIS_i(t) = IIS_i(0) + \int_0^t (INP_i(t) - ID_i(t))dt$$ for i=1…*s*

s	is the total number of sectors
t	is time
$IIS_i(t)$	is the intermediate input stock by sector and at time t
$IIS_i(0)$	is the initial level of intermediate input stocks by sector, which value is obtained from the Initial II Converter

$INP_i(t)$ is the rate of inputs (inflow) used by sector at time t

$ID_i(t)$ is the rate of intermediate demand (outflow) by sector at time t

Inputs Inflow (units: thousands of euros)

This flow represents the total use of inputs by each regional sector (in thousands of euros). Users do not have to modify this converter.

$$INP_i = \sum_{j=1}^{s}(Tr_{i,j}) \qquad \text{for i \& j=1...}s$$

s is the total number of sectors

INP_i is the inputs used by sector

$Tr_{i,j}$ is the inputs required by each sector

Intermediate Demand Outflow (units: thousands of euros)

This flow is the demand for intermediate inputs. It is assumed that the inventories of intermediate inputs are completely consumed. Users do not have to modify this converter.

Transpose 2 Converter (units: thousands of euros)

This two-dimensional array converter (sector and sector) is used for calculation purposes only. Due to the way that Stella calculates products of arrays and vectors, we must first create a square matrix of initial production levels that transposes the data before multiplying by the IO coefficients. This converter calculates the initial intermediate inputs (in thousands of euros) required by each sector. It is calculated by finding the product of the transposed initial production levels matrix (from the Initial Conditions Module) and the input-output coefficients. Users do not have to modify this converter.

$$Tr2_{i,j} = IOC_{i,j} * SP^{T}_{i,j}(0) \qquad \text{for i \& j=1...}s$$

s is the total number of sectors

$Tr2_{i,j}$ is the inputs required by each sector

$IOC_{i,j}$ is the input-output coefficients

$SP^{T}_{i,j}(0)$ is the square and transposed matrix of initial production levels (this information comes from the Initial Production Converter in the Initial Conditions Module)

Initial II Converter (units: thousands of euros)

This one-dimensional converter (sectors) sums the estimated initial intermediate inputs by summing the rows of Transpose 2. Initial intermediate inputs are used by the intermediate input stock to start simulations at near-equilibrium levels of stocks. Users do not have to modify this converter.

$$I2S_i(0) = \sum_{j=1}^{s}(Tr2_{i,j}) \qquad \text{for i \& j=1...}s$$

s	is the total number of sectors
$I2S_i(0)$	is the initial inputs used by sector
$Tr2_{i,j}$	is the inputs required by each sector

Labour Output Ratios Converter (units: persons /thousands of euros)

This two-dimensional array converter (level of education and sector) represents the number of workers by education level demanded per one thousand of euros of output in each sector. For instructions for entering this data, see the data entry section.

Non-Ag Labour Demand Converter (units: persons)

This two-dimensional array converter (level of education and sector) represents the labour required for production in each sector. Users do not have to modify this converter.

$$NALD_{i,j} = LOR_{i,j} * SP_j \qquad \text{for i=1}\ldots e \text{ \& j=1}\ldots s$$

s	is the number of sectors
e	is the number of education levels
$NALD_{i,j}$	is the labour with education level demanded by sector
$LOR_{i,j}$	is the labour output ratio by sector and education level
SP_j	is the production by sector

Per Capita Income Converter (units: thousands of euros / persons)

This converter represents the Per Capita Income. Users do not have to modify this converter.

$$PCI = \frac{SP_{households}}{TP}$$

PCI	is the per capita income
$SP_{households}$	is the production by the households sector
TP	is the total population (this information comes from the Indicators Module)

Final Demand Stock (units: thousands of euros)

This converter represents the final demand for the products of each sector including households (in thousands of euros). Final demand includes regional exports, investment, government expenditures, and external earnings of households excluding transfers. Users do not have to modify this converter.

$$FD_i(t) = FD_i(0) + \int_0^t FDG_i(t)dt \qquad \text{for i=1}\ldots s$$

t	is time
s	is the number of sectors

FD_i is the final demand stock by sector at time *t*

$FD_i(0)$ is the initial final demand stock by sector (this comes from the Initial Conditions Module)

FDG_i is the rate of final demand growth by sector

EEI is the exogenous expenditures and income by sector

It is important to distinguish among the alternative ways of introducing household income. Household income introduced through the final demand converter is earned from external employment, investment income, and other sources that vary with time, sectoral activity, and so on. Alternatively, income that varies with the level of the population, such as retirement benefits and transfer income, can be introduced on a per capita basis using the Transfer Income Converter in the Policy Controls Module.

Final Demand Growth Inflow (units: thousands of euros)

This inflow is the growth in final demand for each sector. Users do not have to modify this converter.

$$FDG_i = FDGR_i * FD_i \qquad \text{for i=1…s}$$

s is the number of sectors

FDG_i is the final demand growth by sector

$FDGR_i$ is the final demand growth rate

FD_i is the final demand stock by sector

Final Demand Growth Rates Converter (units: proportion, 0 to 1)

This converter introduces a constant rate of growth that affects the Initial Final Demand from the Region Module. This information is used in the Final Demand Growth Inflow. For instructions for entering this data, see the data entry section.

Exogenous Expenditures and Income Converter (units: thousands of euros)

This converter represents the extra income and expenditures by farms and farm families. This converter adds income and expenditures to the Consumption Outflow in the Region Module. For instructions for entering this data, see the data entry section.

QOL Final Demand Converter (units: thousands of euros)

This converter calculates the total final demand for the products in each sector required to employ the quality of life induced migrants (endogenous migration) who are able to work (20-64 age groups) and who are accompanied by dependents. In this converter it is assumed that QOL migrants are like the current residents in terms of employment and skill levels and that this change in final demand is proportional to other final demand (such as exports). In this manner, this converter allows the supply-based change in population (due to changes in regional amenities) to be added to the demand-based change (through the Consumption Converter in the Region Module). Users do not have to modify this converter.

$$QOLFD_i = \frac{(QOLMS_{20-39} + QOLMS_{40-64})}{\sum_{j=1}^{e} LOR_{j,i}} \times \frac{FD_i}{\sum_{i=1}^{s} FD_i}$$ for i=1…*s* & j=1…*e*

s	is the number of sectors
e	is the number of education levels
a	is the number of cohorts
$QOLFD_i$	is the final demand required by sector to employ QOL migrants for cohorts
$QOLMS_j$	is the QOL inventory of migrants by cohorts (this information comes from the Quality of Life Module)
$LOR_{j,i}$	is the labour:output ratio for education level and by sector
FD_i	is the final demand by sector

Other Final Demand Converter (units: thousands of euros)

This converter calculates the final demand generated by the changes in population unrelated to employment such as transfer income per capita obtained from sources outside the economy. Users do not have to modify this converter.

$$OFD_{households} = \sum_{i=1}^{a} (TI_i * \sum_{i=1}^{e} P_{i,j})$$ for i=1…*a* & j=1…*e*

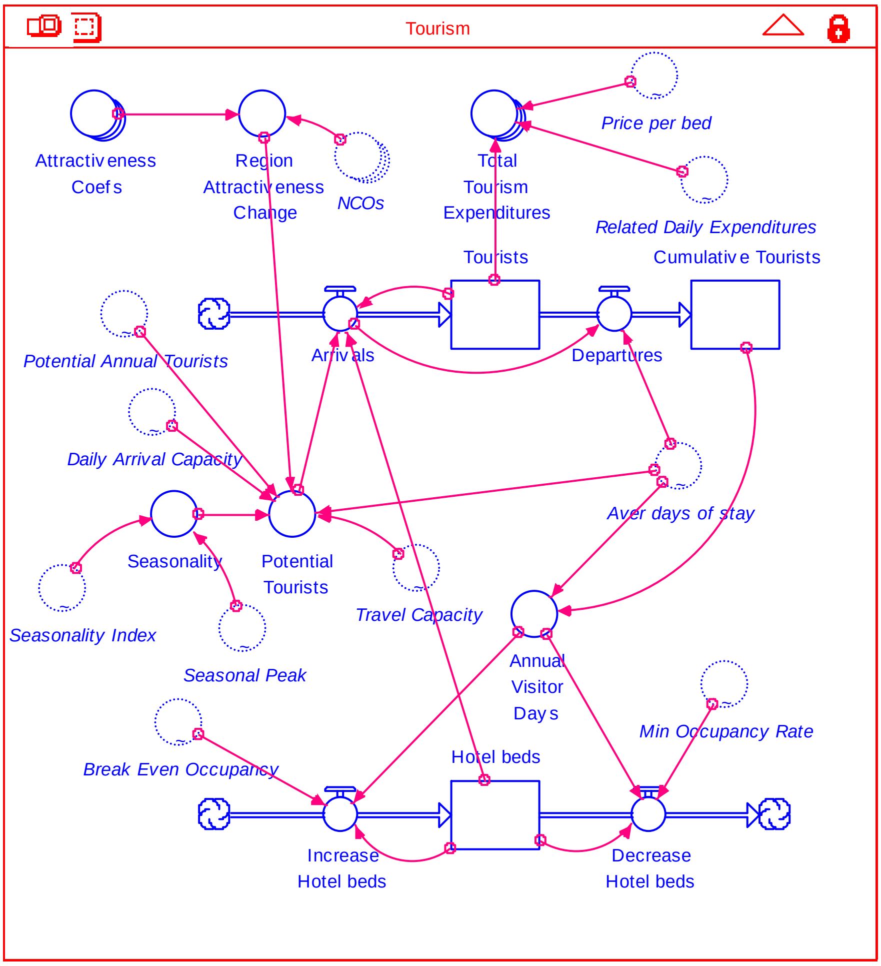
e	is the number of education levels
a	is the number cohorts
$OFD_{households}$	is the other final demand by households
TI_i	is the transfer income per capita by cohort
$P_{i,j}$	is the total population by cohort and level of education (this information comes from the Human Resources Module)

Transfer Income Converter (units: thousands of euros)

This converter represents a constant extra per person income received by residents in each cohort group that is not earned from local sources. This information is used to determine Other Final Demand. For instructions for entering this data, see the data entry section.

The Tourism Module

Figure A.12 The Tourism Module



The Tourism Module determines total tourism expenditures, which, in turn affect the size of the regional economy.

Tourism is demand-driven in POMMARD. The attractiveness coefficients link tourism to changes in NCO production (in particular, of percent of land in forests in the region. The sector is constrained by hotel beds, in-region tourist limits, and daily arrival capacity. If all hotel beds are filled, tourists are turned away. Those that stay remain in the region for the specified time period. Moreover, the model makes the tourism sector subject to seasonality, which leads to periodic stress on hotel capacity during peak season and results in relatively lower occupancy rates for the rest of the year. Hotels beds are added when the expected annual occupancy rises to a level that justifies investment in additional beds. Beds are allowed to decline when the average occupancy rate falls below that level needed to cover variable costs. Additions and closures are based on the previous year's occupancy, so there is a lag in changes. Those within the limit arrive according to the seasonal schedule.

The tourism module is linked to the Land and Agriculture modules through the regional attractiveness change, which is determined in part by changes in land use. Tourism is linked to the Region Module through its income, purchases, and employment.

Tourists Stock (units: persons)

This stock records the changing number of tourists over time. The stock rises as tourists arrive and falls when they depart. Users do not have to modify this converter.

$$TOUR(t) = TOUR(0) + \int_0^t (ARRIVE(t) - DEPT(t))dt$$

t	is time
$TOUR(t)$	is the total number of tourists in the region at time t
$TOUR(0)$	is the initial number of tourists, which is obtained as:

$$TOUR(0) = PAT / 365 * ADS$$

ADS	is the number of days that tourists stay in the area
PAT	is the potential number of annual tourists

$ARRIVE(t)$	is the rate of arrivals of tourists at time t
$DEPT(t)$	is the rate of departure of tourists at time t

Cumulative Tourists Stock (units: persons)

The cumulative tourists stock records the number of tourists as they depart the region. This stock is used to calculate the annual occupancy rates. Users do not have to modify this converter.

$$CT(t) = CT(0) + \int_0^t DEPT(t)dt$$

t	is time
CT_t	is the cumulative number of tourist that have visited the region since the beginning of the simulation
$CT(0)$	is the initial cumulative number of tourist. Initial value of zero is predetermined in order to evaluate the accumulation between period 0 and t
$DEPT(t)$	is the rate of departure of tourists at time t

Arrivals Inflow (units: persons)

The arrivals inflow calculates the number of current tourists arriving in the region. This is obtained by comparing the minimum total potential tourists (PT) and the current number of hotel beds available ($(HR - T) * 365$). Because hotel rooms (HR) and number of tourists (T) are both current levels, and the units in the simulation are in years, the available beds must be converted to an annual equivalent before the comparison is made with flow of tourists, which is an annualized number. Users do not have to modify this converter.

$$ARRIVE = MIN(PT, (HR - T) * 365)$$

$ARRIVE$	is the annual arrival flow of tourists
PT	is the current flow of tourists wishing to visit
T	is the number of tourists currently in the region

HR is the hotel rooms stocks available for tourists

Departures Flow (units: persons)

The departures flow reduces the current tourists in the region after being in the stock for the prescribed length of time (in this case, after staying the average days of stay). Users do not have to modify this converter.

$$DEPT(t) = ARRIVE(t - \frac{ADS}{365})$$

$DEPT(t)$	is the total departure of tourists during the year
$ARRIVE(t - \frac{ADS}{365})$	is the annual arrival flow of tourists lagged ADS/365 periods

Hotel Rooms Stocks (units: hotel beds)

This stock counts the number of hotel rooms currently available to tourists. Initial values are assumed to be equal to the values into the Initial Hotel Beds Converter from the Initial Conditions Module). See instructions to enter data.

$$HR(t) = HR(0) + \int_{o}^{t} (IHB(t) - DHB(t))dt$$

$HR(t)$	is the number of hotel rooms available to tourists at time t
$HR(0)$	is the initial number of hotel rooms (this is the Initial Hotel Beds Converter, which comes from the Initial Conditions Module)
$IHB(t)$	is the increase in hotel beds at time t
$DHB(t)$	is the decrease in hotel beds at time t

Increase Hotel Beds Inflow (units: hotel beds)

This flow calculates the number of hotel beds that are increased based on the annual visitor days and the number of rooms at which beds start to be added. The number of hotel beds increases when the annual visitor days at certain time (AVD/365) is larger than the minimum amount of rooms from which beds start to be added (determined by the Break Even Occupancy Rate or BEO)[33]. Users do not have to modify this converter.

$$IHB = 0 \quad \text{if t<1}$$

$$IHB = \frac{AVD}{365} - HR * BEO \quad \text{if t>1}$$

IHB	is the rate of increase in hotel beds
HR	is the total number of rooms available
BEO	is the break-even occupancy rate
AVD	is the annual visitor days
t	is time

[33] Because of the need to calculate the minimum amount of rooms, this converter starts to operate at the end of the first year when occupancy is calculated.

Decrease Hotel Beds Outflow (units: hotel beds)

This flow represents the rate of hotel bed reduction because of low occupancy (less than the minimum occupancy needed to avoid losses). The latter is determined through the Minimum Occupancy Rate or MOR. The number of rooms lost is the difference between the minimum number of rooms that must be occupied and the average number of rooms actually occupied over the previous year.[34] Users do not have to modify this converter.

$$DHB = 0 \qquad \text{if } t<1$$

$$DHB = HR * MOR - \frac{AVD}{365} \qquad \text{if } t>1$$

DHB is the decrease in hotel beds
HR is the total number of rooms available
MOR is the minimum occupancy rate
AVD is the annual visitor days
t is time

Attractiveness Coefficients Converter (units: ratios)

This converter contains coefficients that relate changes in the community capitals to the region's attractiveness to tourists. These coefficients were estimated from data on regional natural and other capital levels and tourism levels. Users should not change these values unless they re-estimate these relationships for their region.

Seasonality Index Converter (units: 0 to 1)

This converter represents the seasonality index, values of which vary from 0.0 (no seasonality) to 1.0 (maximum seasonality). A value of 1 means that seasonality is extreme and the lowest point of the season is zero, whereas 0 implies that the flow is even throughout the year. For instructions for entering this data, see the data entry section.

Seasonal Peak Converter (units: 0 to 12)

This converter represents the point where the maximum demand is realized during the year. It is roughly based on months. January 1 at 0:00 hours is 0.0 (or 12.0) whereas August 1 is about 7.0. For instructions for entering this data, see the data entry section.

Seasonality Converter (units: proportion, 0 to 1)

This converter generates a sinoidal flow of tourists over the year. A value of 0 indicates there is no seasonality and that a constant flow of tourists visit the region throughout the year, whereas a value of 1 means that the flow is extremely seasonal (i.e., the flow falls to zero during the off-season). The calculation is based on the seasonality index and the seasonal peak. Users do not have to modify this converter.

$$S = SI * SIN(2 * \pi * (t + \frac{SP}{12} + 0.25)) + 1$$

[34] Because of the need to calculate annual average occupancy, this converter starts to operate at the end of the first year when occupancy is calculated.

S	is the seasonality value (proportion of potential annual tourists)
SI	is the seasonality index
SP	is the seasonal peak
t	is time

Regional Attractiveness Change Converter (units: proportion)

This converter generates an index of the region's attractiveness to tourists that is based on the attractiveness coefficients and the change in NCOs' production in the non-commodity forest % (from the Non-Commodities Module). A score of 0.0 means that there is no change in the attractiveness of the region and the potential tourist will equal potential annual tourists (subject to infrastructure and transportation constraints). Users do not have to modify this converter.

$$RAC = AC_{natural\_capital} * (NCOs_{forest\_\%} - NCOs_{forest\_\%}(0))$$

RAC	is the regional attractiveness change
$AC_{natural\_capital}$	is the attractiveness coefficients by natural capital
$NCOs_{forest\_\%}$	is the NCOs' production of forest %
$NCOs_{forest\_\%}(0)$	is the initial NCOs' production of forest %

Potential Annual Tourists Converter (units: persons)

This converter represents the total annual tourists expected to visit the region in the base year if the regional attractiveness change is 0.0 and there are no constraints caused by hotels, in-region travel capacity, or arrival limits. For instructions for entering this data, see the data entry section.

Daily Arrival Capacity Converter (units: persons)

This is the maximum number of new guests that can be accommodated each day (airports, buses). This capacity should be expressed in number of arriving tourists. For instructions for entering this data, see the data entry section.

Travel Capacity Converter (units: persons)

This is the maximum number of current guests that roads (or other types of infrastructure other than hotel beds) can accommodate at any given time. This capacity should be expressed in maximum number of tourists in the region at one time. When the numbers of tourists in the region reach this level, no more will be allowed to enter the region until some leave or the constraint is relaxed through policy. For instructions for entering this datum, see the data entry section.

Average Days of Stay (units: days)

This is the average number of days that tourists are assumed to stay in the area. This value will typically be constant throughout the simulation but could be changed for scenario purposes. For instructions for entering this data or to simulate scenarios, see the data entry section.

Potential Tourists Converter (units: persons)

This converter calculates the total number of potential annual tourists by comparing the minimum to the following three levels: (1) the total potential arrivals wishing to visit, which is influenced by the region's attractiveness, the potential number of tourists and the seasonality information; (2) the current arrival constraint, which is obtained based on the annualized daily arrival capacity ($DAC*365$); and, (3) the infrastructure capacity constraint, which represents the number of guests that the infrastructure can accommodate at any time. Because the constraints and revenues are based on daily tourists whereas the model uses year as the unit of time, a number of conversions from daily rates to annual rates must be made. Thus the daily arrival constraint must be multiplied by 365 and constraint on arrivals due to infrastructure is $TC*365/ADS$ .Users do not have to modify this converter.

$$PT = Min(PAT * S * (1 + RAC), DAC * 365, TC * 365 / ADS)$$

PT	is the current flow of tourists wishing to visit
PAT	is the potential number of annual tourists
S	is the seasonality, which represents the flow of guests during the year
RAC	is the region attractiveness change
DAC	is the maximum number of new guests that can be accommodated each day
TC	is the maximum number of guests that infrastructure can accommodate at any time
ADS	is the number of days that tourists stay in the area

Annual Visitor Days Converter (units: days)

This converter calculates the total number of visitor days that all visitors stay in the region during the year. This value is used to calculate the increase in hotel beds. Users do not have to modify this converter.

$$AVD = (CT(t) - CT(t-1)) \times ADS$$

AVD	is the total number of visitor days during the previous year
$CT(t) - CT(t-1)$	is the cumulative number of tourist that have stayed in the region between over the period *t-1* to *t*
ADS	is the average days of stay by a tourist

Minimum Occupancy Rate Converter (units: proportion, 0 to 1)

This converter is the occupancy rate at which hotels no longer cover their variable costs and begin to reduce beds. For instructions for entering this data, see the data entry section.

