Report to the GTAP Advisory Board 2018

Wageningen Economic Research (previously LEI), part of Wageningen University and Research (WUR), has been a member of the GTAP consortium since November 1996. We use the GTAP database and model for a variety of research activities related to the agri-food sector and beyond.

In particular, 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 standard 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. See annex 2 for an overview of the current structure of the MAGNET model.

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. A website has been launched (http://www.magnet-model.org/) in order to provide access to project information, module descriptions and publications. Consolidating and developing MAGNET, we continue to hold regular update meetings and research seminars at Wageningen Economic Research to present research and address specific issues in depth.

In the following a summary of the activities of the MAGNET group at Wageningen Economic Research in 2017/2018 is presented.

People

In Annex 1 a list of the team members and their main area of CGE related research with contribution to GTAP/MAGNET is presented. Within this reporting period two new colleagues have joined the team. *David Cui* has started in WEcR since autumn 2017 working on long term projections, climate and scenario analyses in general. *Saeed Moghayer* has started in Spring 2018 focusing on the food-water-energy nexus.

Marijke Kuiper, Lindsay Shutes, Andrzej Tabeau and Heleen Bartelings have been managing the MAGNET team within Wageningen Economic Research. Their main task is coordinating the programming activities in the GTAP/MAGNET work on a day to day basis. Hans van Meijl remains the scientific leader and contact person for GTAP/MAGNET work.

Awards

Emerald Citations of Excellence Winner 2017
von Lampe, M., Willenbockel, D., Ahammad, H., Blanc, E., Cai, Y., Calvin, K., Fujimori, S., Hasegawa, T., Havlik, P., Heyhoe, E., Kyle, P., Lotze-Campen, H., Mason d'Croz, D., Nelson, G. C., Sands, R. D., Schmitz, C., **Tabeau, A.**, Valin, H., van der Mensbrugghe, D. and **van Meijl, H.**, 2014, Why do global long-term scenarios for agriculture differ? An overview of the AgMIP Global Economic Model Intercomparison. Agricultural Economics,

Alan A. Powell Award: Hans van Meijl
Each year at the GTAP Advisory Board meeting we present an award to one of the members of the Board in recognition of outstanding service. This award is in honor of one of the Founding Members of the Advisory Board, and the intellectual grandfather of GTAP - Alan A. Powell.
The 2017 recipient of the Alan A. Powell Award is Dr. Hans van Meijl, Research coordinator, bioeconomy and energy-climate-water-food nexus, Wageningen Economic Research. Hans van Meijl has been an outstanding contributor to the GTAP Network for more than two decades. He assumed leadership for all of the global economic research at LEI and proceeded to build up a first rate team of researchers. Importantly, he has also worked to forge intra-EU collaborations across those European institutions using GTAP, leading a number of very important EU-funded projects.

Looking ahead – focus areas for the coming year

The sizeable group of researchers involved with MAGNET work makes it worthwhile to exploit potential economies of scale, overcoming limits posed by project-driven research as done at Wageningen Economic Research. For the coming year work on the following cross-cutting themes is planned, funded by a range of projects (more details can be found under CGE-related research).

- *Bio-based economy*: MAGNET has been extended with a large number (about 20) new sectors related to the supply of biomass (residues, plantations, pellets) and conversion of biomass (electricity, chemicals). In 2017, MAGNET was applied to quantify the impact of a Bioeconomy in the European Union (JRC project, Philippidis et al. 2018). Several policies related to the current and new Renewable Energy Directive were quantified. The impacts were quantified on several SDGs. The focus in 2018/2019 is on various assessments of the socio-economic and environmental impacts of bioenergy use and especially on synergy and trade-off effects of strategies to avoid undesirable land use change and food security effects. The H2020 Biomonitor project will be a key project to enhance data and add new biobased sectors.

- *Food and nutrition*: work on a sustainable, healthy and accessible diet in the SUSFANS project continues this year by exploiting the model developments of the past years (waste, imperfect competition, macro and micro nutrient availability) in scenario-based assessments jointly with GLOBIOM and CAPRI while connecting to detailed food intake data for 4 EU countries (France, Italy, Denmark, Czech republic) to better capture the variability in nutritional content of especially processed food (across demographic groups in long term projections). Scenario results will be presented in a consistent SUSFANS framework of nutrition, profitability, environment and equity metrics.

