

Wageningen Economic Research Agency Report – MAGNET activities 2021-2022

1 Introduction

Wageningen Economic Research part of Wageningen University and Research (WUR), has been a member of the GTAP consortium since November 1996. The standard GTAP model constitutes the basis of the MAGNET model, a modular CGE model approach developed at Wageningen Economic Research. Hence the name MAGNET, short for “Modular Applied GeNeral Equilibrium Tool”. MAGNET has the V7 GTAP model at its core with all extensions added in a modular fashion. It allows the user to select which additional modules he/she wishes to include by adjusting the model settings and by including the relevant data. In addition to Wageningen Economic Research, MAGNET is used and developed by researchers from the Joint Research Centre of the European Commission (JRC) and the Thünen Institute (TI), with the cooperation being organized in a MAGNET consortium.

Extensions to the GTAP model and database in MAGNET are driven by our motivation to navigate to a more equitable and sustainable future world. Our focus is on integrative macro-economic analyses through cooperation within the MAGNET team and by connecting to other models. We deliver foresight macro-economic analyses of climate change, food and nutrition security, inequality and the biobased economy.

In the following a summary of the activities of the MAGNET team at Wageningen Economic Research in 2021/2022. It again has been a busy year. Next to a wide variety of model developments (expanding our contributions in integrated assessments jointly with biophysical models, increasing detail on food system functioning, better capturing inclusiveness, technical change for a greener future, linking to spatially explicit assessments of environmental and food security impacts) we ran policy focussed projects. These ranged from regularly planned projects (like the IFAD Rural Development Report 2021, analysing impacts of Brexit on fisheries and Scotland) to sudden requests pushing everything aside to support the Dutch ministries in responding to the war in Ukraine.

The future looks bright with several large projects being granted, securing funds for future work on inclusiveness, further links to spatial micro-simulation models, better capturing the role of forestry in the bioeconomy, measuring and where possible internalizing externalities of food production and modelling of biodiversity and natural capital. The new projects also make a stronger connection to academics by hiring new PhD students and participating in various stakeholder platforms and foresight groups. The MAGNET website (<https://www.magnet-model.eu/>) provides access to project information, module descriptions, publications and presents the MAGNET team members.

The MAGNET team changed composition again in the past year. In 2021 Caitlyn Carrico left to join the United Nations Economic Commission for Africa in Cameroon. And a few years in the making both Andrzej and Ewa Tabeau retired in 2021. They will remain honorary MAGNET team members for their enormous contributions to the model and the team. In 2022 Patrizio Lecca joined the team, an experienced policy-oriented CGE modeller formerly with the Dutch Environmental Assessment Agency and the JRC Growth and Innovation Unit at Sevilla. We also welcomed Thijs de Lange, who started as a trainee at WEcR but has now joined the MAGNET team. He brings a mixed background of development economics which fits well with MAGNET’s contributions to integrated assessments.