Break Even Occupancy Converter (units: proportion, 0 to 1)

This converter represents the occupancy rate at which hotels begin to add beds. Break-even occupancy should be at the level whereby each new bed can pay variable costs and cause a return on investment. Note that increases and decreases are asymmetric because (1) hotel investments have a sunk-cost nature and (2) increases are based on actual losses of sales rather than on high occupancy rates. This is critical because of the seasonal nature of the business. This assumes a perfectly competitive market in which a high average occupancy rate attracts investment, even though total profits in the sector may be driven down and marginal returns are less than average. For instructions for entering this data, see the data entry section.

Price per Bed Converter (units: euros)

This converter represents the average revenue obtained by each visitor on tourism (hotels, bed and breakfasts). It is assumed that this revenue is spent in the tourism sector.
For instructions for entering this data, see the data entry section.

Related Daily Expenditures Converter (units: euros)

This converter represents other revenues coming from daily expenditures derived from the current visitors. It is assumed that this revenue is spent in the recreation sector of the economy and is in addition to that amount of spending on hotels. For instructions for entering this data, see the data entry section.

Total Tourism Expenditures Converter (units: euros)

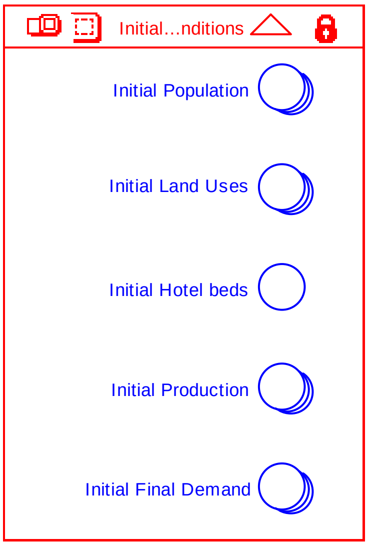
This represents the revenues obtained from either hotel revenues or other daily expenditures. This number is transferred to the regional economic sector. Users do not have to modify this converter.

$$TTE_{tourism} = T * PB * 365$$
$$TTE_{recreational} = T * RDE * 365$$

$TTE_{tourism}$	is the total tourism expenditures in the tourism sector
$TTE_{recreational}$	is the total tourism expenditures in the recreational sector
T	is the current number of visitors
PB	is the price per bed
RDE	is the related daily expenditures

The Initial Conditions Module

Figure A.13 The Initial Conditions Module



This module allows the entry of the initial conditions of certain variables in the Human Resources, Tourism, Agriculture and the Region Modules.

Initial Population Converter (units: persons)

This converter is the initial population by cohort and education level. This information is used as the initial value for the Population Stock in the Human Resources Module. For instructions for entering this data, see the data entry section.

Initial Land Uses Converter (units: hectares)

This converter is the initial land use by the production system. This information together with Change Land Use (from the Policy Controls Module) is used to determine the Land Use (from the Land Module). For instructions for entering this data, see the data entry section.

Initial Hotel Beds Converter (units: hotel beds)

This converter is the base year level of hotel beds in the region. It is used as the initial value for the Hotel Rooms Stock in the Tourism Module. For instructions for entering this data, see the data entry section.

Initial Production Converter (units: thousands of euros)

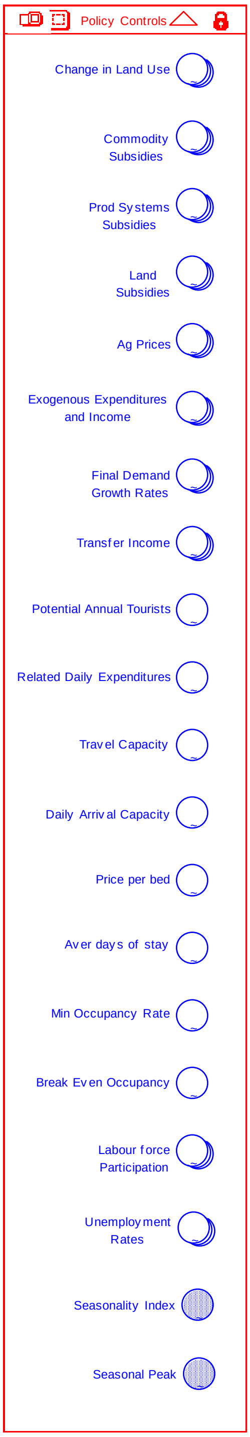
This converter is the initial production level by sector. These values are used as the initial values of the Inventory Stock in the Region Module. For instructions for entering this data, see the data entry section.

Initial Final Demand Converter (units: thousands of euros)

This converter represents the initial final demand **for** the products of each sector including households (in thousands of euros). It includes exports, all government expenditures, investment (from domestic and external sources), and external income (from commuters and investment income but excluding transfers that are earned on a per capita basis). These values are used as the initial values of the Final Demand in the Region Module. For instructions for entering this data, see the data entry section.

The Policy Controls Module

Figure A.14 The Policy Controls Module



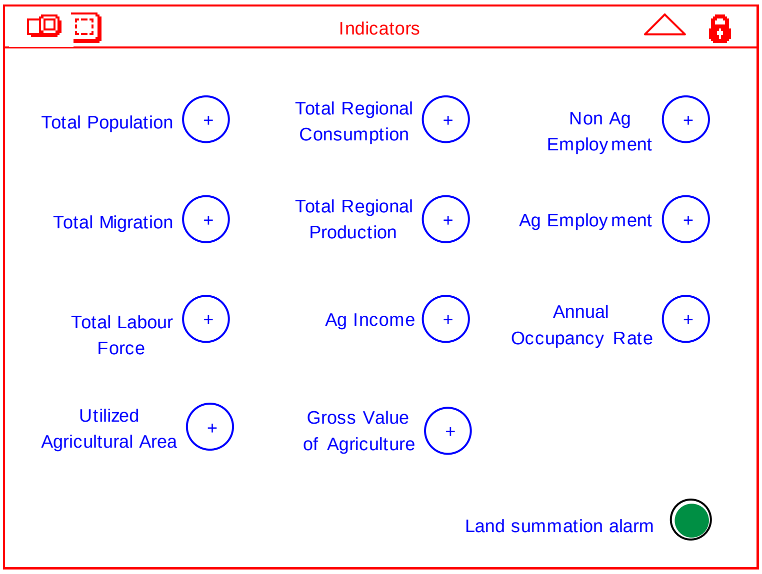
The Policy Controls Module provides a list of the variables commonly used in policy scenarios. Each of these variables may be modified by the user. Typically changes are made using the Scenario spreadsheet. To simplify the model diagram, "ghost" converters have been created for all of the variables. The ghosts are incorporated into those modules where they connect to converters of flows. The description of these variables is also incorporated into the module descriptions. The user may go to the appropriate modules by clicking on the hyperlinks below.

Change in Land Use
Commodity Subsidies
Prod Systems Subsidies
Land Subsidies
Ag Prices
Exogenous Expenditures and Income
Final Demand Growth Rates
Transfer Income
Potential Annual Tourists
Related Daily Expenditures
Travel Capacity
Daily Arrival Capacity
Price per Bed
Average days of stay
Min. Occupancy Rate
Break-Even Occupancy
Labour Force Participation
Unemployment Rate
Seasonality Index
Seasonal Peak

These policy variables may be changed directly using these converters from a LID or by using an Excel sheet such as the Scenario spreadsheet provided.

The Outcome Indicators Module

Figure A.15 The Outcome Indicators Module



The Outcome Indicators Module allows the user to observe the behaviour of certain key variables.

Total Population Converter (units: persons)

This converter sums all age and education categories to obtain the total population. Users are not required to modify any values.

$$TP = \sum_{j=1}^{e}\sum_{i=1}^{a} P_{i,j} \qquad \text{for i=1}\ldots a \text{ \& j=1}\ldots e$$

a	is the total number of cohorts
e	is the total number of education levels
TP	is the total population
$P_{i,j}$	is the population by cohort and education level (from the Human Resources Module)

Total Migration Converter (units: persons)

This converter sums all types of exogenous and endogenous migration. Users are not required to modify any values.

$$TM = \sum_{j=1}^{e}\sum_{i=1}^{c} M_{i,j} + \sum_{j=1}^{e}\sum_{i=1}^{c} DM_{i,j} + \sum_{j=1}^{e}\sum_{i=1}^{c} QOLMg_{i,j}$$

a	is the total number of cohorts
e	is the total number of education levels
TM	is the total migration
$M_{i,j}$	is the migration demanded by cohort and educational level (from the Human Resources Module)
$DM_{i,j}$	is the accompanied migration by cohort and education level (from the Human Resources Module)

$QOLMg_{i,j}$	is the quality of life migration by cohort and education level (from the Human Resources Module)

Total Labour Force Converter (units: persons)

This converter sums all the labour force available. Users are not required to modify any values.

$$TLF = \sum_{j=1}^{a} \sum_{i=1}^{e} LF_{i,j} \text{ for i=1}\ldots e \text{ \& j=1}\ldots a$$

a	is the number of cohorts
e	is the number of education levels
TLF	is the total labour force
$LF_{i,j}$	is the labour force by education and cohort levels (from the Human Resources Module)

Utilized Agriculture Area Converter (units: hectares)

This converter sums area used in annual crop, permanent crop and grass land. Users are not required to modify any values.

$$UAA = \sum_{j=1}^{p} LSU_{annual\_crop\_land,j} + \sum_{j=1}^{p} LSU_{permanent\_crop\_land,j} + \sum_{j=1}^{p} LSU_{grass\_land,j}$$
for j=1…p

p	is the number of production systems
UAA	is the utilized agriculture area
$LSU_{i,j}$	is the land stock by use, by land type and production system (from the Land Use Module)

Total Regional Consumption Converter (units: thousands of euros)

This converter calculates the total consumption in the regional economy. Users are not required to modify any values.

$$TRC = \sum_{i=1}^{s} C_i$$

s	is the number of sectors
TRC	is the total regional consumption
C	is the consumption by sectors (this comes from the Region Module)

Total Regional Production Converter (units: thousands of euros)

This converter calculates the total sum of production of the regional economy. Users are not required to modify any values.

$$TRP = \sum_{i=1}^{s} SP_i$$

s	is the total number of sectors
TRP	is the total regional production
SP	is the production by sectors (this comes from the Region Module)

Ag Income Converter (unit: thousands of euros)

This indicator represents the total income received by farmers. Users do not have to modify this converter.

$$AGI = \sum_{i=1}^{p} AI_{households,i} + \frac{AICh_{households}}{1000} \qquad \text{for i=1…}p$$

p	is the total number of production systems
AGI	is the total agriculture income received by farmers
$AI_{households,i}$	is the payments received by farmers (from the Agriculture Module)
$AICh_{households}$	is the agriculture income change received by farmers for changes in prices and subsidies (from the Agriculture Module)

Gross Value of Agriculture (units: euros)

This converter sums the value of agriculture commodities at constant prices. Users are not required to modify any values.

$$GVA = \sum_{i=1}^{c} AV_i \qquad \text{for i=1…}c$$

c	is the total number of commodities
GVA	is the gross value of agriculture
AV_i	is the agriculture value by commodities (from the Agriculture Module)

Non-Ag Employment Converter (units: persons)

This converter calculates the total sum of the non-agricultural employment. Users are not required to modify any values.

$$NAE = \sum_{j=1}^{s} \sum_{i=1}^{e} NALD_{i,j}$$

e is the total number of education levels
s is the total number of sectors
NAE is the total non-agricultural employment
$NALD_{i,j}$ is the non-agricultural labour demand by educational level and sector (this comes from the Region Module)

Ag Employment Converter (units: persons)

This converter calculates the total sum of the agricultural employment. Users are not required to modify any values.

$$AE = \sum_{j=1}^{p} \sum_{i=1}^{e} ALD_{i,j}$$

e is the total number of education levels
p is the total production systems
AE is the total agricultural employment
$ALD_{i,j}$ is the agricultural labour demand by educational level and production systems (this comes from the Agriculture Module)

Annual Occupancy Rate Converter (units: proportion)

This converter calculates the hotel occupancy rate based on the annual visitor days. The value of this converter could be used to make decisions regarding investment in hotel beds. Users do not have to modify this converter.

$$AOR = \frac{AVD/365}{HR}$$

AOR is the annual occupancy rate (this information comes from the Tourism Module)
AVD is the annual number of visitor days (this information comes from the Tourism Module)
HR is the number of hotel rooms available to tourists (this comes from the Tourism Module)

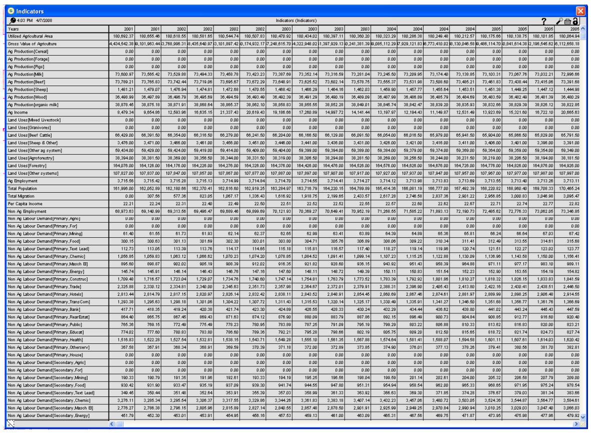
Land Summation Alarm

This converter allows users to see whether the Total Land is increasing or decreasing. In most cases, this will indicate an error in the data or in a scenario. This information comes from the Total Land Check Converter from the Land Module. Users are not required to modify any values.

Output Indicators

In addition to the Indicators Converters, the Indicators table in the interface window contains information about the main variables of interest for the period of analysis. Descriptions of these variables are included in the respective modules. The user may go to the appropriate modules by clicking on the hyperlinks below:

Figure A.16 The Output Indicators Table



1. Utilized Agriculture Area
   - units: hectares
   - from the Indicators Module
2. Gross Value of Agriculture
   - units: euros
   - from the Indicators Module
3. Ag Production by production system
   - units: vary
   - from the Agriculture Module
4. Ag Income
   - units: thousands of euros
   - from the Indicators Module
5. Land Uses by production system
   - units: hectares
   - from the Land Module
6. Ag Employment
   - units: persons
   - from the Agriculture Module
7. Total Population
   - units: persons
   - from the Human Resources Module
8. Total Migration
   - units: persons
   - from the Human Resources Module
9. Per Capita Income
   - units: thousands of euros
   - from the Region Module
10. Non Ag Employment
    - units: persons
    - from the Region Module
11. Non Ag Labour Demand by education and sector
    - units: persons

- from the Region Module

12. Cohorts Sums by age
    - units: persons
    - from the Human Resources Module
13. Education Sums by education level
    - units: persons
    - from the Human Resources Module
14. Change in Capital
    - units vary
    - from the Quality of Life Module
15. NCOs
    - units vary
    - from the Non-Commodities Module

Customizing the POMMARD Model for your Study Area

Adding/Changing Categories (Elements) in Model Dimensions

It is quite simple to change the number and/or names of categories in the arrays. To alter elements:

1. Go to the array editor from the Map or Model level by clicking on Model (in the tool bar), Array Editor.

2. Scroll through the Dimension Names by clicking on the up or down arrows until you come to the one you want to alter.

3. In the Element Name/# box, scroll to the element you want to alter. You can delete it by clicking on Delete, or rename it by typing over the name in the box. You can add a new element by clicking the Add box and then typing the desired name over the element number that has appeared. Clicking on Add places the new element directly after the name or number currently in the box.

4. Click on OK to save changes.

Caution:

- It is easy to add unwanted elements. This is especially true at the end position. See Removing Unwanted Dimensions and Elements.
- ***Adding elements to some dimensions requires making changes to the equations***. This is true for the dimensions listed in the table below. The starred converters require different or additional data, whereas those that are not starred require changes in the formula themselves.

Dimension	Converters and Flows Affected
Non-Commodities	Change in Capital Land Coefficients* Livestock Coefficients* Land Cover Coefficients* NCO PS Coefficients* Shannon Converter*

Land types	Land Coefficients* Land Requirements* Land Cover Coefficients* Land Subsidies* Shannon Converter* Utilized Agriculture Area
Production Systems	Ag Inputs Coefficients* Ag Output Coefficients* Change in Land Uses* Initial Land Uses* Labour Land Ratios* Land Requirements* Livestock Coefficients* NCO PS Coefficients* Production System Subsidies*
Cohorts elements	Age In Age Out Births Death Rates* Dependent Shares* Dependent Migration Initial Population* Labour Force Participation* Migration Shares* Other Final Demand QOL Coefficients* QOL Final Demand QOL Migration Other Final Demand Transfer Income* Working Age Population
Education	Age In Age Out Births Dependent Shares* Initial Population* Labour Force Participation* Labour Land Ratios* Labour Output Ratios* Labour Supply Migration Shares* QOL Migration Unemployment Rates*

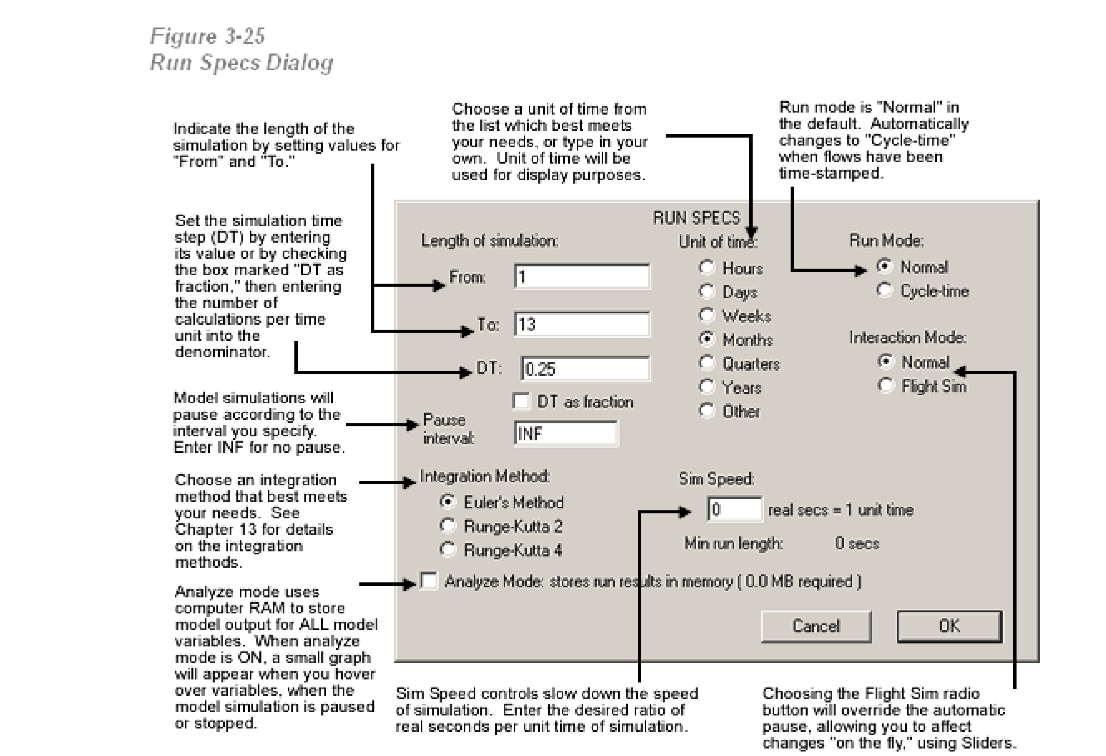
Sectors	Ag Income Change Ag Inputs Coefficients* Exogenous Expenditures and Income* Initial Final Demand* Final Demand Growth Rates* Initial Production* IO Coefficients* Labour Output Ratios* Per Capita Income Other Final Demand Total Tourism Expenditures
Commodities	Ag Output Coefficients* Ag Prices* Commodity Subsidies*
Capital	Attractiveness Coefficients* Change in Capital QOL Coefficients* QOL Migration Regional Attractiveness Change

- ***Changing the name of the elements of the categories could change the meanings of some converters, especially those non-starred***. It is important to ensure that the initial formulas assumed make sense with the new meaning proposed by the user. For example, if in the Sectors dimension, new elements are added and/or changes in some of the elements are implemented, the Total Tourism Expenditures Converter would be affected. In order to fix it, zero values must be added to the new categories and the formulas must be altered for those elements that contain formulas (for this case, "Recreational" and "Tourism" elements).
- ***Adding or subtracting sectors in the middle of the list of elements rather than at the end would keep households in the last position, and formulas would not change***.
- If problems arise, check the section Problems while increasing, decreasing or changing the elements in categories
- If after adding data and/or changing the formulas some converters still appear to have a question mark, the converters are probably not updated, and the program will not run. In order to update those converters, double-click on each of the converters and press OK in the converter dialog box.