- *Microsimulation tool for modelling diets:* In order to reflect better the ongoing processes of food systems transformation connected to diet quality changes and corresponding nutrition-health linkages, an effort will be made to build a microsimulation tool that will enable to link macro drivers with household/individuals' consumption choices. Tracing aggregate consumption to the household and/or individual level will enable to estimate precisely the nutritional outcomes (both macro and micronutrients) and will be useful for capturing the health effects linked to consumption of particular foods (relevant for food-borne disease burden in developing countries and obesity-related diseases in developed countries).

- *Food security and environment nexus:* exploiting the modular character of MAGNET we will analyze the food security implications of the bio-based economy and climate change; i.e. combining several main strands of MAGNET developments to assess potential food security/environment trade-offs.

- *Water:* An explicit accounting of water use in agriculture has been included in the MAGNET model as an ex-post analysis to assess the change in water demand. In the coming year this will be linked to an explicit agricultural water endowment. In addition, in the coming year a framework to trace virtual water flows and assess a water (and land) footprint will be included.

- *Dynamic Natural Resource Stocks:* In order to capture the effects of a global carbon tax and the subsequent reduction in the production of fossil energy. Magnet will be extended with dynamic natural resource stocks developments for gas, coal and crude oil. Available stock of resources will be endogenous in the model instead of exogenous.

- *Sustainable Development Goals:* Expand the coverage of SDG indicators produced by the model for evaluating progress towards the SDGs in an ex-ante modelling framework.[1]

- *Imperfect competition:* In response to the relatively recent advances in the modelling literature on the role of market power, an imperfectly competitive market module has been incorporated into MAGNET. The module permits the user to switch between perfect competition, Spence-Dixit-Stiglitz-Krugman type monopolistic competition and the more recent Melitz model.

- Post processing: Magnet results will be incorporated in an access data model and PowerBI templates will be made available for result analysis and reporting.

[1] http://www.magnet-model.org/MAGNET%20SDG%20Insights%20Module%20Flyer.pdf

CGE-related research in 2017/2018

Data and model management software

- The GENUS database with global data on macro and micro nutrient availability for 225 (primary) commodities has been added to the MAGNET database

Emission module

- The developed emission module makes it now possible to solve MAGNET either with a CO2 tax or with an emission reduction target.
- Carbon tax driven adoption of new technology by producers is implemented as means to reduce emissions. This is done by means of abatement curves. Costs of adopting a new technology enter the production function. The approach enables use of alternatives (tax or subsidy) to incentivize emission cuts.
- A system of emissions permit trading is incorporated into the model.

Linking of models and long term scenario development

- AgMIP: Comparison of alternative approaches for long-term scenarios for agricultural markets and trade
  - Wageningen Economic Research/MAGNET and PBL/IMAGE teams are busy with quantification of RAPs (Representative agricultural pathways) and climate scenarios. The SSP1, 2, 3, 4 and 5 story lines and macro-economic assumptions are used. Teams involved are GCAM, AIM, IIASA (GLOBIOM for land use part), PIK (Remind-MagPie). For JRC, mitigation and adaptation scenarios are analyzed by Wageningen Economic Research\PBL (MAGNET-IMAGE), IIASA (Globiom), PIK (Magpie) and UniBonn (CAPRI). This work is published at JRC website (Meijl et al. 2017) and in ERL (Meijl et al. 2018b). A paper focusing on food security impacts of climate change and mitigation is led by Tomoko Hasegawa (forthcoming, Nature Climate Change). In a follow up JRC project (Agclim50II) various mitigation (CO2 taxes) and diet change scenarios have been quantified (Frank et al. submitted, NCC).
  - Impact of different shocks on scenario results will be investigated. The decomposition method will be used.
- In SUSFANS a link with a micro-level diet data is developed. This provides a new set of challenges with the need to simultaneously account for diversity in the population (age, sex and education) while the micro detail lack socio-economic detail needed for detailed demand modelling
- Combining forces with similar needs in the CGIAR sponsored A4NH and CCFAS projects a approach is being developed where a micro-simulation diet model bridges the macro and micro level approaches. This will be tested for Nigeria (A4NH) and Bangladesh (CCFAS).
- In the ongoing SIM4NEXUS project, MAGNET is working together with the models IMAGE-GLOBIO (PBL), E3ME (Cambridge Econometrics), MAgPIE (PIK), CAPRI (UPM), and OSeMOSYS (KTH), to explore variations of the SSP2 scenario, particularly focusing on the consequences of aggressive global mitigation policy, from the perspective of the Nexus of Water, Food, Land, Energy and Climate.