2 Journal papers

- A. Pyka, G. Cardellini, H. van Meijl, P. J. Verkerk (2022). Modelling the bioeconomy: Emerging approaches to address policy needs. **Journal of Cleaner Production**, 330, pp. 129801.
- Ignacio Perez Dominguez, Agustin del Prado, Klaus Mittenzwei, Jordan Hristov, Stefan Frank, Andrzej Tabeau, Peter Witzke, Petr Havlik, Hans van Meijl, John Lynch, Elke Stehfest, Guillermo Pardo, Jesus Barreiro-Hurle, Jason F. L. Koopman, Maria Jose Sanz-Sanchez (2021). Short- and long-term warming effects of methane may affect the cost-effectiveness of mitigation policies and benefits of low-meat diets. **Nature Food**, 2(12), pp. 970–980.
- Catharina Latka, Marijke Kuiper, Stefan Frank, Thomas Heckelei, Petr Havlik, Heinz-Peter Witzke, Adrian Leip, Hao David Cui, Anneleen Kuijsten, Johanna M. Geleijnse, Michiel van Dijk (2021). Paying the price for environmentally sustainable and healthy EU diets. **Global Food Security**, 28, pp. 100437.
- Stefan Frank, Petr Havlik, Andrzej Tabeau, Peter Witzke, Esther Boere, Mariia Bogonos, Andre Deppermann, Michiel van Dijk, Lena Hoglund-Isaksson, Charlotte Janssens, Monika Kesting, Hans van Meijl, Ignacio Perez Dominguez, Hugo Valin (2021). How much multilateralism do we need? Effectiveness of unilateral agricultural mitigation efforts in the global context. **Environmental Research Letters**, 16(10), pp. 104038.
- Maximilian Kardung, Kutay Cingiz, Ortwin Costenoble, Roel Delahaye, Wim Heijman, Marko Lovrić, Myrna van Leeuwen, Robert M'barek, Hans van Meijl, Stephan Piotrowski, Tevecia Ronzon, Johannes Sauer, David Verhoog, Pieter Johannes Verkerk, Maria Vracholi, Justus H. H. Wesseler, Benz Xinqi Zhu (2021). Development of the Circular Bioeconomy: Drivers and Indicators. **Sustainability**, 13(1), pp. 413.
- Michiel van Dijk, Tom Morley, Marie Luise Rau, Yashar Saghai (2021). A meta-analysis of projected global food demand and population at risk of hunger for the period 2010-2050. **Nature Food**, 2(7), pp. 494–501.
- Sandra G. Marquardt, Jonathan C. Doelman, Vassilis Daioglou, Andrzej Tabeau, Aafke M. Schipper, Sarah Sim, Michal Kulak, Zoran J.N. Steinmanna, Elke Stehfest, Harry C. Wilting, Mark A.J. Huijbregts, 2021, Identifying regional drivers of future land-based biodiversity. **Global Environmental Change**, Volume 69, July 2021, 102304.
- Jonathan C Doelman, Felicitas D Beier, Elke Stehfest, Benjamin L Bodirsky, Arthur H W Beusen, Florian Humpenöder, Abhijeet Mishra, Alexander Popp, Detlef P van Vuuren, Lotte de Vos, Isabelle Weindl, Willem-Jan van Zeist and Tom Kram. "Quantifying synergies and trade-offs in the global water-land-food-climate nexus using a multi-model scenario approach." **Environmental Research Letters** 17.4 (2022): 045004.
- Fujimori, S., Wu, W., Doelman, J., Frank, S., Hristov, J., Kyle, P., Sands, R., Van Zeist, W.J., Havlik, P., Domínguez, I.P. and Sahoo, A., 2022. Land-based climate change mitigation measures can affect agricultural markets and food security. **Nature Food**, 3(2), pp.110-121.
- Fastré, C., van Zeist, W.J., Watson, J.E.M. and Visconti, P., 2021. Integrated spatial planning for biodiversity conservation and food production. *One Earth*, 4(11), pp.1635-1644.
- Shinichiro Fujimori, Wenchao Wu, Jonathan Doelman, Stefan Frank, Jordan Hristov, Page Kyle, Ronald Sands, Willem-Jan van Zeist, Petr Havlik, Ignacio Pérez Domínguez, Amarendra Sahoo, Elke Stehfest, Andrzej Tabeau, Hugo Valin, Hans van Meijl, Tomoko Hasegawa, Kiyoshi Takahashi, Land-based climate change mitigation measures can affect agricultural markets and food security, **Nature Food** 3, 110–121 (2022). <https://doi.org/10.1038/s43016-022-00464-4>.
- Detlef van Vuuren, Elke Stehfest, David Gernaat, Harmen-Sytze de Boer, Vassilis Daioglou, Jonathan Doelman, Oreane Edelenbosch, Mathijs Harmsen, Willem-Jan van Zeist, Maarten van den Berg, Ioannis Dafnomilis, Mariësse van Sluisveld, Andrzej Tabeau, Lotte De Vos, Liesbeth de Waal, Nicole van den Berg, Arthur Beusen, Astrid Bos, Hester Biemans, Lex Bouwman, Hsing-Hsuan Chen, Sebastiaan Deetman, Anteneh Dagnachew, Andries Hof, Hans van Meijl, Johan Meyer, Stratos Mikropoulos, Mark Roelfsema, Aafke Schipper, Heleen Van Soest, Isabela Tagomori, Victhalia Zapata Castillo. 2021. The 2021 SSP scenarios of the IMAGE 3.2 model. **EarthArXiv Preprint**: <https://eartharxiv.org/repository/view/2759/>

3 Presentations

3.1 Upcoming

Alessandro Gatto, Marijke Kuiper and Hans van Meijl. **Eat good waste less? Global food loss and waste in the context of sustainable diets.** GTAP conference, 9-11 June, Online.