Setting Run Specifications

In order to run the POMMARD model, it is important to understand various Stella specifications that affect the accuracy, time dimension, and outputs from the model. For additional information on run specifications, see *Run Specs* in the Stella manual.

Figure A.17 Run Specs Dialog



Length of Simulation

"From" and "To" determine the period over which each simulation takes place. In POMMARD the typical period of analysis is 25 years, starting on January 1, 2001.

Delta Time

Stella operates by calculating all variables after advancing time by small increments, called delta time (*dt*). It represents the interval of time between calculations. Its value is very important in a complicated dynamic model such as POMMARD. A *dt* value of 0.25 for year periods means that calculations are performed every quarter year, whereas a *dt* value of 1.0 means that calculations would be generated once each year.

Smaller *dt*s can never make results less accurate. A value of 0.01 is better than a value of 0.1 as fewer delays are allowed in the calculations. But lower values cause the model to run slowly and require much more computer memory. The solution is to experiment until the ideal balance between accuracy and model efficiency is determined.

Because the POMMARD model incorporates very short run events, especially in the Tourism module, *dt* values greater than 0.01 should only be used when the seasonality is turned off (or the seasonality index is equal to zero). Large *dt* values can give very inaccurate results even with few short-term changes. The default *dt* value in the POMMARD Core 1.41 is 0.25, which means that the Stella recalculates all values every quarter year. This is adequate for trials and rough simulations. For **final results** it is advised that smaller *dt*s be used. We have had satisfactory results with a *dt* of 0.01 (about 4 days). To see more about possible problems see the section Model is running too slow, gives a message that the length of simulation is too great or gives erratic results

<u>Important Note</u>: The choice of *dt* does not require any changes in units or values in the variables because *dt* only affects calculations in the model. To see how it works in more detail, see the Stella Help.

Units of Time

Units of time represent the time units that simulations would run. The POMMARD model assumes that the time unit is one year.

Sim Speed

The purpose of this option is not to increase the speed of the simulation by itself. It basically provides some time to the user to stop or pause the running while the simulation is in process. In order to accelerate the run-time of simulation, the sim speed in POMMARD is set at 0.

Integration Method

There are three numerical integration methods available in the program: Euler's Method, Runge-Kutta 2, and Runge-Kutta 4. Each of these has different strengths and weaknesses. To see the assumption of these methods, check "Eurler's Method" and the "Rugge-Kutta Methods" in the Stella manual. For POMMARD, the integration method used is the Euler's Method because of the mixed continuous discrete nature of the model.

Entering Data into the POMMARD Model

The model user will have several occasions to enter data into the model. The first and most significant data entry time will be when the model is first prepared for a new region. After the basic data have been entered and a satisfactory baseline project is established, the user will enter data for alternative baselines, scenario analysis and what-if analysis. The subsequent data entry uses largely different procedures, which are explained below.

In many cases, there are alternative methods for entering data. These alternative methods generally make no difference to the simulation results but require different skills and time. As users gain familiarity with the model, they learn which methods make the most sense in different circumstances.

Alternative Methods for Entering Data

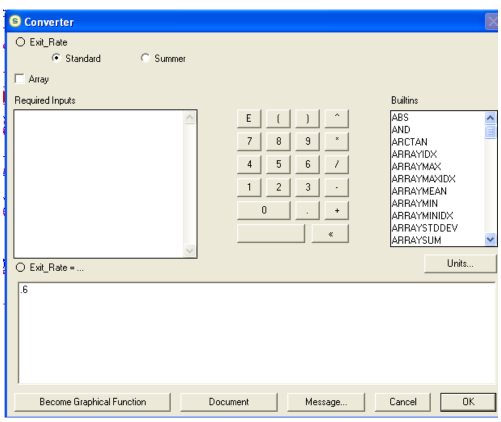
Five methods of entering data are described below. Direct Entry into the converters is the easiest when only one or two entries are required. It can become time-consuming when large arrays are involved. The Copy and Paste option is useful when data is already available in electronic format (e.g., word processor files or spreadsheets). Importing POMMARD from an Excel spreadsheet is the fastest approach when large arrays are involved.. Finally, the Graphical option allows drawing the behaviour of variables over the entire period of analysis.

Importing data from an Excel spreadsheet has been facilitated by the construction of two types of templates (see Entering Data Using the Customized Spreadsheets). These are discussed below.

Direct Entry
(Return to the Specific Data Entry Instructions Section)

For ***non-arrayed (i.e. single valued) converters:***

Figure A.18 Single Value Converter Window



1. From the Model Window, click on the converter.
2. Enter the data.
3. Click on OK.

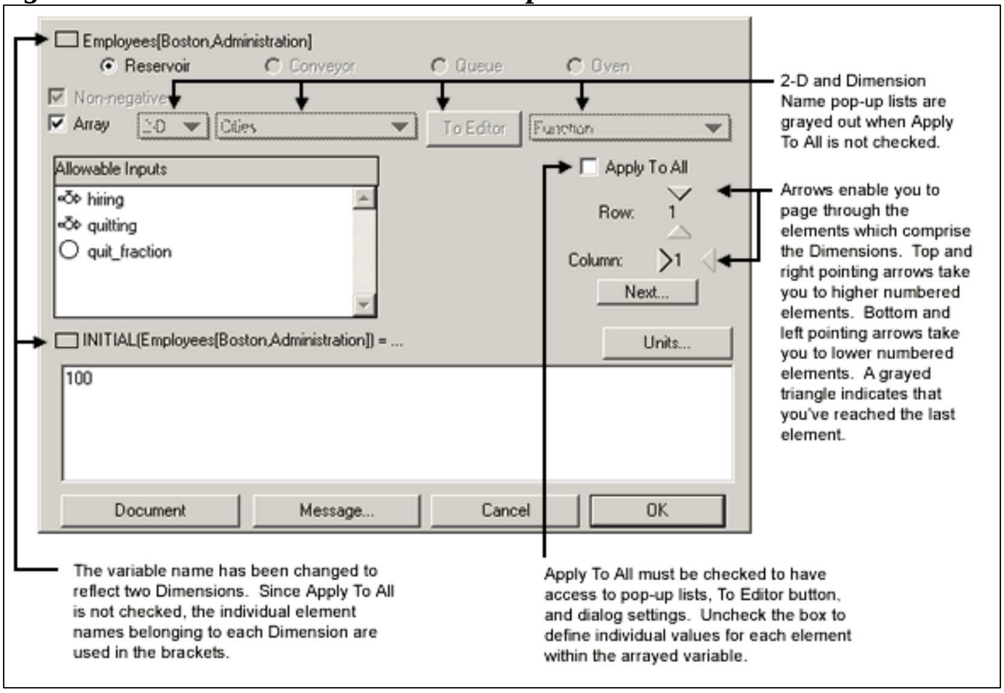
For arrayed variables, there are two options for direct data entry:

a. Option 1, cell by cell:

1. From the Model Level, click on the converter to open the dialog box (see figure below).

2. Make sure the Apply to All box is NOT checked.
3. Scroll through the rows and columns until you arrive at position 1 (in a one-dimensional array) or 1,1 (in a two dimensional array).
4. Enter the data for position (1,1).
5. Click Next, or scroll to the next row or column (remember that the first dimension is the row and the second is the column) and add the data for this element.
6. Continue through to the end of the array adding data to each cell.
7. Click OK.

Figure A-19: Converter Window and Explanations



Source: Stella manual

b. Option 2, full array:

1. From the model level, click on the converter to open the dialog box (see figure 19).
2. Make sure the Apply to All box IS checked.
3. Enter the data, row by row. Start with a square bracket and list all data, separated by commas. End with a square bracket. Note that rows can follow directly after each other. However, it is frequently conveniently to start each new row of data on a new line. All entries must be separated by commas. Each row can follow directly.

[100,200,300,400,500]	[100,200,300,400,500, 10,20,30,40,50, 60,70,80,90,100]

4. Click OK.

Most of the arrayed variables have been set up to accept data in the full array approach but if the user prefers, this can be easily changed by un-checking the Apply to All box.

Copy and Paste
(Return to the Specific Data Entry Instructions Section)

Importing data into an arrayed variable in a model via Paste follows the same basic process as that used for non-arrayed variables. One data set can be applied to all elements of an arrayed converter if:

1. Apply to All is checked in the arrayed variable's dialog (see figure 19).
2. There is the same number of data points in the data set to be pasted as there are cells in the arrayed variable (number of cells = number of elements in column * number of elements in row).
3. The data are enclosed in square brackets [] and all data points are separated by commas. The correct format for a column of data is illustrated here.

[100	,	If the data are being imported from a spreadsheet Excel file, a column of commas can be created alongside the column of data. Square brackets should be put in front of the first number and after the last number. Copying them together will bring the data into the necessary format.
200	,	
300	,	
400	,	
500	]	

[100,200,300,400,500]

arranged either as a elements are separated by put in front of the first Copying them together format.

[100,
200,
300,
400,
500]

If the data are being imported from a Word file, the data may be column or a row, as long as the commas. Square brackets should be number and after the last number. will bring the data into the necessary

To copy and paste:
1. Select the area in the spreadsheet or document.
2. Click Copy.
3. From the Model Window of POMMARD open the converter (see figure 19).
4. Make sure Apply To All box IS checked.
5. Erase or select all existing data in the data box, and paste the new data.

Importing from an Excel Spreadsheet[35]
(Return to the Specific Data Entry Instructions Section)

This option is the most common. Two Excel spreadsheets have been designed to accompany the POMMARD model. The first is designed primarily for the initial data entry, whereas the second sheet is designed for scenario development. The following section describes the use of spreadsheets in general.

Non-Arrayed Converters

To import values from an Excel file into a model, the Excel file must contain the exact names of the variables in the model into which you want to import values and the values that you want to import. You do not need to include all model variables in your Excel file—only the variables whose values you want to import into the model. Model variables that do not appear in the Excel file are not affected during the import process.

If any of the variables in the Excel file do not match those in the model, you will receive a warning message during the import telling you what data could not be imported. You can

[35] Source: The Import File Format. From The Stella Manual

enter the variable names as column headings or row headings (indicate the format you choose when you set up your link to your model).

The following Excel worksheet example (from the Stella manual) defines the initial values for population (a stock), birth rate (a converter), and death rate (a graphical function) with the variable names in the column headings:

	A	B	C	D
1	population	birth rate	death rate	
2	100	0.2	0.1	
3			0.102	
4			0.105	
5			0.113	
6			0.13	

The name of each variable appears as a column heading, and the values to import for each variable appear immediately beneath it.

All values for the graphical function (death rate), ordered from minimum *x* to maximum *x*, appear under the variable heading. If there are not enough values for the graphical function, the last value will be repeated to fill it out. If there are too many values, the excess values will be ignored.

The following example shows the same data with the variables as row headings:

	A	B	C	D	E	F
1	population	100				
2	birth rate	0.2				
3	death rate	0.1	0.102	0.105	0.113	0.13
4						

Note that the data in the spreadsheet do not have to start at row 1, column A. The import process searches the first 20 rows and 10 columns (200 cells) for a variable name, so you can begin entering data anywhere within that area. This allows you to enter header data or other documentation in the file that will not affect the import process. You can also enter descriptive information between columns (if you are using a column format) or between rows (if you are using a row format).

Between each variable, you can have up to five columns (or rows, if you are using row format) that have a blank header line. Data can appear in any other row (or column, in row format) than the header row and these columns (or rows) will be ignored during the import.

One-Dimensional Arrays Converter

To import values in an Excel file into a one-dimensional array in a model, the Excel file must contain one column (or row) of data for the array. The column (or row) heading specifies the array name. All subsequent columns (or rows) contain the data.

The following example from the Stella manual shows a one-dimensional array (OneD array) set up with a column heading and seven specified values.

OneD array	4	5	6	7	8	9	10

Two-Dimensional Arrays Converter

To import values in an Excel file into a two-dimensional array in a model, the Excel file must contain more than one column (or row) of data for the array. The first column (or row) specifies the array name. All subsequent columns or rows for the array contain an ellipsis ("...").

In the following example from the Stella manual, there are three variables for the array (TwoD array) set up with column headings. For each variable, the Excel spreadsheet provides three values for each variable.

TwoD array	...	...
4	2	-1
5	3	-7
6	4	0

If there are not enough values for the array, the last value will be repeated to fill it out. If there are too many values, the excess values will be ignored.

Note: For two-dimensional arrays, the data in Excel rows always map to rows in the model array and the data in Excel columns always map to columns in the model array, regardless of whether there are row headings or column headings in the Excel file.

TwoD array	4	2	-1
...	5	3	-7
...	6	4	0

The following example shows the same data as in the TwoD array example above, with row headings rather than column headings. Notice that the data is in the same order in both examples.

One-Dimensional Graphical Functions

To import values in an Excel file into a one-dimensional graphical function, format the data in the same way as you would for a two-dimensional array, with an ellipsis ("...") in subsequent rows or columns. For one-dimensional graphical functions, however, your specification of row vs. column headings determines how the values are read into the graphical function.

The following example from the Stella manual shows how you would format the Excel file for a one-dimensional graphical function (called OneDgf array) with four elements (in column headings).

OneD gf array	...	...	...
5	6	5	5
6	3	2	6
3	4	1	6
2	2	7	6
2	1	5	3
1	6	8	2
6	9	9	2
7	3	2	1
9	2	1	1

If there are not enough values for the elements, the last value will be repeated to fill it out. If there are too many values, the excess values will be ignored.

Two-Dimensional Graphical Functions

Finally, to import values in an Excel file into a two-dimensional graphical function, format the values in row-major order (values are imported from the first row, moving from left to right, then from the second row, left to right, and so on). Succeeding columns in a row start with an ellipsis ("..."). To indicate the start of a new row, use "***" in the first column of the row.

The following example from the Stella manual shows the format for a 4x3 array (called TwoDgf array) of graphical functions (one column for each cell in row-major order).

TwoD gf array	...	...	***	...	...	***	...	...	***	...	...
4	5	6	5	3	5	3	2	4	6	1	5
3	6	7	4	4	4	4	4	5	4	3	3
4	4	5	2	2	3	5	5	3	2	4	2
3	3	4	3	3	2	6	6	2	2	5	2
3	2	4	2	2	3	7	7	3	4	3	3
3	3	3	3	3	2	8	8	4	5	5	2
2	4	2	4	2	3	5	9	5	6	6	2

Entering Data Using the Customized Spreadsheets

(Return to the Specific Data Entry Instructions Section)

All the required data to initialize the POMMARD model for a particular region can be entered using the *Composite Input Template*. This spreadsheet includes 20 worksheets. The first of these is a composite of the other 19. The last 19 worksheets include pre-designed links to all the data converters in POMMARD other than those for scenario development. Required data is highlighted in each sheet. The spreadsheets are designed this way so that the user can link individual worksheets when changes are being made to one or two sheets or to the *Composite* worksheet when all or many converters must be updated. The first worksheet, *Composite,* is linked to the other 19 and should not be altered.

Both these spreadsheets are oriented using row headings. The following procedure is recommended for using the *Composite Input File*.

1. Make a copy of the original file using an appropriate name that indicates the region and the version of the data. Put the original in a folder where it will not be altered or confused with your working versions.
2. Add rows and columns (in the interior rows and columns so that formatting and summations are preserved) until each sheet includes exactly the number of elements in each dimension to correspond to your model. For instance, the core model has 23 sectors. If your study area has 30 sectors, 7 rows or columns must be added to those arrays that have sectors as a dimension. This is best done by adding rows and/or columns somewhere in the middle of the arrays and then copying addresses to the new cells. Changes must be made to both the primary worksheet and to *Composite*. The *Composite* sheet must be unprotected in order to make these changes. It is recommended that the user protect the *Composite* sheet following changes to prevent inadvertent changes.
3. You may add names above each section and to the right of the tables if you wish. Do not alter the first column except to add ellipsis where needed.
4. Enter data into each of the worksheets except the first. The first worksheet (named *Composite*) will be automatically updated.
5. Be sure that the number of elements in all dimensions in the POMMARD and the *Composite Input File* agree.
6. Save the spreadsheet. You are ready to link the spreadsheet to the POMMARD model.

The second spreadsheet, *Scenario*, is similar to the *Composite Input File*, except that it is organized as a single worksheet. Most scenarios can be developed using this file, although some with unusual changes may require additional data entry. The following procedure is suggested to make the *Scenario* spreadsheet ready for use.

1. Make a copy of the original file using an appropriate name that indicates the region and the version of the data. Put the original in a folder where it will not be altered or confused with your working versions.
2. Add rows and columns (in the interior rows and columns so that formatting and summations are preserved) until each sheet includes exactly the number of elements in each dimension to correspond to your model. The user may be able to copy and paste from the appropriate areas of the *Composite Input Template* to save time.
3. You may add names above each section and to the right of the tables if you wish. Do not alter the first column except to add ellipsis where needed.
4. Enter data into the *Baseline Scenario* worksheet to reflect the assumptions of this scenario. Once the baseline has been set up, make copies of the sheet, rename them, and change the assumptions to create the various scenarios. If preferred, separate spreadsheet files may be created.
5. Save the spreadsheet. You are ready to link the spreadsheet to the POMMARD model.

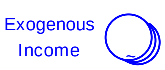
Caution: Be careful when customizing these spreadsheets. When new elements are added, the *Composite* and the *Scenario* spreadsheets must be updated with the link formulas as well. In addition, it is important not to forget to copy the "*" and "…" symbols. For more information about the use of these symbols, see the section Importing from an Excel Spreadsheet.

To import either the *Composite Input Template* or the *Scenario* spreadsheet to POMMARD, follow these steps:

1. Choose Edit from the main menu; click on Import Data.
2. Choose the *One time* link and the row orientation (the choice on the right).
3. Click Browse and find the spreadsheet with the name you have given it.
4. Click on the drop-down menu for worksheet name and choose *Composite* if you are importing all data from the Composite Input Template, one of the other worksheets if you are importing data into only one converter, or from the sheet for the appropriate scenario.
5. Click OK and wait for the message that indicates that the operation is complete. Check for any error messages.
6. The model is now ready to run.

Entering Data using a Graphical Function
(Return to the Specific Data Entry Instructions Section)

Graphical functions are an option in converters that are particularly useful when the user wants to vary the input levels over time. Several converters in the POMMARD model have graphical functions preset, but this option is available to the user in other cases as well. For instructions on changing a standard converter into one with graphical functions, see the Stella manual. This section describes the use of the preset graphical functions in the POMMARD model. This section draws heavily from the Stella manual.