Examining the interactions between climate and trade, and implications for global food security

- Climate change is expected to have an overall negative impact on food security and alter trade flows in multiple dimensions: exports and imports in different regions and different sectors may respond to climate change differently. On the other hand, changes in trade environment via removing border tariffs are expected to mitigate to some extent the overall negative impacts of climate change to global economy and food security.

Impacts of bioenergy production and use

- In a project, financed by JRC, the impact of a bioeconomy in the European Union has been quantified (Philippidis et al. 2018). Several policies related to the current and new Renewable Energy Directive were quantified. Impacts were quantified for various SDGs.
- The macro-economic assessment study of the bioeconomy for the Netherlands has been published (Meijl et al. 2018).
- Biofuel production and use scenarios will be developed and implemented in MAGNET to analyze the impacts of biofuel policies on food security in Ghana. The analyses will be done

at household level, possibly results will be given for nutritional values. This project is carried out in collaboration with Utrecht University.

Food loss and waste

- An analyses of the socio-economic and environmental effects of reducing food loss and waste in agricultural supply, food processing, food retail and in the household consumption phase in France in 2030 is carried out using MAGNET. This project is commissioned by the French Environment and Energy Management Agency (ADEME) and is coordinated by Vertigo Lab.
- Supported by knowledge funding program of ministry of economic affairs work in the field has culminated in a) a framework to determine consumer food waste as driven by income b) a systematic framework to look at Food losses justified by some micro-case study results. Further going in the direction towards implementing a circular system of food waste and loss in MAGNET.

Household modeling

- The household module has been applied this year in a study for the World bank to assess the economic costs and benefits of an improved food safety system in India, accounting for differential impact across household types. Results will be presented in Cartagena.

Global household database

- In the context of SUSFANS multiple household groups are being introduced Czech Republic.

Consumption and nutrition

- A GENUS nutrition module has been added to MAGNET, allowing targeting of food-based guidelines or macro/micro nutrient availability.
- In the longer term the CGIAR flagship programme, coordinated by Wageningen UR and administered by Wageningen Economic Research on Food systems for Healthier Diets will shape much of future work on diets and nutrition.

Imperfect competition

- Under the auspices of the Jobs and Growth project financed by the European Commission (JRC), a study was undertaken to examine the export competitiveness of the EU dairy sector. To this end, a Melitz model variant was employed, following the work of Akgul et al. (2016). This model is particularly pertinent for this topic, since as well as including the traditional 'scale' and 'variety' effects associated with market power and endogenous product differentiation, the Melitz model also explicitly contemplates the self-selection of firms by sales markets, which allows the user to contemplate changes in exports at the extensive margin (i.e., penetration into previously untapped export markets).

CAP module

- The current CAP module employs detailed auditing data supplied by the European Commission (DG Agri). The data covers the split of pillar 1 payments (market support) between coupled (including article 68/69) and decoupled payments, whilst the coverage of pillar 2 (rural development) covers Axis 1 to 6. From this data, a CAP baseline has been developed, although the coverage of years is limited. In addition, the modelling of the CAP budget module has been modified to permit more detailed policy shocks by specific CAP measures as well as the creation of an 'own-resources' component where CAP expenditure is explicitly co-financed by Member States. The rebate component of this module will also be updated with the change of benchmark years from 2007 to 2011.