Michiel van Dijk, Marijke Kuiper, Thijs de Lange and Jason Levin Koopman (2022). **Subnational projections of income and poverty for Ethiopia: A CGE - spatial microsimulation approach.** GTAP conference, 9-11 June, Online.

Willem-Jan van Zeist, Andrzej Tabeau, Hans van Meijl (2021). **The future of EU agriculture in a global context.** GTAP conference, 9-11 June, Online.

Michiel van Dijk, Marijke Kuiper, Thijs de Lange and Jason Levin Koopman (2022). **SSP based subnational projections of income and poverty: A dynamic spatial microsimulation-CGE modelling approach,** Poster, Scenarios Forum 2022, 20-22 June, Laxenburg, Austria.

Marijke Kuiper, Michiel van Dijk, Hans van Meijl (2022). **Deepening the economic contribution to integrated assessments scenarios by adding more detailed labour projections as drivers of structural change.** Scenarios Forum 2022, 20-22 June, Laxenburg, Austria.

Alessandro Gatto. **Tracing flows of lost or discarded food biomass along global food supply chains.** Agricultural & Applied Economic Association annual conference, Anaheim, USA, July 2022.

Alessandro Gatto, Marijke Kuiper and Hans van Meijl. **Healthier but wasteful? Changes in global food loss and waste with healthier diet.** Abstract submitted for the upcoming EcoMod Conference, Ljubljana, September 2022.

Smeets Kristkova, Z., Cui, D., van Dijk, M'Barek, R., Boysen Urban, K.: **Assessing the impact of Investments for Sustainable Growth in a CGE model – exploring the role of financing and R&D-driven technological progress.** Abstract submitted for the upcoming EcoMod Conference, Ljubljana, September 2022.

Hans van Meijl, Heleen Bartelings, Siemen van Berkum, David Cui, Zuzana Smeets-Kristkova and Willem Jan van Zeist: **Impacts of the conflict in Ukraine on global food security, a CGE approach.** Abstract submitted for the upcoming EcoMod Conference, Ljubljana, September 2022.

3.2 Conferences

H. Bartelings, K. Boysen-Urban, M. Verma. H. van Meijl. M. Verma. **Waste management and circular economy: building a CGE framework.** Presentation Circular@WUR conference, 11-13 April 2022, Wageningen, The Netherlands

Alessandro Gatto, Marijke Kuiper and Hans van Meijl. **Healthier but wasteful? Changes in global food loss and waste with healthier diet.** Circular@WUR conference, 11-13 April 2022, Wageningen, The Netherlands

Hans van Meijl. **Transition pathway: Economics.** Circular@WUR conference, 11-13 April 2022, Wageningen, The Netherlands

Hans van Meijl, Harriëtte Bos, Berien Elbersen, Marieke Meeusen, Hans Dagevos, Iris Vural Gursel, Wim de Haas, Raymond Jongschaap, Saeed Moghayer, Saskia Visser, **Multidisciplinary science-based tools enabling transitions towards a sustainable circular bioeconomy** Circular@WUR conference, 11-13 April 2022, Wageningen, The Netherlands

Saeed Moghayer, Willem-Jan van Zeist, Heleen Bartelings. **Assessment of the baseline development of the EU Biobased plastic sector: exploring business-as-usual and alternative market and recycling options.** Presentation at Circular@WUR conference, 11-13 April 2022, Wageningen, The Netherlands.