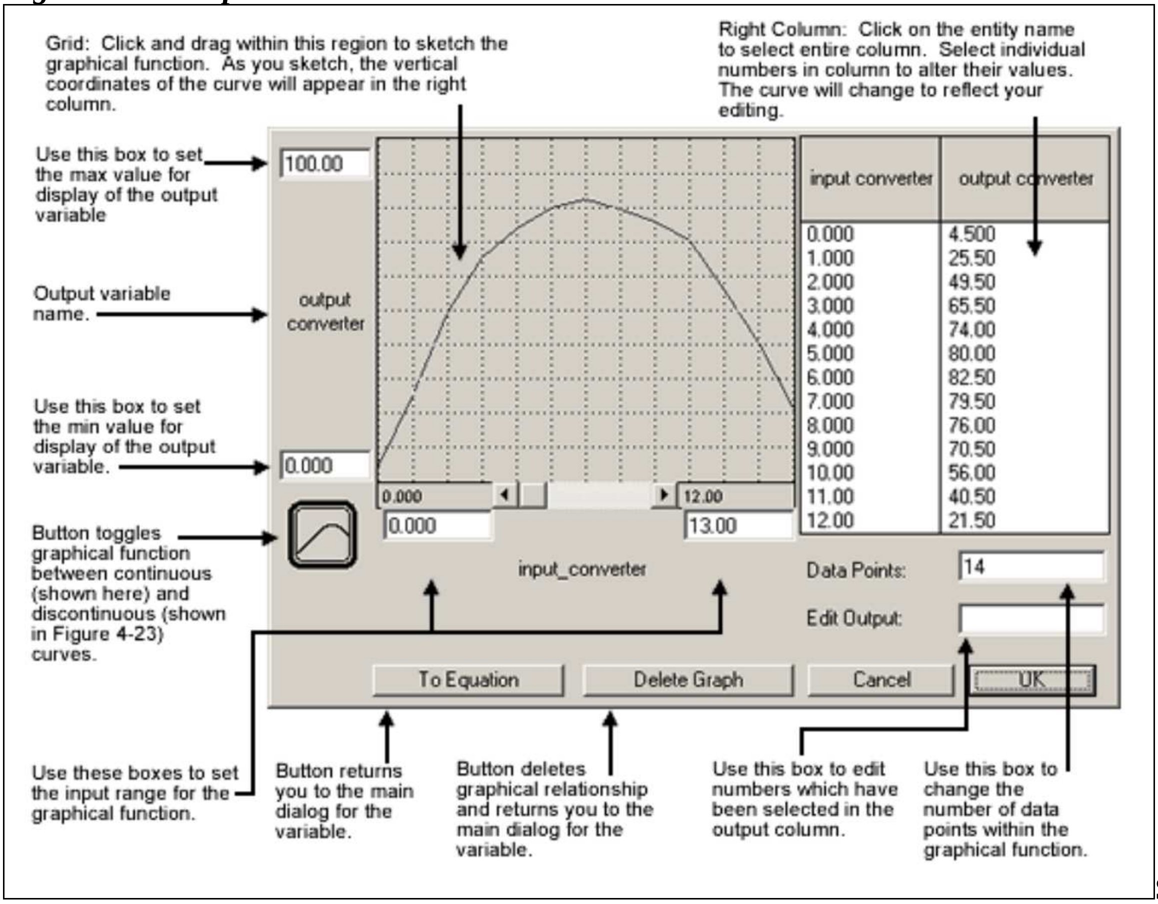


Converters that have been preset to work as graphical functions have a small wave in their icon as shown to the left.

To use the graphical function feature, the user should open the converter and perform the following actions (see figure 20).

1. *Set the min and max values for the X-axis.* Type numbers within the two fields below the graphical function grid. Generally these numbers will be the beginning and ending years of the simulation (i.e., 2001 and 2026). If users wish to introduce changes over a period shorter than this, they may set a shorter period. Hit the Tab key to move from field to field. The minimum and maximum values you choose for the X-axis will be reflected in the non-editable left column (input), to the right of the axes.
2. *Set the min and max values for the Y-axis*. Type numbers within the two fields to the left of the graphical function grid. The number in the bottom field (the minimum value) must be less than the number in the top field (the maximum value). Hit the Tab key to move from field to field.
3. *Set the number of data points.* Type a number into the Data Points field, found below the two columns of numbers. You must have at least two data points in a graphical function. You can have up to 1500 data points. When a graphical function contains more than 13 data points, the grid becomes scrollable. To view the entire function, depress the Alt key (Windows) or Option key (Macintosh). Generally the POMMARD user will want the number of data points to coincide with years, months, or weeks. When the simulation is the standard 25 years, 26 data points will create a yearly pattern, 301 data points (12*25+1) will create a monthly pattern, and 1301 data points will create a roughly weekly pattern.
4. *Create a relationship*. Click and hold the cursor within the grid. As you drag the cursor, a curve will be drawn, following your mouse movements. In addition, the Y-axis coordinates of the curve will be displayed in the right column (output) at the far right of the dialog.

Figure A.20 Graphical Window



Source: Stella manual

The user can edit a graphical function by typing numbers into the right-hand column (the output column). Click on one of the numbers in the output column. The number you select will appear in the Edit Output box. Type the number you want; then hit the Tab key on your keyboard. The point you have just defined will appear on the curve, and the next number down the output column will become selected.

A graphical function's output column can be copied and/or pasted. To copy/paste data into the output column to/from the clipboard, select a number (or a set of numbers) in the output column (to select the entire column, click once on the entity name at the top). Then, under Windows, type control C to copy or control V to paste. On the Macintosh, type command C to copy or command V to paste. The number(s) you select will be replaced by the data you paste. The number of data points will be adjusted to reflect the size of the data set being pasted.

It is also possible to create data links to your model from an Excel spreadsheet; these links allow you to import data from a spreadsheet and to export data to the same or different spreadsheet. For instructions see Importing from an Excel Spreadsheet.

The small button near the minimum boxes enables you to make the graphical function into either continuous or discontinuous line segments.

Specific Data Entry Instructions: Initial and Static Data

This and the next section give detailed instructions for entering data into each of the converters that require or accept data from the user. The converters in this section are primarily used to set up the original baseline. In the next section we cover those converters used to create scenarios and analysis. A later section on scenario development discusses the process of creating scenarios.

Ag Input Coefficients Converter
Units: thousands of euros/ hectare
(Return to the Agriculture Module)

Each coefficient represents the purchase of inputs per hectare in each production system.
For example, a value of 0.02 in the agriculture input coefficients in the energy row and mixed livestock column (see table below) means that 0.02 thousands of euros/ha were spent in energy for the mixed livestock production system.

Ag Input Coefficients		**Production Systems (j)**							
		Mixed Livestock	Granivores	Beef Cattle	Sheep and Other	Other Ag System	Agro forestry	Forestry	Other Systems
Sectors (i)	Energy	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Meat	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Other food processing	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Milk processing	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Textile	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Paper	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Chemicals	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Construction Machinery	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Metals	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Other Machinery	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Automobiles	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Furniture	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Energy Dist	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Construction	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Trade	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Tourism	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
		0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02

Transpo

	rt								
	Post	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Banking	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Public	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Recreati onal	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Other Services	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Househ olds	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076

Users that do not have access to input coefficients for each production system can use the agriculture column of the IO table as a guide. These coefficients must be adjusted to reflect thousands of euros values of inputs per hectare rather than thousands of euros values of inputs per thousands of euros of output. The ratio of total value of market commodities per hectare in each production system would be required in order to do that. But that approach makes the assumption that each production system uses the same mix of outputs, which is clearly not the case. If partial knowledge of the production systems is known (e.g., the income to owners, or operators and hired labour), replacements of the estimated numbers with known numbers will improve the linkages between agriculture and the regional economy.

To incorporate these values for the first time, users can use one of the four options available: (1) direct entry for arrayed variables, (2) copy and paste, (3) importing from an Excel spreadsheet for arrayed variables, or (4) the customized spreadsheet. As those values are expected to be constant during the simulation, it is expected that those values would not be modified in the simulation or what-if analysis.

Ag Output Coefficients Converter
Units: units vary/hectare
(Return to the Agriculture Module)

Each coefficient represents the yield of each output commodity relative to each production system. Yields can be represented by tons, livestock units, cubic meters, or hectares of land, depending on the commodity that we are talking about.

	Commodities	**Units**
1	Cereals	Tons/ha
2	Forage	Tons/ha
3	Pigs	LU/ha
4	Milk	Tons/ha
5	Beef	LU/ha
6	Sheep	LU/ha
7	Wood (cubic meters)	$100m^3$/ha
8	Non Conventional	Euros/ha

For example, a value of 1 in the cereal commodity row and mixed livestock production system column (see table below) means that 1 ton of cereal per hectare of land is produced in the mixed livestock production system.

Ag Outputs Coefficients		Production systems (j): Mixed Livestock	Granivores	Beef Cattle	Sheep & Other	Other ag system	Agro forestry	Forestry	Other System
Commodities (i)	Cereal	1	0	0	0	0	0	0	0
	Forage	0.1	0	0.1	0	0	0	0	0
	Pigs	0	1	0	0.1	0	0	0	0
	Milk	0.8	0	0	0	0	0	0	0
	Beef	0.3	0	0.4	0	0	0	0	0
	Sheep	0	0	0	0.05	0	0	0	0
	Wood	0	0	0	0	0	1	1	0
	Non-conventional	8.4	0	8.4	0	8.4	0	0	0

To incorporate these values for the first time, users can use one of the four options available: (1) direct entry for arrayed variables, (2) copy and paste, (3) importing from an Excel spreadsheet for arrayed variables or (4) the customized spreadsheet. As those values are expected to be constant during the simulation, it is expected that those values would not be modified in the simulation or what-if analysis.

Birth Rate Converter
Units: proportion, 0 to 1
(Return to the Human Resources Module)

This value is an estimate of the annual rate of birth among families aged 20 to 39. One way to calculate the latter value is by using the following formula: (births per thousand population /1000) *(Total Population/Population (20-39)). Alternatively, you can divide total births per year by population in the 20 to 39 cohort.

To incorporate these values for the first time, users can use one of the four options available: (1) direct entry for non-arrayed variables, (2) copy and paste, (3) importing from an Excel spreadsheet for non-arrayed variables, or (4) the customized spreadsheet. As those values are expected to be constant during the simulation, it is expected that those values would not be modified in the simulation or what-if analysis.

Death Rates Converter
Units: proportion, 0 to 1
(Return to the Human Resources Module)

This converter represents the annual number of deaths per member of each cohort. It could be obtained by dividing annual deaths in each cohort by the total population in each cohort.

To incorporate these values for the first time, users can use one of the four options available: (1) direct entry for arrayed variables, (2) copy and paste, (3) importing from an Excel spreadsheet for arrayed variables, or (4) the customized spreadsheet. As those values are expected to be constant during the simulation, it is expected that those values would not be modified in the simulation or what-if analysis.

Exit Rate Converters
Units: proportion, 0 to 1

(Return to the Human Resources Module)

This is a constant value. The exit rate represents the proportion of secondary school graduates that leave the region after completing secondary school. The remaining graduates are assumed to continue onto higher education (tertiary education) at a local institution or join the local labour force (1-local higher education rate-exit rate).

To incorporate these values for the first time, users can use one of the four options available: (1) direct entry for non-arrayed variables, (2) copy and paste, (3) importing from an Excel spreadsheet for non-arrayed variables, or (4) the customized spreadsheet. As those values are expected to be constant during the simulation, it is expected that those values would not be modified in the simulation or what-if analysis.

Initial Hotel Beds Converter
Units: hotel beds
(Return to the Initial Conditions Module or the Tourism Module)

This value represents the base year level of hotel bed in the region. To incorporate these values for the first time, users can use one of the four options available: (1) direct entry for non-arrayed variables, (2) copy and paste, (3) importing from an Excel spreadsheet for non-arrayed variables, or (4) the customized spreadsheet. As those values are expected to be constant during the simulation, it is expected that those values would not be modified in the simulation or what-if analysis.

Initial Land Uses Converter
Units: hectares
(Return to the Initial Conditions Module)

This converter is the initial land use by production system. To incorporate these values for the first time, users can use one of the four options available: (1) direct entry for arrayed variables, (2) copy and paste, (3) importing from an Excel spreadsheet for arrayed variables, or (4) the customized spreadsheet. It is expected that those values would not be modified in the simulation or what-if analysis.

Initial Population Converter
Units: persons
(Return to the Initial Conditions Module or Human Resources Module)

These values represent the initial population by cohort and education level. To incorporate these values for the first time, users can use one of the four options available: (1) direct entry for arrayed variables, (2) copy and paste, (3) importing from an Excel spreadsheet for arrayed variables, or (4) the customized spreadsheet. It is expected that those values would not be modified in the simulation or what-if analysis.

Initial Production Converter
Units: thousands of euros
(Return to the Region Module or to the Initial Conditions Module)

These values represent the production level by sector. To incorporate these values for the first time, users can use one of the four options available: (1) direct entry for arrayed variables, (2) copy and paste, (3) importing from an Excel spreadsheet for arrayed variables, or (4) the customized spreadsheet. It is expected that those values would not be modified in the simulation or what-if analysis.

Initial Final Demand Converter
Units: thousands of euros
(Return to the Initial Conditions Module)

This converter represents the initial final demand for the products of each sector including households (in thousands of euros). It includes exports, all government expenditures, investment (from domestic and external sources), and external income (from commuters and investment income, but excluding transfers that are earned on a per capita basis).

Note: It is important to note that because agriculture and forestry sectors are supply driven and external to the regional economy, they are excluded. In addition, given that it is modelled separately, the final demand for the tourism sector should exclude overnight visitors and related daily expenditures predicted by the tourism sector. This value is entered as a final demand from the tourism sector.

To incorporate these values for the first time, users can use one of the four options available: (1) direct entry for arrayed variables, (2) copy and paste, (3) importing from an Excel spreadsheet for arrayed variables, or (4) the customized spreadsheet. It is expected that those values would not be modified in the simulation or what-if analysis.

IO Coefficients Converter
Units: 0 to 1
(Return to the Region Module)

This is a standard A matrix from a regional input-output table. Each column is the portion of total purchases of inputs by that sector from each other sector (rows). For example, a value of 0.0001 in the energy row of the other food-processing column means that a 0.0001 of each euro of inputs purchased by the food-processing sector were supplied by the energy sector.

Note that the sum of each column of the IO Coefficients must be less than 1 because of the leakages from in the economy. Smaller regions will have larger leakages and smaller coefficients.

It is important to note that the last sector is the household sector.[36] The IO column for the household sector should be local expenditure coefficients for the average household in the region. The IO row for the household sector is the payments to households (wages, salaries, profits, rents, dividends, and so on) by firms in each sector.

Each user must complete this information. To incorporate these values for the first time, users can use one of the four options available: (1) direct entry for arrayed variables, (2) copy and paste, (3) importing from an Excel spreadsheet for arrayed variables, or (4) the customized spreadsheet. As those values are expected to be constant during the simulation, it is expected that those values would not be modified in the simulation or what-if analysis.

Labour Land Ratio Converter
Units: person/hectare

[36] By making the last row and column the household sector, the model is said to be closed with respect to households. As a result, the implicit multipliers involved in changes in final demand include the impacts of spending induced by new income.

(Return to the Agriculture Module)

Each ratio indicates the person-years of labour (measured in full-time equivalents, or FTE) required from each education level per hectare of each production system. For example, a value of 0.002 in the primary education row and mixed livestock production systems columns (see table below) means that for 1 hectare of the mixed livestock production systems 0.002 FTE of labour with primary education is required each year.

Labour Land Ratios		**Production systems (j)**							
		Mixed Livestock	Granivores	Beef Cattle	Sheep & Other	Other ag system	Agroforestry	Forestry	Other System
Education level (i)	In Primary	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Primary	**0.002**	**0.003**	**0.002**	**0.003**	**0.002**	**0.003**	**0.002**	**0.002**
	In Secondary	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Secondary	**0.005**	**0.008**	**0.005**	**0.008**	**0.005**	**0.008**	**0.005**	**0.005**
	In Tertiary	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Tertiary	**0.003**	**0.005**	**0.003**	**0.005**	**0.003**	**0.005**	**0.003**	**0.003**

It is assumed that students do not work in the labour force. Thus, labour land ratios that correspond to in-primary, in-secondary, and in-tertiary education should be zero.

It may be difficult or impossible to estimate the education level required for these tasks. If this information is not known, then the user must apply the overall education levels of agrarian workers. For example, if it is known that 20% of agrarian workers are have a primary education, 50% have a secondary education, and 30% have a tertiary education, these percentages should be applied to the estimated labour demand in each production system. It may also be difficult to estimate the total labour required per hectare by each production system. These numbers must be estimated from known full-time and part-time farms in the study area, or from reasonable estimates by experts.

To incorporate these values for the first time, users can use one of the four options available: (1) direct entry for arrayed variables, (2) copy and paste, (3) importing from an Excel spreadsheet for arrayed variables, or (4) the customized spreadsheet. As those values are expected to be constant during the simulation, it is expected that those values would not be modified in the simulation or what-if analysis.
Labour Output Ratios Converter
Units: persons/thousands of euros
(Return to the Region Module)

These values represent the number of workers with each education level demanded per one thousand of euros of output in each sector. We assume that students do not work and thus in-primary, in-secondary, and in-tertiary are zero.

Labour Output Ratios		Sectors (j)																						
		Energy	Meat	Other food processing	Milk processing	Textile	Paper	Chemicals	Construction Machinery	Metals	Other Machinery	Automobiles	Furniture	Energy Dist	Construction	Trade	Tourism	Households	Transport	Post	Banking	Public	Recreational	Others
Education level (i)	In Primary	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Primary	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	In Secondary	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Secondary	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	In Tertiary	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tertiary	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

To incorporate these values for the first time, users can use one of the four options available: (1) direct entry for arrayed variables, (2) copy and paste, (3) importing from an Excel spreadsheet for arrayed variables, or (4) the customized spreadsheet. As those values are expected to be constant during the simulation, it is expected that those values would not be modified in the simulation or what-if analysis.

Land Requirements Converter
Units: proportions
(Return to the Land Module)

Each value represents the proportion of total land required by each production system that comes from each land type. For example, the values in the beef cattle column (see table below) mean that of each hectare of land required by beef cattle 0.1986 (or 19.86%) must be crop land, 0.3422 hectares must be grass land, and 0.4582 must be forest land.

Land Requirements		**Production Systems (j)**							
		Mixed Livestock	Granivores	Beef Cattle	Sheep & Other	Other ag system	Agro-forestry	Forestry	Other Systems
Land Types (i)	Annual_crop_land	0.192	0	0.1986	0.1772	0	0	0	0
	Perm_crop_land	0	0	0	0	1	0	0	0
	Grass_land	0.3318	0	0.3422	0.3061	0	0	0	0
	Forest_land	0.4762	0	0.4582	0.5168	0	1	1	0
	Other_land	0	0	0	0	0	0	0	1

It is important to notice that *the sum of each production system (column) should be equal to 1.*

To incorporate these values for the first time, users can use one of the four options available: (1) direct entry for arrayed variables, (2) copy and paste, (3) importing from an Excel Spreadsheet for arrayed variables, or (4) the customized spreadsheet. As those values are expected to be constant during the simulation, it is expected that those values would not be modified in the simulation or what-if analysis.

Livestock Coefficients Converter
Units vary
(Return to the Non-Commodities Module)

These coefficients represent the number of livestock units per hectare per year. Livestock units are defined for different types of animals as follows:

	Livestock units equivalence
Dairy cows	1
Dairy Followers	0.5
Suckler Cows	0.75
Finishing Beef sold	1
Breeding Ewes	0.08
Finishing Lambs sold	0.04

Because the numbers of animals typically change during the year, we suggest a weighted (by time) annual average.

To incorporate these values for the first time, users can use one of the four options available: (1) direct entry for arrayed variables, (2) copy and paste, (3) importing from an Excel spreadsheet for arrayed variables, or (4) the customized spreadsheet. As those values are expected to be constant during the simulation, it is expected that those values would not be modified in the simulation or what-if analysis.

Local Higher Education Rate Converter
Units: proportion, 0 to 1
(Return to the Human Resources Module)

This is a constant value. The local higher education rate is the proportion of secondary-school graduates that continue onto higher education (tertiary education) at a local institution. The remaining graduates are assumed to leave the region after completing secondary school or join the local labour force (1-local higher education rate-exit rate).
To incorporate these values for the first time, users can use one of the four options available: (1) direct entry for non-arrayed variables, (2) copy and paste, (3) importing from an Excel spreadsheet for non-arrayed variables, or (4) the customized spreadsheet. As those values are expected to be constant during the simulation, it is expected that those values would not be modified in the simulation or what-if analysis.

Migration Shares and Dependents Converters
Units: proportion, 0 to 1
(Return to the Human Resources Module)

Because immigrating workers who respond to changing labour demand or quality of life will often have families with both young and elderly members, these two converters should be determined together.