Fisheries

- The database used by MAGNET was extended to include both wild catch fisheries, aquaculture and fish processing sectors. Interactions between aquaculture and fisheries, for example fisheries providing fishmeal and fish seed to aquaculture were taken into account. Feed is also explicitly modelled and attention is given to the competition between aquaculture and cattle sectors for available feed. Since the size of the fish stock is one of the primary drivers for the fisheries sector, attention was given to modelling of the fish stocks. Fish stocks are treated independently of other natural resources, removing thus the unwanted competition of mining sector and fisheries over the same natural resource. Given that the parameters of fish stocks vary significantly across fish types, three broad fish types were included in MAGNET: Pelagic Marine fish, Demersal Marine Fish and Crustaceans. The fish module has

been used in the horizon 2020 project SUCCESS to calculate the impact Brexit will have on fish related sectors. This research has been published in the Guardian[2].

Sustainable Development Goals

- A range of official and supporting indicators for measuring progress towards the Sustainable Development Goals have been introduced in the MAGNET SDG Insights module[1] and applied to the case of the bioeconomy in Europe.

Climate module

- The climate module of MAGNET was introduced in MAGNET. It implements the climate variables and related equations - CO2 concentration, radiative forcing, potential temperature and actual temperature – to the model and introduces a function linking change in the temperature to impact on agricultural yields productivity.

Land use emissions

- GHG-emissions calculation due to land use and land use change is implemented in the model.

Climate and agriculture

- Examining relation between climate, adaptation and mitigation policies and climate change by mean of analysing a set of alternative scenarios by five several global climate and agro-economic models including, among others, integrated assessment (IMAGE) model, partial equilibrium (CAPRI, GLOBIOM, MAgPIE) model and computable general equilibrium (MAGNET) model

Migration

- Inclusion of international migration in MAGNET based on the GMig2 model (Walmsley, Winters, & Ahmed, 2007) which extends the GTAP framework to include bilateral labour migration data and explicitly models the movement of workers and estimates the level of remittances.

MAGNET related 2017/2018 publications

Journal articles & book chapters:

- Boulanger, P., Philippidis, G., Urban, K. (2017) Assessing potential coupling factors of European decoupled payments with the Modular Agricultural GeNeral Equilibrium Tool (MAGNET), Joint Research Centre Technical Report, EUR 28626 EN. Luxembourg (Luxembourg): Publications Office of European Union; 2017. JRC104276
- Doelman, J., Stehfest, E., Tabeau, A., van Meijl, H., Lassaletta, L., Neumann-Hermans, K., Gernaat, D.E.H.J. ,Harmsen, M., Daioglou, V., Biemans, H., van Vuuren, D.P., 2018. Exploring SSP land-use dynamics using the IMAGE model: regional and gridded scenarios of land-use change and land-based climate change mitigation, Global environmental change : human and policy dimensions, 48 . - p. 119 - 135.
- Helming, J., Tabeau, A., 2018. The economic, environmental and agricultural land use effects in the European Union of agricultural labour subsidies under the Common Agricultural Policy. Regional Environmental Change, March 2018, Volume 18, Issue 3, pp 817–830.
- Lotze-Campen, H., Verburg, P., Popp, A., Lindner, M., Verkerk, H., Moiseyev, A., Schrammeijer , E., Helming, J., Tabeau, A., Schulp, N., van der Zanden, E., Lavalle, C., Batista de Silva, F., Eitelberg, D., Walz, A., Bodirsky, B., 2018. A cross-scale impact assessment of European nature protection policies under contrasting future socio-economic pathways. Regional Environmental Change, March 2018, Volume 18, Issue 3, pp 751–762.

[2] Guardian 24 April - Hard Brexit would mean more and cheaper British fish – but there's a catch

- Mellios, N., Koopman, J.F.L, Laspidou, C. , 2018. Virtual Crop Water Export Analysis: The Case of Greece at River Basin District Level. Geosciences (Switzerland). 9.10.3390/ geosciences8050161.

- Philippidis, G., Bartelings, H., Smeets, E., 2018. Sailing into Unchartered Waters: Plotting a Course for EU Bio-Based Sectors. Ecological Economics, 147: 410-421.

- Philippidis, G., Waschik, R., 2018. Melitz Meets Milk: The Impact of Quota Abolition on EU Dairy Export Competitiveness, Journal of Agricultural Economics, (forthcoming).