Saeed Moghayer, Sjaak Conijn, Hans van Meijl, Chen Liu, Pim Mostert, Peter Verweij. **Circular bio-economy as a climate strategy: an integrated quantitative assessment of its potential and costs in agri-food sector.** Presentation at Circular@WUR conference, 11-13 April 2022, Wageningen, The Netherlands.

Willem-Jan van Zeist, Andrzej Tabeau, Hans van Meijl. **The future of EU agriculture in a global context.** Circular@WUR conference, 11-13 April 2022, Wageningen, The Netherlands

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- Koen Meesters, Lesly Garcia-Chavez, Willem-Jan van Zeist. **On the sustainability of bio-based polymers versus fossil-based polymers.** Poster presentation Circular@WUR conference, 11-13 April, Wageningen, The Netherlands
- H. Bartelings, K. Boysen-Urban, R. M'barek, G. Philippidis, M. Verma. **Modelling food waste and loss in a computable general equilibrium framework.** Presentation at the EU Conference on Modelling for Policy support 22-26 November 2022, Online.
- Wolfgang Britz, Marijke Kuiper, Katarzyna Zawalińska, Luca Salvatici (2021). **Increasing model transparency, quality and coherence by deploying tested modules.** Presentation at the 2021 EU Conference on modelling for policy support: collaborating across disciplines to tackle key policy challenges, 22-26 November, online event.
- Robert M'barek, Kirsten Boysen-Urban, George Philippidis, Hans van Meijl (2021). **All for one and one for all – Considerations about holistic challenges of sustainability analysis.** Presentation at the 2021 EU Conference on modelling for policy support: collaborating across disciplines to tackle key policy challenges, 22-26 November, online event.

3.3 Media outreach

A two-episode documentary on the Bangladesh delta plan 2100 was aired in May 2022, which features also our contribution in food security assessment and delta plan 2100 scenario modelling. Link on YouTube: <https://www.youtube.com/watch?v=ufuiYymo1M8>.

3.4 Other presentations

- Willem-Jan van Zeist & Andrzej Tabeau. **A fresh SSP2 Baseline.** IMAGE symposium, 14-12-2021.
- Willem-Jan van Zeist. **MAGNET.** IMAGE Lecture Series, 26-03-2021.
- Bartelings, H., Smeets Kristkova, Z., **Workshop on impacts of the EU-UK Trade and Cooperation Agreement on fisheries and aquaculture in the EU: Trade aspects.** Presentation given for the European Parliament's Committee of Fisheries.

4 Reports

- Bartelings, H and Smeets Kristkova, Z (2022), **Research for PECH Committee – Workshop on impacts of the EU-UK Trade and Cooperation Agreement on fisheries and aquaculture in the EU – Part II: Trade aspects**, European Parliament, Policy Department for Structural and Cohesion Policies, Brussels.
- Emanuele FERRARI, Wolfgang Britz, Houssein Guimbard, Heleen Bartelings, Torbjörn Jansson, Luca Salvatici (2021). **Definition test case and application in existing models.** D7.1, BATMODEL.
- Karine Latouche, Iliaria Fusacchia, Carl Gaigné, Christophe Gouel, Marijke Kuiper, Alessandro Olper, Andreea Piri, Luca Salvatici, Hans Van Meijl (2022). **Broaden welfare implications of trade policy**, D1.1, BATMODEL.
- Levin-Koopman, Jason; Meijl, Hans van; Cervi, Walter; Moghayer, Saeed; Conijn, Sjaak; Hengeveld, Geerten; Nabuurs, Gert Jan; Jong, Anjo de; Vos, Lotte de; Verweij, P.J.F.M.; Pishgar Komleh, Hassan; Mollenhorst, Erwin; Mostert, Pim. **Linking Manual WR models from KB34 1C toolbox, KB33 WMG toolbox and KB35 MSX.** [Integrated toolbox for cross-sectoral forward looking assessments and scenarios - WUR](#)
- Koen Meesters, Lesly Garcia-Chavez, Willem-Jan van Zeist. **Model of the World/MAGNET Biobased plastics report.** <https://library.wur.nl/WebQuery/wurpubs/593484>
- Van Meijl, H., H. Bartelings, S. van Berkum, D. Cui, Z. Smeets-Kristkova and W.J. van Zeist, 2022. **Impacts of the conflict in Ukraine on global food security.** Wageningen, Wageningen Economic Research, Report 2022-052. 44 pp.; 10 fig.; 3 tab.; 22 ref.
- Moghayer, S.; Meijl, Hans van; Meesters, K.P.H.; Garcia Chavez, L.Y.; Eupen, M. van; Verweij, P.J.F.M.; Conijn, J.G.; Mostert, P.F.; Meer, J. van der; Liu, C.; Fels, H.J. van der, **Integrated toolbox for cross-sectoral forward looking assessments & scenario's for circularity and climate neutrality.** [Integrated toolbox for cross-sectoral forward looking assessments and scenarios - WUR](#)