One way to estimate these proportions is to use the demographic structure of national migrants and apply these to the regional in-migrant process. The following example describes how a model user may calculate the migration and dependent shares:

1. Assume the average household (active in the labour force) has 1.5 adults (0.15 aged 0-19, 0.6 aged 20-39, 0.75 aged 40-64), 0.45 dependent children and 0.03 retirees.
2. Normalizing on the number of working adults (i.e., dividing by the number of adult members of the workforce) gives 0.1 persons 0 to 19, 0.4 persons 20 to 39, and 0.5 persons 40 to- 64 in the workforce.
3. The dependents are then normalized using the same denominator giving .2 students in primary school, 0.1 students in secondary school, and 0.02 retirees as dependents. (Note: Retirees may be distributed among education groups if known, but this is not important to model results.)

Age Group	**Average household with working age members**	**Migration Share Coefficients**	**Dependents Coefficients**
0-19 In primary or preschool	0.30		0.20
In secondary	0.15		0.10
In labour force	0.15	0.10	
20-39	0.60	0.40	
40-64	0.75	0.50	
>65	0.03		0.02
Total Working Aged persons	**1.50**	**1.00**	

For the Migration Shares Converter, only the primary-, secondary-, and tertiary-educated categories should contain non-zero values. *Note that the columns should always sum to 1*

Migration Shares		**Education level (j)**					
		In Primary	**Primary**	In Secondary	**Secondary**	In Tertiary	**Tertiary**
Cohorts (i)	Age 0_19	0	**0.1**	0	**0.1**	0	0
	Age 20_39	0	**0.4**	0	**0.4**	0	**0.4**
	Age 40_64	0	**0.5**	0	**0.5**	0	**0.6**
	Age 65 plus	0	0	0	0	0	0

For the Dependents Converter, values can be established for dependents aged 0 to 19 in primary and in secondary school, and possibly retirees with primary, secondary, or tertiary education.

Dependents		**Education level (j)**					
		In Primary	Primary	In Secondary	Secondary	In Tertiary	Tertiary
Cohorts (i)	Age 0_19	**0.2**	0	**0.1**	0	0	0
	Age 20_39	0	0	0	0	0	0
	Age 40_64	0	0	0	0	0	0
	Age 65 plus	0	**0.0067**	0	**0.0067**	0	**0.0067**

To incorporate these values for the first time, users can use one of the four options available: (1) direct entry for arrayed variables, (2) copy and paste, (3) importing from an Excel spreadsheet for arrayed variables, or (4) the customized spreadsheet. As those values are expected to be constant during the simulation, it is expected that those values would not be modified in the simulation or what-if analysis.

NCO Production Systems Coefficients Converter
Units vary
(Return to the Non-Commodities Module)

Each coefficient represents the quantities of non-commodities produced by one unit (hectare) of each production system. These coefficients only apply to the mineral fertilizer, excess nitrogen, biodiversity, and CO2 balance. Other non-commodities (land types, Shannon converter, land cover change, and livestock unit per hectare) are determined in other converters.

NCO PS Coefficients		Production Systems (j)							
		Mixed Livestock	Granivores	Beef Cattle	Sheep & Other	Other ag system	Agro-forestry	Forestry	Other Systems
Non Commodities (i)	Forest_%	0	0	0	0	0	0	0	0
	Arable_ land_ %	0	0	0	0	0	0	0	0
	Grassland _%	0	0	0	0	0	0	0	0
	Permanent_ Crops_ %	0	0	0	0	0	0	0	0
	Shannon Index	0	0	0	0	0	0	0	0
	Mineral Fertilizer	**600**	**0**	**600**	**0**	**0**	**0**	**0**	**0**
	Excess Nitrogen	**1800**	**10**	**1800**	**0**	**0**	**0**	**0**	**0**
	Biodiversity	**0.63**	**0**	**0.13**	**0.16**	**0**	**1**	**1**	**0**
	Livestock_units per_hectare	0	0	0	0	0	0	0	0
	Land_cover_ change	0	0	0	0	0	0	0	0
	CO2_Balance	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

The following are the interpretation of each of the non-commodity coefficients that are subject to modification:

Row 6: Mineral fertilizers for each production system (units: kg/ha). The kg of mineral fertilizer used per hectare per year.

Row 7: Excess nitrogen (units: kg/ha). This is the surplus of nitrogen applied over that used by plants.

Row 8: Biodiversity (units: proportion, 0 to 1). This represents the proportion of utilized agriculture area under low-input farming systems.

Row 11: C02_Balance (units: CO2/ha). This indicator records the net release of CO2 per hectare each year. It can be positive or negative (in the case of net sequestration).

To incorporate these values for the first time, users can use one of the four options available: (1) direct entry for arrayed variables, (2) copy and paste, (3) importing from an Excel spreadsheet for arrayed variables, or (4) the customized spreadsheet. As those values are expected to be constant during the simulation, it is expected that those values would not be modified in the simulation or what-if analysis.

QOL Coefficients Converter
Units: proportion

(Return to the Quality of Life Module)

These coefficients represent the proportion of net migration (in migration – out migration) of each cohort due to changes in each type of capital. Only natural and material capitals are being used at this time.

QOL Coefficients		**Cohorts (j)**			
		Age 0_19	Age 20_39	Age 40_64	Age 65 plus
Capital (i)	**Natural capital**	**-0.13138**	**0.445757**	**0.445757**	**0.248794**
	Material capital	**0.285505**	**0.294772**	**0.294772**	**0.14503**
	Human capital	0	0	0	0
	Cultural capital	0	0	0	0
	Social capital	0	0	0	0

The sum of each coefficient by capital (rows) should equal 1.

To incorporate these values for the first time, users can use one of the four options available: (1) direct entry for arrayed variables, (2) copy and paste, (3) importing from an Excel spreadsheet for arrayed variables, or (4) the customized spreadsheet. As those values are expected to be constant during the simulation, it is expected that those values would not be modified in the simulation or what-if analysis. Values only need to be changed if the QOL regression is re-estimated with new data.

Secondary Education Rate Converter
Units: proportion, 0 to 1
(Return to the Human Resources Module)

This converter is a constant value that represents the rate of participation in secondary education. It applies only to those students completing primary school.

To incorporate these values for the first time, users can use one of the four options available: (1) direct entry for arrayed variables, (2) copy and paste, (3) importing from an Excel spreadsheet for arrayed variables, or (4) the customized spreadsheet. As those values are expected to be constant during the simulation, it is expected that those values would not be modified in the simulation or what-if analysis.

Specific Data Entry Instructions: Dynamic data

This section gives detailed instructions for entering data used to set up scenarios. These data are dynamic in the sense that they can change continuously during model runs. All of these converters employ Graphic Input Devices. In order to incorporate these values, users should see the section on Entering Data Using a Graphical Function or Entering Data Using the Customized Spreadsheets. It is important to remember that changes made in these devices are temporary; that is, an increase in final demand in 2010 will last only for that year. If the change is permanent, the new value must be entered in all years after 2010.

Ag Prices Converter
Units: euros
(Return to the Agriculture Module or the Policy Controls Module)

This converter is used to introduce real agricultural prices over the length of the simulation. Changes in these real prices should reflect trends and/or policy interventions. To incorporate this data, users should enter data directly in the graphical function or use a customized spreadsheet.

Average Days of Stay Converter
Units: days
(Return to the Tourism Module or the Policy Controls Module)

This is the average number of days that tourists are assumed to stay in the area. To incorporate this data, users should enter data directly in the graphical function or use a customized Spreadsheet.

Break-Even Occupancy Converter
Units: proportion, 0 to 1
(Return to the Tourism Module or the Policy Controls Module)

This value represents the occupancy rate at which hotels begin to add beds. Break-even occupancy should be that level where each new bed can pay variable costs and cause a return on investment. To incorporate this data, users should enter data directly in the graphical function or use a customized spreadsheet.

Change in Land Use Converter
Units: hectares
(Return to the Land Module or Policy Controls Module)

This converter is used when changes are made to the original land use numbers in order to introduce trends and/or policy interventions. This converter has been preset as a graphical function. To incorporate this data, users should enter data directly in the graphical function or with a customized spreadsheet.

Important Note: The user must ensure that the net effect of change in land use is zero. For example, if 1,000 hectares of land changes from production system 1 to production system 2, then 1,000 should be entered in production system 1 and -1,000 hectares in production system 2. The changes should start at the same time and be equal and opposite throughout the entire simulation. Also, the change using this method lasts only as long as the input continues. For example, if 1,000 is entered in the graphical function for production system 1 for one year and is then returned to zero, the model returns the land use levels to the original numbers.

Commodity Subsidies Converter
Units: euros
(Return to the Agriculture Module or the Policy Controls Module)

This converter permits the entry of subsidies provided to farmers for the production of agricultural commodities. Values should reflect the euros of subsidy per unit of commodity. This converter has been preset as a graphical function. To enter this data, users should enter data directly in the graphical function or use a data entry spreadsheet.

Daily Arrival Capacity Converter
Units: persons
(Return to the Tourism Module or the Policy Controls Module)

This is the maximum number of new guests that can be accommodated each day (airports, buses). This capacity should be expressed in number of arriving tourists. To incorporate this data, users should enter data directly in the graphical function or use a customized spreadsheet.

Exogenous Expenditures and Income Converter
Units: thousands of euros
(Return to the Policy Controls Module or the Region Module)

This converter is used only when exogenous changes are made to agricultural expenditures or income in order to introduce trends and/or policy interventions such as:

1. *Changes in expenditures from one sector to another*. For example changes in technology may lead to lower chemical use and more energy use. In these cases the sum of all exogenous expenditures and income must add-up to zero for each year (see important note below).
2. *Changes in cost of production*. For example, an increase in price would increase expenditures on the affected sector and decrease income for households. Again, in these cases the sum of all exogenous expenditures must be zero each year (see important note below).
3. *Changes in final demand* (expenditures or income from external sources). For example, if a Leader program were to inject additional purchases from certain regional sectors then this converter could be used. Note that in these cases the sum of changes may be positive or negative.

Also note that changes introduced here are not affected by the Final Demand Growth Rate Converter.

To incorporate this data, users should enter data directly in the Graphical Function or use a data entry spreadsheet.

Important Note: The user must be careful to make consistent changes in this converter. If change shifts expenditures from one sector to another or from net income to additional inputs, then the net effect of changes should be zero. For example, if a scenario indicates that 1,000 thousands of euros must be shifted to expenditures on the energy sector, this would imply that farmers (and households in this case) would have 1,000 fewer thousands of euros available to spend. The changes should start at the same time and be equal and opposite throughout the entire simulation. Also, the change using this method lasts only as long as the input continues. For example, if 1,000 thousands of euros of expenditure is entered in the graphical function for sector 1 for one year and is then returned to zero, the model returns the input demands from agriculture to the original numbers.

Final Demand Growth Rates Converter
Units: proportion, 0 to 1
(Return to the Policy Controls Module or the Region Module)

These values represent the annual growth in final demand in each sector. To incorporate this data, users should enter data directly in the graphical function or with a customized spreadsheet.

Labour Force Participation Converter
Units: proportions, 0 to 1
(Return to the Human Resources Module or the Policy Controls Module)

This converter is the proportion of the total population by age and education level that is active in the labour market. It is assumed that members of the 65 years and over cohort do not participate in the labour force. For the rest, the model requires participation rates for each education level.

Labour Force Participation		**Education level (j)**					
		In Primary	Primary	In Secondary	Secondary	In Tertiary	Tertiary
Cohorts (i)	**Age 0_19**	**0**	**0.8**	**0**	**0.8**	**0**	**0**
	Age 20_39	**0**	**0.6**	**0**	**0.6**	**0**	**0.8**
	Age 40_64	**0**	**0.8**	**0**	**0.8**	**0**	**0.8**
	Age 65 plus	0	0	0	0	0	0

It is important to note that people pursuing a degree are not considered part of the labour force. A value of 0.8 for the 0-19, secondary population group means that 80% of the 0-19 population with a *secondary degree* are in the labour force. To incorporate this data, users should enter data directly in the graphical function or with a customized spreadsheet. Changing values directly in the converter on the model window changes the default.

Land Subsidies Converter
Units: euros
(Return to the Agriculture Module or the Policy Controls Module)

This converter represents the subsidies paid to farmers on the basis of hectares of particular land types. Values should reflect the euros paid per hectare. This converter has been preset as a graphical function. To incorporate this data, users should enter data directly in the graphical function or with a data entry spreadsheet.

Minimum Occupancy Rate Converter
Units: proportion, 0 to 1
(Return to the Tourism Module or the Policy Control Module)

This converter is the occupancy rate at which hotels no longer cover their variable costs and begin to reduce beds. To incorporate this data, users should enter data directly in the graphical function or the data entry spreadsheet .

Potential Annual Tourists Converter
Units: persons

(Return to the Tourism Module or the Policy Control Module)

This converter represents the number of tourists expected to visit the region annually in the base year if the regional attractiveness change is 0.0 and there are no constraints caused by hotels or transportation limits. If this value is unknown, an alternative is to use the current total annual number of tourists that visit the region during the base year. Users should not confuse this value with the initial hotel beds. To incorporate this data, users should enter data directly in the graphical function or use a customized spreadsheet.

Price per Bed Converter
Units: euros
(Return to the Tourism Module or the Policy Controls Module)

This value represents the average revenue obtained by each visitor on tourism (hotels, bed and breakfasts). It is assumed that this revenue is spent in the tourism sector.
To incorporate this data, users should enter data directly in the graphical function or use a customized spreadsheet.

Production System Subsidies Converter
Units: euros
(Return to the Agriculture Module or the Policy Controls Module)

This converter reflects the subsidies provided to farmers for hectares of particular production systems. Values entered here should be on a per hectare basis. This converter has been preset as a graphical function. To incorporate this data, users should enter data directly in the graphical function or with a customized spreadsheet. Changing values directly in the converter on the model window changes the default.

Related Daily Expenditures Converter
Units: euros
(Return to the Tourism Module or the Policy Controls Module)

This value represents other revenues coming from daily expenditures derived from the current visitors. It is assumed that this revenue is spent in the recreation sector of the economy and is in addition to that amount spent on hotels. To incorporate this data, users should enter data directly in the graphical function or use a customized spreadsheet.

Seasonality Index Converter
Units: 0 to 1
(Return to the Tourism Module or the Policy Control Module)

This value represents the seasonality index, values of which vary from 0.0 (no seasonality) to 1.0 (maximum seasonality). A value of 1 means that seasonality is extreme and the lowest point of the season is zero; whereas 0 implies that the flow is even throughout the year. Users can obtain this value by dividing the difference of the maximum and minimum number of tourists by the maximum number of tourists. To incorporate this data, users should enter data directly in the graphical function or use a customized spreadsheet.

Seasonal Peak Converter
Units: 0 to 12
(Return to the Tourism Module or the Policy Control Module)

This value represents the point where the maximum demand is realized during the year. It is roughly based on months. January 1 at 0:00 hours is 0; August 1 is about 7. To incorporate this data, users should enter data directly in the graphical function or use a customized spreadsheet

Transfer Income Converter
Units: thousands of euros
(Return to the Policy Controls Module or the Region Module)

This converter represents a constant extra income that households receive. This converter is designed to accommodate income received by retirees, since this income is not related to regional economic activity. It can also be used to introduce changes in income-support programs that increase or decrease the income of individuals regardless of their employment status. To incorporate this data, users should enter data directly in the graphical function or with a customized spreadsheet. Changing values directly in the converter on the model window changes the default.

Travel Capacity Converter
Units: persons
(Return to the Tourism Module or the Policy Controls Module)

This is the maximum number of current guests that roads (or other types of infrastructure other than hotel beds) can accommodate at any given time. This capacity should be expressed in number of tourists. When the number of tourists in the region reaches this level, no more will be allowed to enter the region until some leave or the constraint is relaxed through policy. To incorporate this data, users should enter data directly in the graphical function or use a customized spreadsheet .

Unemployment Rate Converter
Units: proportion, 0 to 1
(Return to the Human Resources Module or the Policy Controls Module)

This represents the unemployment rate for each education level. It is assumed that people pursing a school or higher degree are not looking for job and they are not unemployed. To incorporate this data, users should enter data directly in the graphical function or use a customized spreadsheet.

Step by Step Instructions for Setting Up and Testing POMMARD

Step 1: Make a list of the elements (categories) in each dimension of your model.

The core model has eight dimensions with a number of elements with predetermined names. These are described in the section Categories (elements) in the Core Model. Each study area model will potentially have a different number of elements with different names.

Step 2: Update and customize the Composite Input Template spreadsheet and Baseline Scenario spreadsheet so that they contain the correct number of elements (categories) in each array.

The two input spreadsheets provided with the core model assume the number of elements and names used in the core model (see the section Categories (elements) in the Core Model). Teams must customize their spreadsheets to match their model. To do this, follow the instructions in the section Entering Data Using the Customized Spreadsheets. Do not forget to save both customized spreadsheets.

Step 3: Update the data input spreadsheets with data for your study area.

Aside from Composite (from the Composite Input Template 1.1) and Baseline Scenario (from the Baseline Scenario), the user must complete information according to the variables indicated for each of the following pages.

Step 4: Change the name of the elements (categories) in your model.

Users must amend the core model to reflect the list of elements in step 1. Follow the instructions described in the section Adding/Changing Elements in the Categories. Do not forget to save.

It is important to note that changing the name and number of elements in each dimension in the model may affect some formulas and dimensions of some converters. The user should refer to the "Caution" subsection in the Adding/Changing Elements in the Categories for guidance during this step. Do not forget to save.

Step 5: Import the data from the Composite Input Spreadsheet into the POMMARD model.

Once you have customized both the spreadsheets and the model, it is time to import the data into the model. Until users are familiar with this procedure, they should follow the instructions in the section Entering Data Using the Customized Spreadsheets. Do not forget to save.

Step 6: Check question marks ("?") symbols.

After adding data and/or changing formulas, some converters, stocks, or flows will typically have a question mark on them. This indicates that they require more data or have not yet updated within the model. The model will not run until all question marks are dealt with. In order to update these converters, flows, and stocks, it is often enough to double-click on them to open them and then press OK in the dialog box. This resets them. If the question mark remains, this indicates that additional changes are needed. Do this with all the converters, flows, and stocks where a question mark symbol appears. Do not forget to save from time to time.

If the dialog box does not close because of a message such as *"Was expecting ,"* the customization of either the spreadsheets or the model was incorrect and the user should look for the problem.

Step 7: Run the program.

At the left bottom corner of the Model Window there are Run, Fast Forward, Stop, Loop Off and Restore all Devices icons. Click on the Run icon to run the program.

Inconsistencies in the data can cause one of several problems while the model is running. If these problems arise, a message explaining the reason for the problem will appear. Problems may be due to inconsistencies in the values of the variables (values too big, values equal to zero, values outside the ranges, etc). The user should consider the messages carefully in order to determine the cause of the problem.

Step 8: Identify inconsistencies in the data by running the model out to equilibrium.

In order to determine whether your input values are consistent, you will want to run the model without changing conditions out enough years to find equilibrium values. To do this, follow these steps:

1. Make sure there are no sources of change in the scenario assumptions. The variables Change in Land Use, Exogenous Expenditures and Income, Final Demand Growth Rates, Commodity Subsidies, Production Systems Subsidies, and Land Subsidies should have zero values in all cells in the input spreadsheet, whereas all other variables should have the same base year values for all periods of analysis. Save the spreadsheet when you are sure that it has no changes in it.
2. Go to the Run Specs Menu and change the year's box "To" from 2026 to 2101.
3. In the program, be sure that the On for No Change is On.
4. Import the customized spreadsheet to the model.
5. Run the model.
6. Go to the Interface level and open the Tabular Projections. Print these or export them to a spreadsheet.
7. Check the final year numbers with your initial year numbers and you will immediately see which data or assumptions are causing early year disequilibria. Suggestions for probable causes are given in the manual.
8. Correct any errors you find.
9. Redo this process until you find all the possible inconsistencies and the model quickly finds equilibrium not too different from the beginning levels.

Step 9: Turning the On for No Change Switch Off and running the model.

Click the On for No Change switch to allow the feedback from the QOL module. This should create more change in most of the variables. If the change is too great, then check your assumptions about Transfer Income, Migration Shares, and other determinants of per capita income.

Step 10: Start testing the scenarios.