- Riahi, K., van Vuuren, D. P., Kriegler, E., Edmonds, J., O'Neill, B., Fujimori, S., Bauer, N., Calvin, K., Dellink, R., Fricko, O., Lutz, W., Popp, A., Cuaresma, J.C. ,Samir K.C. , Leimbach, M., iang, L., Kram, T. ,Rao, S., Emmerling, J., Ebi, K., Hasegawa, T. , Havlik, P. ,Humpenöder, F. , Aleluia Da Silva, F. , Smith, S., Stehfest, E., Bosetti, V., Eom, J., Gernaat, D., Masui, T. , Rogelj, J., Strefler, J. , Drouet, L. , Krey, V. ,Luderer, G. , Harmsen, M., Takahashi, K., Baumstark, L. , Doelman, J. , Kainuma, M., Klimont, Z., Marangoni, G. , Lotze-Campen, H. ,Obersteiner, M. , Tabeau, A. ,Tavoni, M. , 2017. The Shared Socioeconomic Pathways and their Energy, Land Use, and Greenhouse Gas Emissions Implications: An Overview. Global Environmental Change Volume 42, January 2017, Pages 153–168.

- Shutes, L., Philippidis, G., M'barek, R., Ronzon, T., Ferrari, E., van Meijl, H., 2017. SDGs in the global MAGNET model for policy coherence analysis. Research Brief. European Commission-Joint Research Centre. JRC108799.

- Smeets- Kristkova, Z. , van Dijk, M., van Meijl, H., 2017. Assessing the impact of agricultural R&D investments on long-term projections of food security, Frontiers of Economics and Globalization 17 . - p. 1 - 17.

- Stürck, J., Levers, C., van der Zanden, H., Schulp, C.J.E., Verkerk, P.J. , Kuemmerle, T., Helming,J., Lotze-Campen, H., Tabeau, A., Popp, A., Schrammeijer, E., Verburg, P., 2018. Simulating and delineating future land change trajectories across Europe. Regional Environmental Change, March 2018, Volume 18, Issue 3, pp 733–749.

- Tabeau, A., van Meijl, H., Overmars, K. P. and E. Stehfest, 2017. REDD policy impacts on the agri-food sector and food security, Food Policy, Volume 66, Pages 73–87.

- van Meijl, H.,Tsiropoulos,Y., Barteling, H., Hoefnagels, R., Smeets, E., Tabeau, A., Faaij, A. , 2018. On the macro-economic impact of bioenergy and biochemicals – Introducing advanced bioeconomy sectors into an economic modelling framework with a case study for the Netherlands, Biomass and Bioenergy, 108 . - p. 381 - 397 (Impact factor 3.1).

- van Meijl, H., Havlik, P., Lotze-Campen, H., Stehfest, E., Witzke, P., Perez-Dominguez, I., Bodirsky, B., van Dijk, M., Doelman, J., Fellmann, T., Humpenöder, F., Levin-Koopman, J, Müller, C., Popp, A., Tabeau, A., Valin, H., van Zeist, W.J., 2018b. Comparing impacts of climate change and mitigation on global agriculture by 2050, Environmental Research Letters. https://doi.org/10.1088/1748-9326/aabdc4.

- Verkerk, P.J., Lindner, M., Pérez-Soba, M., Paterson, J.S., Helming, J., Verburg, P. H., Kuemmerle, T., Lotze-Campen, H., Moiseyev, A., Müller, D., Popp, A., Schulp, C.J.E., Stürck, J., Tabeau, A., Wolfslehner, B. and van der Zanden, E.H. ,2016. Identifying pathways to visions of future land use in Europe. Regional Environmental Change, doi:10.1007/s10113-016-1055-7.

Conference papers

- Smeets-Kristkova, Z., 2018. Are national food systems delivering on the Sustainable Development Goals? Macro-level analysis of Nigeria, Vietnam, Ethiopia and Bangladesh. Paper will be presented at International Conference on Economic Modelling, EcoMod 2018, Venice.

- Koopman, J.F.L. , Kuik, O., Tol, R. ,Van Der Vat, M. ,Hunink, J. and Brouwer, R., 2017. The economic impact of irrigation water scarcity from climate change: A CGE analysis distinguishing

between surface and ground water. Presented at the 20th annual conference on Global Economic Analysis, Purdue University. 07-09 June 2017.