Zuzana Smeets-Kristkova, Hao David Cui, Hugo Ferrer Pérez, María Pilar Gracia de Rentería, George Philippidis, Ana Isabel Sanjuán López (2021). " **Green Economy – Improvements of Investments and Indicators Module**", Interim Report of the AgEconEurope Framework contract, D3, 935680-2018-A08-NL.

van Zeist, W.J., Tabeau, A. and van Meijl, H., 2021. **De toekomst van de land- en tuinbouw in Nederland, binnen de Europese en mondiale context** (No. 2021-135). Wageningen Economic Research.

5 Projects

As the MAGNET team is large (13 current members) we also run a large number of projects (a total of 32 in 2022 we highlight the areas we work in, grouping work in different projects together by topic.

Integrated assessments of sustainability

- *KB-Integrated toolbox for climate and circularity, KB-Multiple scales, Macroeconomic modelling for integral decision making (LNV), JRC*

MAGNET has a long standing cooperation with other models (like IMAGE and GLOBIO from the Netherlands Environmental Assessment Agency and GLOBIOM at IIASA). Building on this experience we are developing stronger links to the many biophysical oriented models available at Wageningen University and Research. These projects, where MAGNET provides the socio-economic complement to detailed biophysical analyses in other models generally focus on integrated assessments of sustainability. Furthermore, in two recently started projects for the Dutch Ministry of Agriculture and JRC, we are exploring how to incorporate concepts of natural capital and ecosystem services into the model, thus integrating the impacts of biodiversity changes back into economic modelling.

Food system assessments

- *A4NH Food systems foresight, Dhaka food systems, BGD Deltaplan, CCAFS, SHIFT, MITIGATE, Addressing Synergies and Trade-Offs in the Food System Transformation for the Food System Economics Commission (FSEC), PATHWAYS, Connected Circularity, JRC project X21: Modelling features, MINDSTEP*

Food system work started in the FoodSecure and SUSFANS projects work continues with modelling food system interventions, analysing the system impacts of primary production, supply chain and consumption interventions. These studies vary in terms of global scope with aggregate regions, zooming in on how different economic characteristics alter impacts of comparable policies to country-focussed studies (Nigeria, Ethiopia, Bangladesh, Vietnam) enabling the connection to sub-national analyses with micro simulations at household level (Ethiopia) or with a metropolitan focus (Dhaka). This line of works builds on work developed in different strands of research (like SDGS or climate) bringing these together to identify trade-offs and synergies. For FSEC we are currently working on designing policy bundles for food system transformation taking capturing context through a new food system typology. For the recently initiated OneCGIAR initiative SHiFT, we are developing a dynamic spatial microsimulation model that is able to produce subnational projections of income, poverty and food security. The model uses input from MAGNET on wage and price projections to ensure consistency with global-to-national linkages. To aid targeted food system interventions MAGNET sector splits are continuously expanded (current detail is 122 sectors and 141 commodities), where possible cross-checked with technical experts (for example in livestock production). Current focus is on better modelling animal feed, better capturing animal-specific feeding restrictions. Another strand of work focuses on more detail in human diets, among which better tracing of sugar from for example high fructose corn syrup hidden in the other processed food sector. Based on HS6 data for the fruit and vegetable sector, we have implemented a module that standardly splits the v_f sector into five new sectors (vegetables, fruit, pulses, roots, nuts) and includes all relevant data into the SAM. As the program is generic, the split can be changed depending on the demands of the project.