Once you are satisfied that the model is working well for the No Change and QOL migration cases, you are ready to test the model with scenarios. The first scenario to test is the main baseline. In this case, enter the changes between January 1, 2001, and December 31 2007, and projected changes from January 1, 2008, to the end of the simulation, January 1, 2026. The variables that should be changed are:

- Ag Prices
- Average Days of Stay
- Break-Even Occupancy Rate
- Change in Land Uses
- Commodity Subsidies
- Daily Arrival Capacity
- Exogenous Expenditures and Income
- Final Demand Growth Rates
- Land Subsidies
- Minimum Occupancy Rate
- Potential Annual Tourists
- Price per Bed
- Production System Subsidies
- Related Daily Expenditures
- Seasonal Peak
- Seasonal Index
- Transfer Income
- Travel Capacity
- Unemployment Rates

The manual contains detailed instructions for estimating and entering these data. If the projections change dramatically, check units and assumptions and rerun.

Step 11: Start analyzing!

Developing Scenarios and What- If Analysis

Developing Scenarios

It is expected that the user will work with the Scenario Spreadsheet from the Entering Data Using the Customized Spreadsheets section. This spreadsheet contains a Main Scenario Sheet (or Baseline Scenario) and 7 Alternative Scenarios Sheets (A-F). While the former assumes constant rates of changes in exogenous factors, the latter focuses on policy changes or what if analyses. In addition, users have the option to use converters available at the Policy Controls Module in order to construct scenarios, although the first technique is preferable.

Scenarios are intended to be comparative, either with the Main Scenario of with any other Alternative Scenario created by the user. When developing scenarios it is important that the user considers the following issues:

1. The units of the variables—are they changes, absolutes values, or rates?
2. The time characteristics of the variables. Most are annual totals or rates but some variables in the Tourism Module are on a daily basis.
3. The *dt* value. Again, the Tourism Module is different from the other modules. To reflect accurate dynamics, the model requires a smaller *dt* value (such as 0.01 instead of 0.25)
4. The On for No Change. This switch is used to disable the Quality of Life Module which is highly affected by changes in the per capita income, population and changes in land forest. The user needs to analyze both main and alternative scenarios having this swift either on or off.
5. The nature of the policy change converters. Most of these converters are graphical inputs which mean that for every period of the analysis a value must be incorporated. If no values are incorporated for a particular year, the converter will assume that the value will be zero.
6. Several variables may be changed by the user but this does not imply that all of those variables should be altered for every scenario. For those that are not altered, their values must be those from the Main Scenario.

Tools for Developing Scenarios

In order to track changes when developing scenarios, users may create comparative graphs or tables for the variables of interest. The core model has a variety of graphs and tables incorporated, but the user will typically add more.

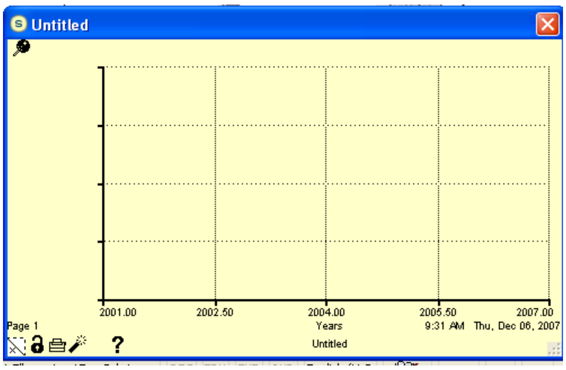
Comparative graph

1. From the Model level, click on the graph pad icon from the tool bar menu.

Figure A.21 The Tool Bar Menu

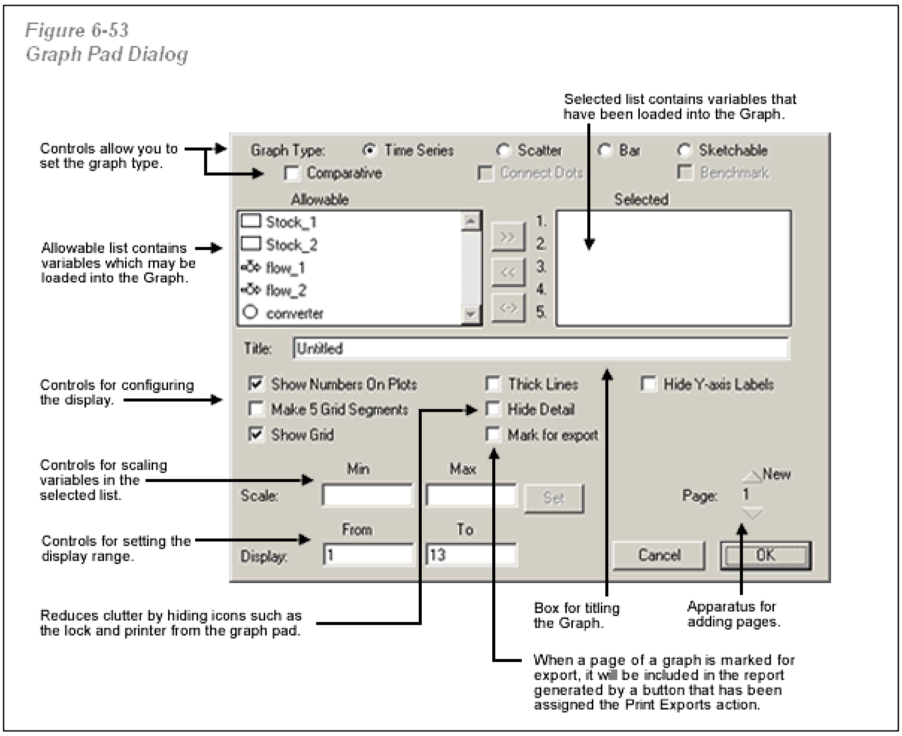
2. A graph page will appear. To see the pattern of the variable of interest while the model is running, make sure the pin button from the graph is in the downward position. Unpin it by clicking again.

Figure A-22: The Graph Page



3. Click in the area of the graph to get into the graph pad dialog.

Figure A.23 Graph Pad Dialog



4. From this dialog menu, ensure that the comparative option is clicked. In comparative analysis you may compare one variable per graph during five different scenarios. It is also possible to add more pages in order to see other variables (one per page) for the different scenarios using the page submenu on the graph pad dialog (this submenu is on the bottom right) using the up or down arrows.
5. To load a variable that you wish to visualize, double-click on the variable of interest in the allowable list or click it once and click on the >> button. Several options are allow in this menu: you can change the display range, add a title, or scale your variable to minimum and maximum values. To see more about the different scale options, see the "*Graph Pad Operations*" in the Help Menu.
6. Run the zero scenario analysis for the first time. Then make the changes in the different converters in order to simulate scenarios. Run the model again. The user can do this up to five times. The zero and the alternative scenarios will be graphed on the same graph page.

Comparative Table

1. From the Model level, click on the table pad icon from the tool bar menu.

Figure A-24: The Table Page

2. A graph page will appear. To see the pattern of the variable of interest while the model is running, make sure the pin button from the table is in the downward position. Unpin it by clicking again.

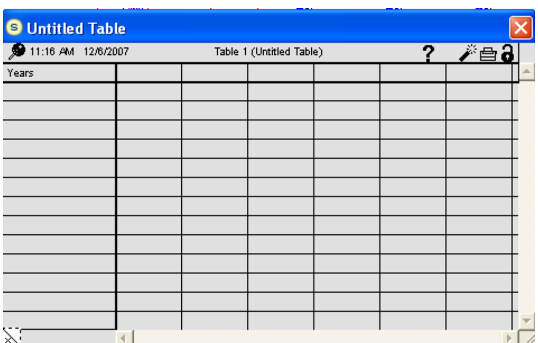
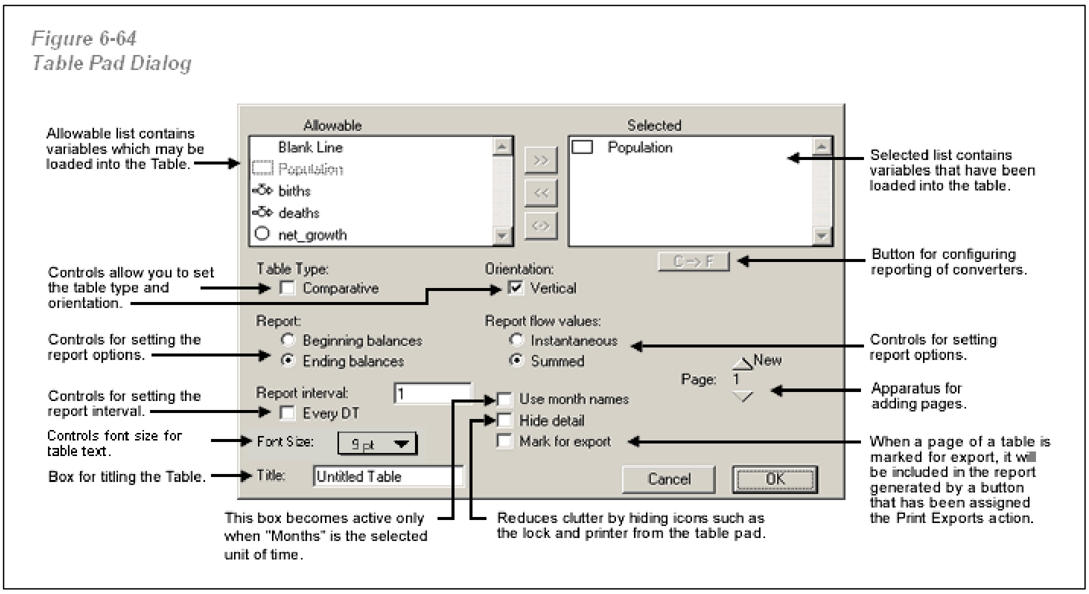


Figure A-25: The Table Page

3. Click in the area of the table to get into the table pad dialog.

Figure A.26 Table Pad Dialog



4. From this dialog menu, make sure the comparative option is clicked. In comparative analysis you have the option to compare one variable per table during five different scenarios. It is also possible to add more pages in order to see other variables (one per page) for the different scenarios using the page submenu on the table pad dialog (this submenu is on the bottom right) using the up or down arrows.
5. To load a variable that you wish to visualize, double-click on the variable of interest in the allowable list or click it once and click on the >> button. You also have the option to see the values in each *dt* time by ensuring that this option is clicked. You can also add a title to the table.
6. Run the zero scenario analysis for the first time. Then make the changes in the different converters in order to simulate scenarios. Run the model again. The user can do this up to five times. The zero and the alternative scenarios will be graphed on the same table page.

Note: The user can erase the contents of comparative graphs (restore values) by going to the Interface Tool Box from the Interface Window and clicking on Restore Graphs and Tables.

Trouble Shooting

This section covers some of the more common problems encountered when setting up and using the model.

Removing Unwanted Dimensions and Elements

As you set up the model and test it, it is easy to add unwanted dimensions and elements. This is especially true at the end position. This happens when you click the down arrow when you are at the last element. Stella assumes you want to add another element and gives you a new element with a number. For example, if you have six categories and you see a seven or higher in the Element Name/# then you have an extra element. To correct this, click Delete until you see the last element name in the box and New above the down arrow.

Out of Memory Alerts

Whenever you attempt to do something that requires more RAM than has been allocated to the software, you will receive an alert that states you are out of memory. When you run out of memory, there is no recourse but to quit the program. You have the option of saving your model under a different name, thus preserving any work that you have done since the last Save command. Below are listed typical causes of this alert as well as some memory-expanding options.

1. Causes of Out of Memory Alert:

- Too much output in comparative graphs/tables. The output displayed in comparative tables and graphs is stored in RAM. As a result, a multiple-run sensitivity analysis with several comparative graphs/tables can quickly consume much of the memory allocated to the software.

- Long simulations with small *dt*. Memory requirements for a simulation increase proportionally with the length of the simulation, and inversely with the size of *dt*. Longer simulations and smaller *dt* will require more memory.

- Analyze mode. When this option is turned on in the Run Specs dialog, model output for all model variables is stored in RAM. With various combination of a large model, a long simulation, and a small *dt*, memory can very quickly be consumed.

2. Memory-Expanding Options:

- Save your work early and often. In so doing, you will minimize the amount of work you will lose if your machine ever "crashes."

- Periodically clear the data displayed in comparative graphs and/or tables. Choose Restore Graphs and Tables from the Interface or Model menu to clear the data. This will free a corresponding amount of memory in RAM.

- Get more RAM or a new computer.

Model is running too slow, gives a message that the length of simulation is too great, or gives erratic results

If the model is running too slow or it is generating erratic outputs (large swings in data series), or if you get an alert that says "The length of simulation is too great for this value of dt," check *dt* by clicking on Run in the main menu, and then Run Specs. *DT* can be changed by entering a number in the *dt* box. Click OK and try it again.

To speed up the simulation, try the following:

1. Close all graphs and tables while the simulation is running. Then open them up after the simulation is complete to review the results.

2. Visit the Run Specs dialog and ensure that the Sim Speed box is set to 0.

3. Increase the *dt*. This will reduce the precision or estimates and introduces volatility into the dynamics, but it may pay to accept these problems during test runs. Final runs may be made at a small *dt* level.

Appendix 1: Tips

These are tips that could help the user avoid inconsistencies in the model:

1. After you have changed all the element names and assured that you have the right number of elements in each dimension, you will need to assure that those converters that refer to the household sector have the correct formula (*Other Final Demand*, *Ag Income Change* and *Per Capita Income*). In the core model the household sector is element No 23 of the sectors dimension, but because the user will have a different number of sectors, this will usually be different than 23. For more see the Adding/Changing Elements in the Categories

2. Another converter that must be changed to match your sectors when change in the number or name of the elements is *Total Tourism Expenditures*. This converter takes the two kinds of tourism expenditure (expenditures on rooms and related expenditures) and converts them into final demand for regional production. The expenditures on rooms should be put in the element for hotels and the related expenditures should be divided between whatever sectors you believe are affected, usually the recreation sector, service sector, transportation sector, and so on. This can be done by multiplying related expenditures by a proportion that goes to that sector and putting that formula in the appropriate element of the converter.

3. Remember that final demand for tourism sectors should not include the amount that is predicted by the tourism module. If your estimated final demand for hotels and restaurants includes tourist purchases, then the initial levels of total tourism expenditures should be subtracted from the final demand for these sectors.

4. After you have imported the data, you will see that a number of converters, flows, and stocks have question marks. This occurs because the model has not reset itself. You can do this by opening each converter and clicking OK. Usually no change to the converter is needed. If this does not eliminate the question mark, then there is something incorrect about the data input sheet or something about the converter needs to be changed.

5. The POMMARD model will frequently predict rapid changes in the early years of the simulation. This is because initial conditions are significantly different from equilibrium levels. This is typically due to the accumulative effects of inaccuracies in initial conditions and coefficients.

6. If your data have largely come from a balanced SAM or regional accounts, then most data will be approximately right. In some cases the problem may be due to inconsistencies in units.

7. The user can trace the cause of the instability by doing the following:
    - Follow Step 8 from Chapter 6.
    - Check the sectoral production levels. If a particular sector's production level has increased or decreased dramatically, then either the initial production or the final demand is wrong. This typically leads to high levels of migration to balance the labour market, but check the production levels first. If output levels are within 50% of initial levels, the discrepancy is probably due to something else.
    - There are a number of possible inconsistencies stemming from the agriculture sector. If labour output, input coefficients, or output coefficients are too far off, this leads to

large or small demands for regional production, large or small levels of income, large or small demands for labour, and so on.

- As you correct some of these areas, most other levels will converge on the stable levels faster.
- If overpopulation levels are fairly stable but particular cohorts are very small or very large compared to originals, check the birth rates and death rates.
- When checking your data, it is probably useful to compare it with the data in the core model. Most of these are artificial, but they are at least in the correct range (order of magnitude). If your numbers are 10 times or larger, or less than 1/10, then they are probably wrong.

When I hover over a converter, certain data appear, but if I click on the converter and open it, I see different numbers. How is this possible?

When you change data using a spreadsheet, the program incorporates the numbers internally but “the picture” of the data has not been updated. In order to make that happen, save the model and run it. Then it is possible to see that the numbers are updated in both the converter and in its converter window.

Why, after changing the number of elements, do some converters, flows, or stocks have questions marks inside them?

When you change the number of elements or even the name of the elements[37], questions marks arise because the program has not reset itself. The user can do this by opening each converter and clicking OK. No change to the converter will usually be needed. If this doesn't eliminate the question mark, then there is something incorrect about the data input sheet or something about the converter needs to be changed.

Could the IO coefficients be the cause of instability in the early years?

The IO coefficients have a very minor impact on the initial conditions. They are used to estimate the near equilibrium intermediate demand levels. Unless the coefficients are too large (columns sum to 1.0, which means that there are no leakages in the economy), the IO coefficients cannot cause instability. Make sure that the IO coefficients correspond to the *A* matrix and not to the *Multipliers* matrix (from X=AX + Y).

Instability in production usually stems from initial conditions that are above or below the equilibrium levels. One way to determine the source of the instability is to run the model with no external changes until it achieves the long run equilibrium levels. Follow the instructions from Step 8 in Chapter 6. Create tables and/or graphs to help you see where the instabilities seem to be coming from.

In addition, the user can compare the total production with the total initial final demand and make sure that the latter is not larger than the former[38].

Finally, another trick is to compare the total population with the total initial production in order to obtain the average production per person. Check whether this average makes sense for your region. High or low levels in average production per person can cause instability.

[37] See the section *Changing or Adding Elements* to check which formulas should be changed

[38] Model 1.5.2 automatically calculates the Initial Final Demand in order to close the Economy. See Annex 3 for more information.

Could the Production formula in the Region Module be the source of instability?

The Production formula (Production=2*Consumption-Inventory) determines the rate of response to changes *but not the equilibrium production*. When production rises, inventories rise until Inventories equal consumption (Consumption-Inventory=0). At that point, production is equal to consumption (Consumption = Production). That is why the formula is equal to (Consumption –Inventory) + Consumption or (2*Consumption – Inventory).

What could cause instabilities in population in the early years?

It is possible that the population is somewhat unstable even when all the data are correct, because the level and mix of population isn't necessarily close to the initial equilibrium levels in the initial year 2001. But other possible reasons for instability in the population include:

1. the birth or death rates are incorrect
2. the IO coefficients are those from the multiplier matrix
3. the IO coefficients are too large (check the column sums to see that they are all significantly less than 1)
4. the labour output ratios, which determine the non-agriculture employment (this latter used to determine the labour demand), are incorrect[39]
5. the initial final demand by sectors (which are part of the variables that determine production, non-agriculture employment, labour demand, and finally population) are incorrect[40]

The Initial Production, Transpose II, Initial II, Ag Values and Cumulative Tourists do not seem to have any effects on the results of the model. What is their purpose?

All those converters are included for a reason. Indeed, in the case of stocks, all the initial conditions do not require any connectors.

The Initial Production is used as the initial values for the Inventory stock (from the Agriculture Module). Those values are important because it starts the model close to dynamic equilibrium so that large adjustments are not necessary in early *dt* periods. In the same way, Transpose II and Initial II appear to be disconnected, but they set the initial conditions in the intermediate Inputs stock (from the Agriculture Module).

The Ag Value Converter does not affect anything in the model directly, but it is used as an indicator.

The Ag Prices do affect the model as they determine the Commodity Value Change converter if changed after the initial conditions.

Finally, Cumulative Tourists is a stock that allows the model to calculate Annual Visitor Days. Because hotel owners understand that their business is seasonal, they make decisions on the basis of annual occupancy rates and not the current instantaneous rate. In order to calculate the annual occupancy rates, the difference between the current cumulative tourists and its value from one year ago is used as an input.

What should I include in the Initial Final Demand and what is the difference between this and the Exogenous Income and Expenditures?

The Initial Final Demand is the Final Demand at time 2001. It includes external earnings by sectors that could be related to regional exports, investment, government expenditures, and

[39] Idem

[40] Model 1.5.2 automatically calculates the Initial Final Demand in order to Close the Economy. See Annex 3 for more information.

external earnings of households *excluding transfers* (as this last is included in Other Final Demand). The Final Demand Growth Rates represent the rates at which this initial final demand at time 2001 would increase. Finally, the Exogenous Income and Expenditures represent the extra income and expenditures by farms and farm families.

How do I calculate the QOL Coefficients?

The QOL coefficients are based on a regression analysis developed as a part of this project. Values should not be altered unless teams have their own, country-specific estimates.