Reports & working papers

- Cui, D. , Kuiper, M., van Meijl, H., and Tabeau, A., 2018. Climate change and global market integration: implications for global economic activities, agricultural commodities, and food security. FAO SOCO 2018 background paper. Wageningen Economic Research 2018.

- Dudu, H., Smeets-Kristkova, Z., 2017. Impact of CAP Pillar II Payments on Agricultural Productivity, JRC Technical Report No: EUR; doi: 10.2760/802100.

- Henderson, B. et al. (2018), A global economic evaluation of GHG mitigation policies for agriculture, OECD, COM/TAD/CA/ENV/EPOC(2018)7.

- Kuiper, M., Shutes, L., Verma, M., Tabeau, A., van Meijl, H., 2018. Exploring the impact of alternative population projections on prices, growth and poverty developments. Background paper to the UNCTAD-FAO Commodities and Development, Report 2017 Commodity markets, economic growth and development. Food and Agriculture Organization of the United Nations. Rome.

- Levin-Koopman, J., van Meijl, H., Smeets, H., Tabeau, A, Faaij, A., Stehfest, E., van Vuuren, D.P., Daioglou, V., Gerssen-Gondelach, S., WickeManaging, B**.,** 2017. LUC-induced GHG emissions and price impacts from bioenergy under different scenarios. Deliverable 13, Knowledge Infrastructure for Sustainable Biomass Project.

- M'barek, R., Barreiro-Hurle, J., Boulanger, P., Caivano, A., Ciaian, P., Dudu, H., Espinosa, M., Fellman, T., Ferra¬ri, E., Gomez y Plana, S., Corrin Gonzalez, C., Himics, M., Louhichi, K., Perni, A., Philippidis, G., Salputra, G., Witzke, P., Genovese, G. 2017. Scenar2030 - Pathways for the European And Agriculture and Food Sector Beyond 2020, Joint Research Centre, Europe¬an Commission, EUR 28797 EN, Publications Office of the European Union, Luxembourg.

- Philippidis, G., Bartelings, H., Helming, J., M'barek, R., Ronzon, T., Smeets, E., van Meijl, H., Shutes, L., 2018. The MAGNET model framework for assessing policy coherence and SDGs - Application to the bioeconomy. EUR 29188 EN, Publications Office of the European Union, 2018, Luxembourg, 2018, ISBN 978-92-79-81792-2, doi:10.2760/560977, JRC111508.

- Philippidis, G., Helming, J., Tabeau, A., 2017, Model linkage between CAPRI and MAGNET: An exploratory assessment, JRC Technical Report No EUR 28625 EN.

- Smeets Kristkova, Z., Grace, D, and Kuiper, M., 2017. 'The Economics of Food Safety in India - a Rapid Assessment'. The Hague: LEI Internationaal Beleid.

- Tabeau, A., Helming, J., Philippidis, G., 2017, Land Supply Elasticities, Overview of available estimates and recommended values for MAGNET, JRC Technical Report No EUR 28626 EN.

- van der Esch, S., ten Brink, B., Stehfest, E., Bakkenes, M., Sewell, A., Bouwman, A., Meijer, J., Westhoek, H, van den Berg, M., Tabeau, A., van Meijl, H., 2017. Exploring future changes in land use and land condition and the impacts on food, water, climate change and biodiversity, PBL publication number: 2076, PBL Netherlands Environmental Assessment Agency, The Hague, 2017.

- Van Meijl, H., Havlik, P., Lotze-Campen, H., Stehfest, E., Witzke, P., Pérez Domínguez, I., Bodirsky, B., van Dijk, B., Doelman, J., Fellmann, T., Humpenoeder, F., Levin-Koopman, J., Mueller, C., Popp, A., Tabeau, A., Valin, H., 2017. Challenges of Global Agriculture in a Climate Change Context by 2050 (AgCLIM50). JRC Science for Policy Report, Luxembourg: Publications Office of the European Union, doi: 10.2760/772445.

Annex 1 – MAGNET team at LEI

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- Fertilizers
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- Fisheries and aquaculture

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Annex 2: Overview of the structure of the MAGNET model