Bioeconomy & circularity

- *Connected Circularity, PATHWAYS, BIOMONITOR, MAGNET bioeconomy modelling, Data for bioeconomy, DG-ENV biobased plastics, KB-Integrated toolbox for climate and circularity, Contribution Bio_economy EU, JRC project X28: foodwaste and loss @Member States*

Early influential work on land and agriculture exemplified by the EURuralis project has expanded in recent years to modelling the bioeconomy in a wider sense to address the food-feed-fuel-fibre competition. When combined with more technical data and modelling efforts MAGNET proves to have an edge in pulling analyses together into an economywide framework beyond the grasp of the partial technical models. Major challenges in this line of work is to combine the dollar-based quantities with biophysical material balances in a consistent manner. Specific extensions of MAGNET are development of a waste module and associated database to analyse different options of using waste and the sectors associated with this; development of a database on biophysical flows accounting for food loss and waste (FLW) jointly with the GTAP centre; current and future to better capture technical details of livestock production and options for a more circular economic system; further enhancement of the modelling of industrial use of biomass (e.g. for bioplastics). The waste module is now extended to include food waste along the supply chain: including post-harvest production loss, processing food waste and retail food waste. As of yet only data for the EU member states is included. It is also intended to include the possibility of using food waste as a source of animal feed. Furthermore, manure will be included as an alternative fertilizer. As a small extension to the bio-economy module, biogas will be included this year.

Climate & energy & water

- *AGCLIM III, AGCLIM IV, SIM4NEXUS, LNV scenario studies, PBL Baselines and mitigation, PATHWAYS, Hard to abate scenarios for PBL*

While connected to the bioeconomy and integrated assessments several projects focus explicitly on climate change mitigation and/or water use. Key developments here are the modelling of natural resource supply functions (needed to allow a reduction in global fossil fuel use in climate mitigation policies) and incorporation of water use in production (top-down and bottom-up modules are available to allowing tailoring to the detail needed in projects). Linked to the analysis of the role of livestock in the circular bioeconomy work is planned to add biogas, manure and swill, adding again more details to the interaction between food and energy sectors. Improving the tracing of biophysical flows (like respecting energy balances) also forms an important component in this strand of work. It is both needed to communicate MAGNET stand-alone results in terms of physical units relevant for policy design as well as enabling a better link to biophysical models in integrated assessments.

Technical change and investment towards a greener economy (Green Deal)

- *MAGNET Green CAP, Bioeconomy to Green Deal, Green deal modelling, LNV scenario studies*

Technical change is an old theme that got revived by changes in the policy landscape: the European Green Deal aims to transform the EU into resource-efficient and competitive economy, with no net emissions of greenhouse gases in 2050. Using MAGNET for investment impact analysis requires that modelling investments is guided by a proper sector investment allocation mechanism, allowing to steer investments into the sectors that are “green”, or aligned with the EU taxonomy (this was completed in 2021). The new advancements in this area are the incorporation of foreign assets and liabilities to gain better insights into the role of foreign ownership of the new green capital. An international database of different types of public R&D has been built with the purpose of disaggregating R&D sector in MAGNET and detailed modelling of R&D effects in for obtaining insights into the role of R&D policies in the Green Deal. Alongside these model enhancements policy focussed work for the Dutch Ministry of agriculture is ongoing on the impacts of a greener EU on the Netherlands.

Trade

- *UK FTA's impact on Scotland, Ukraine, Brexit fisheries, BATmodel*

The revived interest in trade policies continued in our projects with a mix of policy and modelling-focussed projects. In 2021 we updated our 2018 study on the impact of the Brexit on European fisheries, aquaculture and fish processing sectors for the European Parliament. For the Dutch

government we assessed the impact of the Ukraine war on food trade and prices. For the Scottish government we are analysing the impact of UK FTA's on Scotland.