How do I calculate the Ag Inputs coefficients?

The Ag Inputs coefficients represent the purchase of inputs per hectare in each production system. For example, a value of 0.02 in the Agriculture Input coefficients in the energy sector and mixed livestock production system means that 0.02 thousands of euros/ha were spent in energy for the mixed livestock production system. These coefficients *are similar to input-output coefficients* except that they have been converted from euros of expenditures per euro of production to euros of expenditures per hectare. One way to do that is to convert the IO coefficients by the euros of production per hectare for the production system.

How do I calculate the Labour Output Ratios?

One possible way to calculate these numbers is to use the overall percentage of different education classes in the economy and apply them to each sector, or use indirect information about occupations to estimate this. For example if you know that manufacturing has an output of 50,000,000 euros and an employment of 500 and that 10% of workers have primary education, 70% have secondary, and 20% have college degrees, then the ratios will be .001, .007, and .002 (because the denominator is thousands of euros).

What happens if there is no information available in order to calculate daily arrival capacity and/or travel capacity?

You may effectively make this variable nonbinding by entering a very high number.

How do I know if my potential annual tourist value is too high or low?

The user can evaluate the daily average arrival and compare it with the number of hotel beds required to be used in the region to full-fill that demand. For example, a value of 1,000 annual potential tourists arriving to the region would imply an average of 2.7 tourists per day and 11 required hotel beds in the region (using the average days of stay of 4 with no seasonality).

Why are the Agriculture and Forestry sectors excluded from the IO coefficients?

The inputs and outputs of the Agriculture and Forestry sectors are calculated in the agriculture module. For this reason, the IO coefficients should not be included in the region module. Note that eliminating these sectors does not imply that the user needs to recalculate the IO coefficients. The calculation of coefficients ***should include all sectors*** even though the coefficients for agriculture and forestry are not used.

Why, in my model, are tourist arrivals and departures the same?

The tourism module operates on very short time periods—usually about a week or less. This is roughly 0.02 years. To get precise simulations for this sector, the *dt* should therefore be less than 0.02. On the other hand, for many simulations the imprecision here will not be important.

Why are final demand for households and some tourism expenditures excluded from the Final Demand?

Final demand for households has not been excluded from the Final Demand. It has been endogenized by adding a households sector in the IO Coefficients so that it can be calculated by the model. To avoid double counting, Initial Final Demand should exclude the consumption by the households sector. Final demand by households in then calculated by considering income and other factors.

Tourism expenditures are a different issue. Generally, tourism is part of the hotels, restaurants, recreational, and service sectors. The POMMARD model internally calculated the expenditures on beds (hotels, B&B, Inns, etc.) and other related expenditures. These values should be then associated with the appropriate sectors in the model.

Can the production systems be changed (to reflect things such as extensification of production)?

The most appropriate way to change the effects of production is to have alternative production systems that can be introduced during the scenarios. This would be most appropriate for the addition of discrete changes such as a conversion to organic products or the use of waste streams for bio energy.

Appendix 3: POMMARD 1.5.2

POMMARD 1.5.2 was constructed in order to obtain balanced values at time 0.0 of each simulation. Initial Final Demand (equal to the initial output levels) and the Labour Output Ratios (equal to the ratios that will exactly employ the initial labour force to provide the initial output levels) are calculated and entered automatically into the model. If users have accurate values for these initial levels, users do not have to use this model.

The following represents the changes introduced in POMMARD 1.5.2:

1. Initial Final Demand Converter (units: thousands of euros)

This converter calculates consistent initial final demand values for the products of each sector including households (in thousands of euros) at the base year. Users should not make any changes in this converter.

$$FID(0)_i = SP(0)_i - (I2S(0)_i + \sum_{j=1}^{p} AInp_{ij} + \frac{TTE_i}{1000} + \frac{AICh_i}{1000} + OFD_i + EEI_i)$$

for i=1…*s*

s	is the number of sectors
$SP_i(0)$	is the initial production in thousands of euros by sector (this information comes from the Initial Conditions Module)
$I2S_i(0)$	is the initial inputs used by sector (this information comes from the Region Module)
$AInp_{i,j}$	is the agricultural inputs purchased from each sector (this information comes from the Agriculture Module)
TTE	is the total tourism expenditures by sectors (this information comes from the Tourism Module)
$AICh_i$	is the change in agricultural income earned by farm households due to all price changes (this information comes from the Agriculture Module)
OFD_i	is the other final demand from each sector (this information comes from the Region Module)
EEI_i	is the total exogenous expenditures and income from each sector (this information comes from the Region Module)

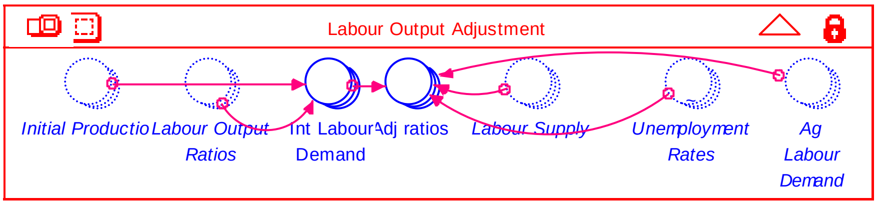
The user must be careful with this variable. Under some conditions the Initial Production (SP(0)) estimated in this manner will imply a negative Initial Final Demand. This typically occurs when there are errors in some of the final demand categories. Negatives total final demand values cause erratic dynamic patterns.

In addition, it is important that the user remember that the Initial Final Demand for the Hotels and Recreational sectors must exclude the values obtained in the Total Tourism Expenditures. Otherwise they will be double counted and could induce negative results in the Initial Final Demand for some sectors.

Finally, special consideration needs to given to the Initial Final Demand for the Household Sector. Unless the user has accurate estimates of this value, its value should be zero.

2. Labour Output Adjustment Module

Figure 27 The Labour Output Adjustment Module



The objective of the Labour Output Adjustment Module is to find an adjustment ratio that will correct the Labour Output Ratios to make the labour demand closer to the labour supply for the non agriculture sector and to avoid extreme instability at the beginning of simulations.

Initial Labour Demand Converter (units: persons)

This two-dimensional converter (education by sectors) represents the total demand for labour, by educational level, for the production required by each of the sectors. Users do not have to make any changes in the converter.

$$ILD_{i,j} = LOR_{i,j} * SP(0)_j$$

for i=1…*e* & j=1…*s*

s	is the number of sectors
e	is the number of educational levels
$ILD_{i,j}$	is the initial labour demand by education level and by sector
$LOR_{i,j}$	is the labour output ratios by sector and education level
$SP_i(0)$	is the initial production in thousands of euros by sector

Adjustment Ratios Converter (units: proportion)

This converter represents the adjustment ratio for the labour output ratios, by educational level, in order to make the labour supply equal (or closer) to the labour demand for the non agriculture sector in the initial period of analysis. Users do not have to make any changes in the converter.

$$AdR_{primary} = \frac{LSp(0)_{primary} * (1 - UR_{primary}) - \sum_{j=1}^{p} ALD_{primary,j}}{\sum_{h=1}^{s} ILD_{primary,h}}$$

$$AdR_{secondary} = \frac{LSp(0)_{secondary} * (1 - UR_{secondary}) - \sum_{j=1}^{p} ALD_{secondary,j}}{\sum_{h=1}^{s} ILD_{secondary,h}}$$

$$AdR_{tertiary} = \frac{LSp(0)_{tertiary} * (1 - UR_{tertiary}) - \sum_{j=1}^{p} ALD_{tertiary,j}}{\sum_{h=1}^{s} ILD_{tertiary,h}}$$

for j=1…*p* & h=1…*s*

s	is the number of sectors
p	is the number of production systems
AdR_i	is the adjustment ratio by educational level
LSp_i	is the labour supply by education level (from the Human Resources Module)
UR_j	is the unemployment rate by education level (from the Human Resources Module)
$ALD_{i,j}$	is each production system's labour demand by level of education (from the Agriculture Module)
$ILD_{i,h}$	is the initial labour demand by education level and by sector

3. Region Module

Adjustment Labour Output Ratios Converter (units: proportion)

This two-dimensional converter calculates the adjusted Labour Output Ratios. Users do not have to make any changes in the converter.

$$AdLOR_{i,j} = LOR_{i,j} * AdR_i$$

for i=1…*e* & j=1…*s*

$AdLOR_{i,j}$	is the adjustment labour output ratios by educational level and sectors
$LOR_{i,j}$	is the labour output ratios by sector and education level
AdR_i	is the adjustment ratio by educational level

It is important to note that for POMMARD 1.5.2 that this will be the new labour output ratios used in the QOL Final Demand, Non Agriculture Labour Demand and the Labour Constraint.

Appendix 4: Variables in the Model

	VARIABLE	DIMENSION	UNITS	LOCATION	DATA ENTRY?	SYMBOL
1	Land Requirements Converter	land types x production systems	proportion	Land Module	YES	LR
2	Land Uses Converter	production systems	hectares	Land Module Policy Controls Module	NO	LU
3	Change in Land Use Converter	production systems	hectares	Land Module Policy Controls Module	YES	ΔLU
4	Land Stocks by Use Converter	land types x production systems	hectares	Land Module	NO	LSU
5	Initial Land by Use Converter	land types x production systems	hectares	Land Module	NO	ILU
6	Total Land Check Converter	constant	hectares	Land Module	NO	TL
7	NCOs Converter	non-commodities	vary	Non Commodities Module	NO	NCOs
8	NCO Production Systems Changes Converter	non-commodities x production systems	vary	Non Commodities Module	NO	NCOPSCh
9	NCO Production Systems Coefficients Converter	non-commodities x production systems	vary	Non Commodities Module	YES	NCOPSC
10	Livestock Coefficients Converter	non-commodities x production systems	vary	Non Commodities Module	YES	LSC

11	NCO Land Cover Changes Converter	non-commodities x land types	vary	Non Commodities Module	NO	NCOLCh
12	Shannon Coefficients Converter	non-commodities x land types	0,1	Non Commodities Module	NO	SC
13	Land Coefficients Converter	non-commodities x land types	0,1	Non Commodities Module	NO	LC
14	Land Cover Coefficients	non-commodities x land types	0,1	Non Commodities Module	NO	LCC
15	Ag Output Inventories	commodities	vary	Agriculture Module	NO	AOI
16	Ag Output Use Outflow	commodities	vary	Agriculture Module	NO	AOU
17	Ag Production Flow	commodities	vary	Agriculture Module	NO	AP
18	Ag Input Coefficients Converter	sectors x production systems	thousands of euros/hectares	Agriculture Module	YES	AIC
19	Ag Inputs Converter	sectors x production systems	thousands of euros	Agriculture Module	NO	AInp
20	Labour Land Ratios Converter	education x production systems	persons/hectares	Agriculture Module	YES	LLR
21	Ag Labour Demand Converter	education x production systems	persons	Agriculture Module	NO	ALD
22	Ag Output Coefficients Converter	commodities x production systems	unit vary/hectares	Agriculture Module	YES	AOC
23	Ag Outputs Converter	commodities x production systems	vary	Agriculture Module	NO	AgO
24	Ag Prices Converter	commodities	euros	Agriculture Module Policy Controls Module	YES	CP
25	Ag Values Converter	commodities	euros	Agriculture Module	NO	AV

26	Commodities Value Change Converter	commodities	euros	Agriculture Module	NO	CVC
27	Ag Income Change Converter	sectors	euros	Agriculture Module	NO	AICh
28	Commodity Subsidies Converter	commodity	euros	Agriculture Module Policy Controls Module	YES	CS
29	Production Systems Subsidies Converter	production systems	euros	Agriculture Module Policy Controls Module	YES	PSS
30	Production Systems Subsidies Income Converter	production systems	euros	Agriculture Module	NO	PSSI
31	Land Subsidies Converter	land types	euros	Agriculture Module Policy Controls Module	YES	LS
32	Land Subsidies Income Converter	land types	euros	Agriculture Module	NO	LSI
33	QOL Migrants Stock	cohorts	persons	QOL Module	NO	QOLMS
34	QOL Migration Flow	cohorts	persons	QOL Module	NO	QOLM
35	QOL Coefficients Converter	capital x cohorts	proportion	QOL Module	YES	QOLC
36	ON for No Change Converter	constant	dummy	QOL Module	YES	ONC
37	Change in Capital Converter	constant	vary	QOL Module	NO	ΔC

38	Population Stock	cohorts x education	persons	Human Resources Module	NO	P
39	QOL Migr Flow	cohorts x education	persons	Human Resources Module	NO	QOLMg
40	Migration Flow	cohorts x education	persons	Human Resources Module	NO	M
41	Migration Shares Converter	cohorts x education	0 to 1	Human Resources Module	YES	MS
42	Labour Demand Converter	education	persons	Human Resources Module	NO	LD
43	Labour Supply Converter	education	persons	Human Resources Module	NO	LSp
44	Labour Force Converter	cohorts x education	persons	Human Resources Module	NO	LF
45	Labour Force Participation Converter	cohorts x education	0 to 1	Human Resources Module Policy Controls Module	YES	LFP
46	Unemployment Rate Converter	education	0 to 1	Human Resources Module Policy Controls Module	YES	UR
47	Dependent Migration Flow	cohorts x education	persons	Human Resources Module	NO	DM
48	Dependents Share Converter	cohorts x education	0 to 1	Human Resources Module	YES	De
49	Births Inflow	cohorts x education	persons	Human Resources Module	NO	B

50	Birth Rates Converter	constant	0 to 1	Human Resources Module	YES	BR
51	Death Outflow	cohorts x education	persons	Human Resources Module	NO	D
52	Death Rates Converter	cohorts	0 to 1	Human Resources Module	YES	DR
53	Age Out Outflow	cohorts x education	persons	Human Resources Module	NO	AO
54	Age In Inflow	cohorts x education	persons	Human Resources Module	NO	AI
55	Secondary Education Rate Converter	constant	0 to 1	Human Resources Module	YES	SER
56	Exit Rate Converter	constant	0 to 1	Human Resources Module	YES	ER
57	Local Higher Education Rate Converter	constant	0 to 1	Human Resources Module	YES	LHE
58	Cohorts Sums Converter	cohorts	persons	Human Resources Module	NO	CS
59	Education Sums Converter	education	persons	Human Resources Module	NO	ES
60	Inventory Stock	sector	thousands of euros	Region Module	NO	I
61	Production Inflow	sector	thousands of euros	Region Module	NO	SP
62	Consumption Outflow	sector	thousands of euros	Region Module	NO	C
63	Labour Constraint Converter	sectors	persons	Region Module	NO	LCo
64	IO Coefficients Converter	sector x sector	proportion	Region Module	YES	IOC
65	Transpose Converter	sector x sector	thousands of euros	Region Module	NO	Tr

66	Intermediate Inputs Stocks	sector	thousands of euros	Region Module	NO	IIS
67	Inputs Inflow	sector	thousands of euros	Region Module	NO	INP
68	Intermediate Demand Outflow	sector	thousands of euros	Region Module	NO	ID
69	Transpose 2 Converter	sector x sector	thousands of euros	Region Module	NO	Tr2
70	Initial II Converter	sector x sector	thousands of euros	Region Module	NO	I2S
71	Labour Output Ratios Converter	education x sector	persons/thousands of euros	Region Module	YES	LOR
72	Non Ag Labour Demand Converter	education x sector	persons	Region Module	NO	NALD
73	Per Capita Income Converter	constant	thousands of euros/ persons	Region Module	NO	PCI
74	Final Demand Stock	sectors	thousands of euros	Region Module	NO	FD
75	Final Demand Growth Inflow	sectors	thousands of euros	Region Module	NO	FDG
76	Final Demand Growth Rates Converter	sectors	proportion	Region Module Policy Controls Module	YES	FDGR
77	Exogenous Expenditures and Income	sectors	thousands of euros	Region Module Policy Controls Module	YES	EEI
78	QOL Final Demand Converter	sectors	thousands of euros	Region Module	NO	QOLFD
79	Other Final Demand Converter	sectors	thousands of euros	Region Module	NO	OFD
80	Transfer Income Converter	cohorts	thousands of euros	Region Module Policy Controls Module	YES	TI

81	Tourists Stock	constant	persons	Tourism Module	NO	TOUR
82	Cumulative Tourists Stock	constant	persons	Tourism Module	NO	CT
83	Arrivals Inflow	constant	persons	Tourism Module	NO	ARRIVE
84	Departures Flow	constant	persons	Tourism Module	NO	DEPT
85	Hotel Rooms Stocks	constant	hotel beds	Tourism Module	NO	HR
86	Increase Hotel Beds Inflow	constant	hotel beds	Tourism Module	NO	IHB
87	Decrease Hotel Beds Outflow	constant	hotel beds	Tourism Module	NO	DHB
88	Attractiveness Coefficients Converter	capital	ratio	Tourism Module	NO	AC
89	Seasonality Index Converter	constant	0 to 1	Tourism Module Policy Controls Module	YES	SI
90	Seasonal Peak Converter	constant	0 to 12	Tourism Module Policy Controls Module	YES	SP
91	Seasonality Converter	constant	0 to 1	Tourism Module	NO	S
92	Regional Attractiveness Change Converter	constant	unit	Tourism Module	NO	RAC
93	Potential Annual Tourists Converter	constant	persons	Tourism Module Policy Controls Module	YES	PAT
94	Potential Tourists Converter	constant	persons	Tourism Module	NO	PT
95	Daily Arrival Capacity	constant	persons	Tourism Module	YES	DAC

	Converter			Policy Controls Module		
96	Travel Capacity Converter	constant	persons	Tourism Module Policy Controls Module	YES	TC
97	Average Days of Stay	constant	days	Tourism Module Policy Controls Module	YES	ADS
98	Annual Visitor Days Converter	constant	days	Tourism Module	NO	AVD
99	Minimum Occupancy Rate Converter	constant	proportion	Tourism Module Policy Controls Module	YES	MOR
100	Break Even Occupancy Converter	constant	proportion	Tourism Module Policy Controls Module	YES	BEO
101	Price per Bed Converter	constant	euros	Tourism Module Policy Controls Module	YES	PB
102	Related Daily Expenditures Converter	constant	euros	Tourism Module Policy Controls Module	YES	RDE
103	Total Tourism Expenditures Converter	constant	euros	Tourism Module	NO	TTE
104	Initial Population Converter	cohort x education level	persons	Initial Conditions Module	YES	P(0)
105	Initial Land Uses Converter	production system	hectares	Initial Conditions Module	YES	LU(0)

106	Initial Production Converter	sectors	thousands of euros	Initial Conditions Module	YES	SP(0)
107	Initial Hotel Beds	constant	hotels beds	Initial Conditions Module	YES	HB(0)
108	Initial Final Demand Converter	sectors	thousands of euros	Initial Conditions Module	YES	FD(0)
109	Total Population Converter	constant	persons	Indicators Module	NO	TP
110	Total Migration Converter	constant	persons	Indicators Module	NO	TM
111	Non Ag Employment Converter	constant	persons	Indicators Module	NO	NAE
112	Ag Employment Converter	constant	persons	Indicators Module	NO	AE
113	Total Regional Production Converter	constant	thousands of euros	Indicators Module	NO	TRP
114	Annual Occupancy Rate Converter	constant	proportion	Indicators Module	NO	AOR
115	Ag Income Converter	constant	thousands of euros	Indicators Module	NO	AGI
116	Total Labour Force Converter	constant	persons	Indicators Module	NO	TLF
117	Utilized Agriculture Area Converter	constant	hectares	Indicators Module	NO	UAA
118	Total Regional Consumption Converter	constant	thousands of euros	Indicators Module	NO	TRC
119	Gross Value of Agriculture Converter	constant	euros	Indicators Module	NO	GVA
120	Land Agriculture Sum Converter	constant	hectares	Indicators Module	NO	LAS

Appendix II: Publications, Presentations to Conferences and Other Dissemination

By Liam Dunne, Joanne Brannigan and Amaia Arandia

In the early stages of the TOP-MARD project the main activities focused on developing a series of common and agreed reporting conventions and a logging system of intentions to publish. Subsequently, a series of dissemination channels were identified and encouraged.

Reporting conventions

A comprehensive set of agreed typographical conventions for TOP-MARD reports and other working documents was prepared and agreed by partners in the early months of the project. The objectives were to:

- develop and facilitate communications between partners in the preparation of reports and publications
- provide a coherent image for the TOP-MARD project, and
- assist in developing and raising a coherent external profile of the overall project.