Longer run modular developments in MAGNET's ability for trade analyses are planned in the EU H2020 BATModel project (2020-2024). The overall goal of BATModel is to improve existing trade modelling tools and approaches, equipped for the analysis of 21st-century trade issues with a focus on agriculture and food to support policy analysis. The current needs of the users are to better account for previously neglected or insufficiently covered issues such as NTMs, GIs, zero trade flows and quality differentiation, as well as GVCs and distributional and sustainability impacts of trade liberalisation and trade policy. MAGNET's contributions in BATModel focus on (1) broadening welfare measurements (specifically employment & income distribution, nutrition & health and SDGs); (2) modelling of Global Value Chains; (3) collaborating with peer research organizations to improve on GTAP's MRIO database; (4) making all CGE model developments available through coding the GEMPACK versions of the BATmodules that will be made publicly available in the course of the project (alongside GAMS versions coded by other consortium members).

Inclusiveness, income distribution and SDGs

- *BATmodel, Addressing Synergies and Trade-Offs in the Food System Transformation for the Food System Economics Commission, KB-Multiple scale*

Work on modelling of labour markets improves as it provides one important channel for changes in income distribution that can be tackled with a global CGE model like MAGNET. Building on the labour-focussed inclusiveness measures for the IFAD rural development report we are currently working on inclusiveness for the Food System Economics Commission in a project aimed at designing policy-bundles that transform food systems towards more inclusiveness, health, and environmental sustainability. This work also builds connections to the spatial downscaling efforts in the KB projects on multiple scales. For the BATMODEL a review has been made on how to broaden trade assessments beyond GDP and monetary welfare measures, also addressing the challenges of communicating a myriad of indicators in a useful way for policy design.

Spatially explicit downscaling

- *KB-Multiple Scales, KB 1C, Dhaka food systems, Innovation project "Bridging the macro-micro gap", OneCGIAR SHiFT*

Linked to the work on food security and inclusiveness (calling for an assessment at household and not national level) and climate change (with spatially heterogenous impacts) work on downscaling MAGNET results continues. One initiative involves the development of MAGNETgrid, which is a separate model that combines spatially explicit economic and biophysical data to pixelate MAGNET output, most importantly, land use and crop area projections. MAGNETgrid allows MAGNET output to be combined with output from biophysical models (e.g. water and crop models) for more detailed and integrated assessments. The model is currently being developed and tested in several WUR internal knowledge base (KB) projects and features in several upcoming projects. Another initiative aims to downscale income and food demand by means of combining MAGNET projections on wage and food prices with household survey data in a dynamic spatial microsimulation framework in order to create subnational projections of income, poverty and food security. Results for Ethiopia of an approach to spatially downscale labour details will be presented at the GTAP conference and is also used for the Dhaka Metropolitan area. Approaches to use machine-learning using household survey data are being tested to improve the spatial downscaling approaches.

Maintenance and quality control

- *KB-Regieteam modellen, Data Stewards, MAGNET improving modelling features, WEcR investment*

Maintaining a model developed by large team in a project based environment with limited to no funds for maintenance and quality control remains a constant battle. Pairing JRC investments in MAGNET and WEcR wide investments we have updated the GTAP model at the core of MAGNET to V7 - a major overhaul as all modules had to be tested and adjusted to match new variable and set definitions. Alongside the model overhaul we are developing a standardized set-up for MAGNET baselines which has highlighted the importance of the indicators chosen to judge a baseline and their possible

conflicts. Given the breadth of scope offered by the MAGNET modules some pragmatic guidance is needed on what to check for in a baseline to avoid potential lopsided calibration driven by the project or modelers' specific indicator focus.

Large investments have also been made in automating the transfer & concatenation of model solution files in the DataWarehouse (DWH) developed for database management at WECR. Through this DWH model solution files are versioned (key for quality control) and made available for further analyses. PowerBI templates of commonly reported MAGNET variables are developed, allowing easy and interactive access to model results. For example, using PowerBI Sankey diagrams of waste flows can be generated to visually communicate complex economywide waste flow. MAGNET results in the DWH can also be queried for further analysis in R or through dashboards developments with Shinyapps. The DWH allows queries of MAGNET solution files facilitating data exchange need for linking to other models, like MAGNETgrid which spatially downscales MAGNET results and ongoing work on spatial micro-simulation models. So far only results are stored in the DWH but that will be changed this year to also include the model basedata in DWH. By adding an version control on the basedata we want to improve the reproducibility of model results and reduce the investments needed to update the data periodically.

This year our interface program called DSS will be completely rewritten to fix bugs, improve functionality and to ensure a stable link between MAGNET and DWH.

6 Other Activities

6.1 Team coherence and synergies

A large team and project portfolio provides a continuous challenge to keep both team and model together. As part of our effort to consolidate and develop MAGNET we hold regular update meetings and research workshops at Wageningen Economic Research to present research and address specific issues in depth. Below an overview of presentations at these workshops. Their aim is to tackle model development relevant for multiple projects to increase synergies across projects and team members. Typically the consist of short presentations of project results or model issues around a particular topic followed by discussions on how to take these further in ongoing and future projects.

- **Food and nutrition security (5 July 2021)**
 - Food & Nutrition Security in MAGNET: Marijke, Michiel, Zuzana, Saeed
- **MAGNET Policy Interface (13 September 2021)**
 - Micro-level and spatial modelling of socio-economic ('just') indicators: Michiel
 - MAGNET SDG insight module: George Philippides
 - Possibilities of Modelling 'Just Space' & SDG Indicators in MAGNET' : Lindsay Shutes
- **Historical baselines (11 October 2021)**
 - Making a long-run baseline in a multi-country model: Peter Dixon
- **Virtual water flows (14 October 2021)**
 - Impact of the implementation of the African Continental Free Trade Area (AfCFTA) on virtual water trade flows: Benedetta Falsetti
- **GTAP V7 baseline (13 December 2021)**
 - New SSP2 baseline: Willem-Jan, Andrzej
- **Biodiversity (8 February 2022)**
 - Biodiversity and MAGNET: Hans
- **Modeling water in MAGNET (10 May 2022)**
 - Review of existing approaches for modelling water in MAGNET: bottom-up and top-down, improvement of the bottom-up approach: Jason with inputs of George
 - Footprint measurement for tracking virtual flows in water, emissions, nutrition, etc. in MAGNET: Jason with George's input
 - Alternative approach for footprint modelling linked to LCA: Willem-Jan with Marijke's input
 - Modelling water using model linkages (MAGNET Grid, MRIO), alternative databases for water modelling: jointly with inputs from Oliver Taherzadeh

6.2 Education and training

The group of MAGNET developers and users is constantly expanding. Therefore it is important to provide adequate training, both in-house for new MAGNET team members as well as for our important clients and potential users, such as new PhD students. Below is a list of training activities organized in the period 2021-2022:

MAGNET Summer School – Wageningen School of Social Sciences (Envisaged 29 August – 2 September 2022, Wageningen)

Linked to Hans van Meijl's professorship at Wageningen University a MAGNET-focused summer school will be organized in September and hosted by the Wageningen School of Social Sciences. This training may become the basis for a regular CGE course at Wageningen University to help attract junior researchers with the required technical skills for modeling. The MAGNET summer school provides both an overview of MAGNET model and important applications in the area of bioeconomy and food security as well as practical hands-on training using the GEMPACK programming language. Using a step-by-step approach, the participants will be able to build their own (simple) version of a CGE model in Gempack. It is also envisaged that a follow-up MAGNET course will be offered using the first open source version of MAGNET.

SUPREMA-GLOBIOM MAGNET Training (December 2020 – or 2021??)

As part of the Horizon 2020 SUPREMA project, the IIASA and Wageningen Economic Research hosted training on GLOBIOM and MAGNET models.

MAGNET IMAGE Lecture Series, 26-03-2021. Presentations linked to MAGNET's role in IMAGE modelling framework for integrated assessments of the global environment.

MAGNET trainings for JRC (September 2021, September 2022)

These periodical trainings provided for the JRC staff are focused on practical use of MAGNET model and all the interfaces such as the DSS software. It guides the participants from building their own MAGNET aggregation to running and interpreting MAGNET scenarios. Attention is also paid to checking the correctness of the solution and solving the potential errors such as closure problems, etc.

More information

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