The main elements of the conventions were:

- Typographical Conventions - for practice amongst the partners when writing, compiling and editing Deliverables within the project
- Publication Acknowledgement – wording agreed within the partnership. On completion of an output, and on submission to a publication, included the acknowledgement
- Standard presentation formats - compiled for use by partners in the event of a presentation of project information
- A standard report cover - developed, including the project title listed in each partner's national language. On completion of each output per partner, the cover was included prior to distribution.

Dissemination channels

The main dissemination and communications channels used were:

- Website – content was developed, with public and members' sections included. Main outputs per partner were included for access by public users. Address is **www.topmard.org**.
- An overview of the project and its main objectives and deliverables was compiled for circulation in general public fora and for use in general publicity activities. This served as a simple delivery of the project's main points
- Notifications of dissemination events such as conferences, seminars and workshops were circulated around the project team, including main deadlines and guidance on submission of papers, posters, etc.

As the project progressed and potential outputs and results could be more easily identified, further dissemination channels were developed. The aim was to provide scope for and encourage:

- cooperation in dissemination activities between both partners and individual researchers across the project where either English or an alternative common language could be used
- individual partners to prepare and publish reports using their native language, using local conventions for domestic audiences.

Project members were encouraged to use the project web site to make available copies of conference papers and Powerpoint presentations and examples of the STELLA model.

Team members were encouraged to:

- **communicate with Stakeholders** other organisations and groups (farmers, economic agents…) and avail themselves of an opportunities for local presentations, etc and obtain feedback
- **Avail themselves of Local publications** to disseminate information about the project
- **Avail themselves of formal publication channels within partners/national institutions for scientific/technical** non-peer-reviewed articles and press releases
- **Prepare and publish National reports** on:
    - the TOP-MARD surveys and their findings
    - National Model outputs and Policy recommendations
- **Prepare and publish papers at International conferences** (for example EAAE, IRSA, EAAP, International Rural Network, European Society of Rural Sociology, European Society of Ecological Economics, International Grassland Association etc,)
- **Arrange a special TOP-MARD special session or panel at an international conference.** For example**, a** special TOP-MARD session attached to the EAAE Seminar in Viterbo, Italy, 20-21 November 2008 is in preparation
- **Arrange a special presentation** of **the POMMARD model** and preliminary results at the annual meeting of the Rural Policy Committee of the Territorial Development Policy Committee of the OECD Paris in December 2007 (Bryden, Johnson and Dax)
- **Arrange for** a **Special issue of an international journal,** perhaps *European Review of Agricultural Economic*s, or the *Journal of Rural Studies* based on that special session
- **Arrange for the publication of a book** on the project as well as chapters in a relevant book. At least one book chapter has already been published, and a whole volume is being discussed with a well-known publisher at the time of reporting.
- **Engage in joint exchanges** (conferences, seminars) with the FP6 MEA-Scope project, FARO, and other FP6 and FP7 projects, as well as specific contracts (IPTS and DG-Agri),
- **Prepare for** the possibility or and avail themselves of **future Invitations of participation in other framework projects (FP6 and FP7)**

The relative emphasis placed on the various dissemination methods and the level of such activity varied greatly between partners. Furthermore, a number of dissemination activities arising both directly and indirectly from the TOP-MARD project are planned for the future. The following is a list of the documented dissemination outputs arising to date from the TOP-MARD project. These are categorised under the following headings:

- Conference presentations (41)
- Popular press (4)
- Workshops (4)
- Book chapters (4)
- Peer reviewed articles (3)
- Other miscellaneous dissemination activities (14).

Dissemination

Conference Presentations

Date of Notice	Partner(s)	Title	Type of Activity	Date Delivered / Published	Country of Circulation
December 14th 2005	BUESPA	Report on second Congress on European Rural Tourism	2nd Congress on Rural Tourism, Yalta, Hungary	September 2005	Hungary
August 22nd 2006	UNIABDN and BABF	Multifunctionality and Pluriactivity across Europe: a comparison between Scotland and Austria	Conference, Vienna, Austria, September 28th-29th 2006	September 27th 2006	Austria, Germany and worldwide
August 28th 2006	BUESPA	Decoupling and Cross-Compliance as Concepts and Instruments in Agricultural Multifunctionality	EAAE Seminar "Impacts of Decoupling and Cross-Compliance on Agriculture in the Enlarged EU", Prague, Czech Republic, September 22-23 2006	September 23rd 2006	Czech Republic and worldwide
August 29th 2006	Bryden, J., K. Refsgaard and T. Johnson	Multifunctional Agriculture and the New Rural Development Policy Paradigm in Europe	EAAE Seminar "Impacts of Decoupling and Cross-Compliance on Agriculture in the Enlarged EU", Prague, Czech Republic, September 22-23 2006	September 23rd 2006	Czech Republic and worldwide
August 29th 2006	Refsgaard, K., J. Bryden and T. Johnson	The effects of multifunctionality on territorial rural development and quality of life: a systems approach	EAAE Seminar "Impacts of Decoupling and Cross-Compliance on Agriculture in the Enlarged EU", Prague, Czech Republic, September 22-23 2006	September 23rd 2006	Czech Republic and worldwide
March 16th 2007	Bryden, J. Refsgaard, K. and Johnson T. G.	Building a Systems Model to link Multifunctional Agriculture, Rural Economies, and Policies in Europe	JRC Seminar, Seville, Dec 06	2006	Europe
November 8th 2006	LJUB	A concept of multifunctionality and its dissemination to some new undefined areas	First International Conference on Agriculture and Rural Development, JCEA, *A New Perspective for Agriculture and Rural Areas in Central*	November 23-25 2006	Croatia and Europe

			and Eastern Europe, Topusko, Croatia		
March 2nd 2007	DR Spain	Adecuación de los actuales instrumentos de la política de desarrollo rural europea y la implementación de la multifuncionalidad.	Presentation at Conference from the Agrarian Economy towards a Rural and Agri-food Economy, Albacete, Spain	September 19-21 2006	Spain
March 16th 2007	Bryden, J. and K. Refsgaard	The concept of multifunctionality and its relationships with the new rural development policy paradigm in Europe	Conference publication based on paper presented at 74th Congress of l'ACFAS (Association Francophone pour le Savoir), Université McGill, Montreal, May 16th 2006	2007	Canada, France
March 19th 2007	DR Spain	Success factors and perspectives of rural development	Oral presentation and publication to special meeting of Alpine Convention on 'Mountain Farming and Rural Development', September 19th 2006	Sept. 16th 2006 (published 2007)	Austria, Germany, France, Switzerland, Slovenia
March 21st 2007	Bergmann, H., T. Dax, G. Hovorka and K. Thomson	Sustainable rural development strategies and multifunctionality of agriculture – a comparison between Scotland and Austria	Paper accepted for European Society for Rural Sociology conference, Mobilities, Vulnerabilities and Sustainabilities: New Questions and Challenges for Rural Europe, Wageningen, The Netherlands, August 20-24 2007	August 2007	Europe

Date of Notice	Partner(s)	Title	Type of Activity	Date Delivered / Published	Country of Circulation
March 21st 2007	Bergmann, H.	Multifunctionality of agriculture and the future of extensive grassland production systems in European remote rural areas	Accepted poster for the 14th European Grassland Federation Symposium Permanent and Temporary Grassland: Plant, Environment and Economy, Gent, Belgium, September 3 – 5 2007	September 2007	Europe
March 21st 2007	Bergmann, H.	Willingness to pay in contingent valuation: depending on the interview situation rather than the respondents?	Poster and paper presentation at the Agricultural Economics Society Conference (AES), Reading, April 1-4 2007	April 2007	Europe
March 21st 2007	Bergmann, H. and K. Thomson	Agricultural multifunctionality: concepts, observation and encouragement	Paper presented at the Agricultural Economics Society Conference, Reading, April 1-4 2007	April 2007	Europe
March 21st 2007	Teagasc	REPS: enhancing its scope and integration with other rural objectives	Oral presentation and publication at the National Teagasc REPS Conference, Tullamore, November 10th 2006	November 2006	Ireland and EU
March 21st 2007	Teagasc	Labour market developments and a future in farming	Oral presentation and publication at Special Training Conference for Master Farmers, Clonmel, Co. Tipperary, October 31st 2006	October 2006	Ireland
March 28th 2007	Jambor, A.	Conformation and market effects of corporate cereal farms in Hungary	EAAE Seminar “Superlarge Farming Companies in Eastern Europe: Emergence and Possible Impacts”, Moscow, Russia, May 17-18 2007	2007	Russia, Europe

Date of Notice	Partner(s)	Title	Type of Activity	Date Delivered / Published	Country of Circulation
March 28th 2007	Fodor, K.	Multifunctional agriculture and the corporative farms	EAAE Seminar “Superlarge Farming Companies in Eastern Europe: Emergence and Possible Impacts”, Moscow, Russia, May 17-18 2007	2007	Russia, Europe
August 20th 2007	Bergmann, H.	North-west Highlands Geoparks agriculture – diversification on crofts and small farms to ensure farm survival	Conference paper and presentation at the North West Highlands Geopark Network Open Conference, Ullapool, Scotland, September 14-16 2007	2007	Europe
August 20th 2007	Bergmann, H.	Marketing Geopark Agriculture	Conference paper and presentation at the North West Highlands Geopark Network Open Conference, Ullapool, Scotland, September 14-16 2007	2007	Europe
August 20th 2007	Bergmann, H.	Income, employment and demographic effects of Dounreay decommissioning	Paper presented to the Caithness Partnership and UKAEA conference	September 2007	Highlands of Scotland
October 24th 2007	NORDREGIO	Multifunctional agriculture and rural viability: an analysis of farm household involvement in the rural labour markets	EUGEO Conference, Amsterdam, The Netherlands, August 20-22 2007	August 2007	Europe
October 24th 2007	Bryden, J.M. and K. Refsgaard	TOP-MARD Problematique, Structure and Progress – the case of Norway	MEA-SCOPE conference, Florence, September 2007	September 2007, Also Chapter in forthcoming book edited by A. Piorr et al, 2008	Europe

Date of Notice	Partner(s)	Title	Type of Activity	Date Delivered / Published	Country of Circulation
October 24th 2007	Jambor, A.	Connections between agriculture and quality of life in county Bacs-Kiskun	Georgikon Scientific Conference, Agri-business for Rural Development, Environment and Quality of Life, Keszthely, Hungary, September 20-21 2007	September 2007	Hungary
October 24th 2007	Refsgaard, K., S. and S. S. Prestegard	Modelling policies for multifunctional agriculture and rural development – a Norwegian approach	Paper presented at the 107th EAAE Seminar Modelling Agricultural and Rural Development Policies, Seville, January 2008	January 2008	Europe
November 14th 2007	Hocevar, V. and L. Juvancic	Estimation of Different Policy Affects on Regional Economic Performance – the case of Gorenjska	Paper presented at the 4th Conference of Slovenian Association of Agricultural Economists Slovenian agriculture and rural development in the extended and changed Europe, November 8-9 2007, Moravske Toplice, Slovenia	November 2007	Slovenia
November 14th 2007	Hocevar, V. and L. Juvancic	Multifunctional role of agriculture in territory – approach with system thinking model	Paper presented at the 4th Conference of Slovenian Association of Agricultural Economists Slovenian agriculture and rural development in the extended and changed Europe, November 8-9 2007, Moravske Toplice, Slovenia	November 2007	Slovenia

Date of Notice	Partner(s)	Title	Type of Activity	Date Delivered / Published	Country of Circulation
January 2008	J. Bryden, T. Johnson and K. Refsgaard	A System Dynamic Model of Agriculture and Rural Development: The TOP-MARD Core Model	Paper presented at the 107th EAAE Seminar Modelling of Agricultural and Rural Development Policies, Seville, Spain, January 29th – February 1st 2008	January 2008	Europe
March 2008	BABF	Evaluation of the less-favoured area payment scheme in Austria	Paper presented at Less Favoured Areas for Agriculture and Rural Areas, conference organised by the Research Institute of Agricultural Economics, Prague (VUZE) and the Regional Government of Vysocina, November 7-10, 2007	November 2007	Austria
March 2008	BABF	Female entrepreneurship in the Alpine region of Pinzgau-Pongau (Austria)	Paper presented at the Conference of the Centro di Ecologia Alpina (CEA) in Trento, December 15-16 2007. Publication in book edited by Claudia Marchesoni and Allessandro Gretter	December 2007	Italy, Austria, Germany, France, Switzerland, Slovenia)
March 2008	Viladomiu, L., J. Rosell and G. Francés	Unknown	Paper to be presented at the EAAE conference in Ghent, Belgium, August 2008	August 2008	Europe
March 2008	Viladomiu, L., J. Rosell and G. Francés	Comparative Analysis of Territorial Impacts of Multifunctional Agriculture in Austria and Slovenia	Paper to be presented at the 6th European Rural Development Network (ERDN) conference, November 20-21 2008, Vienna, Austria.	November 2008	Europe

Date of Notice	Partner(s)	Title	Type of Activity	Date Delivered / Published	Country of Circulation
May 5th 2008	Refsgaard, K., S Prestegard and A. Spissoly	Modellere politick for multifunksjonelt landbruk og distriktsutvikling – en historie fra Norge [Modelling Policies for Multifunctional Agriculture and Rural Development – A Norwegian Approach]	Presentation at the TOP-MARD conference, Brussels, May	May 2008	Europe
May 26th 2008	BUESPA	Modelling Multifunctionality in Hungarian Agricultre	Paper to be presented at the 107th EAAE Seminar Modelling of Agricultural and Rural Development Policies, Seville, Spain, January 29th – February 1st 2008	January 2008	Europe

Date of Notice	Partner(s)	Title	Type of Activity	Date Delivered / Published	Country of Circulation
October 24th 2007	NILF/ UHI	TOP-MARD Towards a Policy Model of Multifunctional Agriculture and Rural Development: a specific targeted research project in Framework 6	General Flyer for Project	2006	UK
January 2008	Bryden, J., Johnson, T., Dax, T	A systems approach to territorial rural policy modelling	OECD Working Party on Territorial Rural Policy, November 27th 2007	November 2007	Europe
May 2008	Refsgaard, K., and S S Prestegard	Modellere politikk for multifunksjonelt landbruk og distriktsutvikling – en historie fra Norge (Modelling policies for multifunctional agriculture and rural development - a case from Norway)	NILF seminar 5. mai 2008	5. May 2008	Norway

Popular Press

Date of Notice	Partner(s)	Title	Type of Activity	Date Delivered / Published	Country of Circulation
February 2nd 2007	Brannigan, J. and L. Dunne	Multifunctionality and Irish Agriculture	Article in TResearch, Teagasc research report	February 2007	Ireland
?	Vermes, Thomas (journalist, Nationen)	Kvam-gründere hjelper Europas bygder. (Kvam-entrepreneurs aiding Europes communities)	Article in national newspaper, Nationen.	1. October 2007	Norway
November 14th 2007	Fereczi, T., E. Miklossy, J. Rosell and L. Viladomiu	Agriculture, society and economy in rural development of municipalities: a Hungarian-Catalan comparison	A Falu (The Village), Vol. 22, No. 3, 2007	November 2007	Hungary

Workshops

Date of Notice	Partner(s)	Title	Type of Activity	Date Delivered / Published	Country of Circulation
March 2nd 2007	UAB	Multifunctionality as a key concept for agricultural sustainability scenarios: the TOP-MARD approach	Workshop on Agrarian Sustainability	October 19th 2006	Members of FORE.SCENE Project
March 2nd 2007	UAB	Towards a Policy Model of Multifunctional Agriculture and Rural Development	Presentation held in informal meeting held by members of the Catalan Agrarian Studies Institute	September 5th 2006	Institute members
March 13th 2007	UAB	Agrarian and rural diversity in Spain	Presentation at the workshop Diversity of Rural Areas in the Enlarged EU, Seville, Spain, JRC Joint Research Centre and Institute for Perspective Technological Studies	December 2006	Europe
March 13th 2007	UAB	Presentation of TOP-MARD project to Academic Experts	Workshop Perspective of Agriculture and Rural Development in Europe, Leuven, Brussels	January 2007	EU

Book Chapters

Date of Notice	Partner(s)	Title	Type of Activity	Date Delivered / Published	Country of Circulation
March 21st 2007	NILF	From sectoral to territorial rural development – less focus on multifunctional agriculture as a driver	Chapter in Norwegian Agriculture – Status and Trends	2006	Norway
January 2008	Bryden, J., T. Johnson and K. Refsgaard	Modelling Rural Social, Economic and Environmental Interactions of EU Agricultural Policy	Chapter included in Model-Based Approaches to Learning: Using Systems Models and Simulations to Improve Understanding and Problem Solving in Complex Domains, Ed. Blumschein, P., Stroebel, J., Hung, W. and Jonassen, D. (Sense Publishers, Rotterdam, NL		
May 2008	Bryden, J. and K. Refsgaard	TOP-MARD Problematique, Structure and Progress – the case of Norway	Chapter in a Book mainly on MEA-SCOPE FP6 project, edited by A.Piorr and others.	2008	Europe et al

Peer reviewed articles

Partner(s)	Title	Type of Activity	Date Delivered / Published
UNIABDN	Willingness-to-Pay in Contingent Valuation –A matter of interview situation or respondents?	Peer reviewed publication Scottish Geographical Journal	2008
UNIABDN	The Importance of Dounreay Decommissioning for the Caithness and Sutherland Job Market,	Submitted, Scottish Journal of Political Economy	2009
Teagasc	Conceptualising Multifunctionality in the Irish Context – issues for policy formulation, implementation and evaluation	Paper accepted for special issue of JEEP	2008 – 2009

Other Miscellaneous Dissemination Activities

Date of Notice	Partner(s)	Title	Type of Activity	Date Delivered / Published	Country of Circulation
?	Refsgaard, K.	Fra sektor til territoriell bygdeutvikling – mindre fokus på multifunksjonelt landbruk som drivkraft. (From sectorial to territorial rural development – less focus on multifunctional agriculture as driver).	Andersen FG (ed) 2006. Utsyn over norsk landbruk - Tilstand og utviklingstrekk 2006. (Norwegian Agriculture - Status and Trends). NILF-series, Oslo.	October 2006	**Norway**
January 25th 2007	Eboli, M.G. and M.C. Macri	Public Goods and the Production of Positive Externalities: Innovative Trends in European Agricultural Policies	Oral presentation in Department of Public Economics, University of Rome, Italy	February 2-3 2007	Italy
March 2nd 2007	UAB	Exploring Scenarios for Rural Europe: the future of agriculture policy	Workshop – Subrosa Association	March 2007	Europe
March 13th 2007	UAB	Agrarian Multifunctionality: the TOP-MARD Project	Presentation of TOP-MARD project to the Spanish Agrarian Ministry	March 2006	Spain
March 13th 2007	UAB	Agrarian Multifunctionality: the TOP-MARD Project	Presentation of TOP-MARD project at the Valladolid University	October 2006	Spain
March 21st 2007	Bergmann, H.	Agricultural multifunctionality: concepts, observation and encouragement	Presentation at the ITRR lunchtime seminar series, March 7th 2007	March 2007	Aberdeen
March 22nd 2007	Spissøy, A.	Cultural Landscape, European Experience	Seminar Presentation at NILF-Bergen	Dec 2006	Hordaland, Norway
July 2007	Bryden, J, T. Johnson, L. Viladomiu and G. Francés	Agricultural Multifunctionality and Rural Development	Lecture and Seminar for the International Comparative Rural Policy Summer School	July 2007	Canada, USA, Belgium, UK, Hungary, Greece, Brazil
August 20th 2007	Bergmann, H.	The Importance of Dounreay Decommissioning for the	Report to the National User Group, Scotland	August 2007	Scotland

		Caithness and Sutherland Job Market			
August 20th 2007	Bergmann, H.	Single Parents in Wick – Exit Poll Results	Data report to Caithness Partnership	September 2007	Caithness, Sutherland, Highlands
August 20th 2007	Bergmann, H.	Functions of Agriculture in Aberdeen and Aberdeenshire	Paper prepared for Aberdeenshire Council	September 2007	Aberdeen
July 2008	Eboli, M.	Multifunctional Agriculture: A Methodological Contribution On Measuring.		July 2008	Italy