



POTSDAM INSTITUTE FOR
CLIMATE IMPACT RESEARCH

GAMS code, modules & realizations

How do the magpie folder and code look like?

Presenter: Isabelle Weindl

weindl@pik-potsdam.de

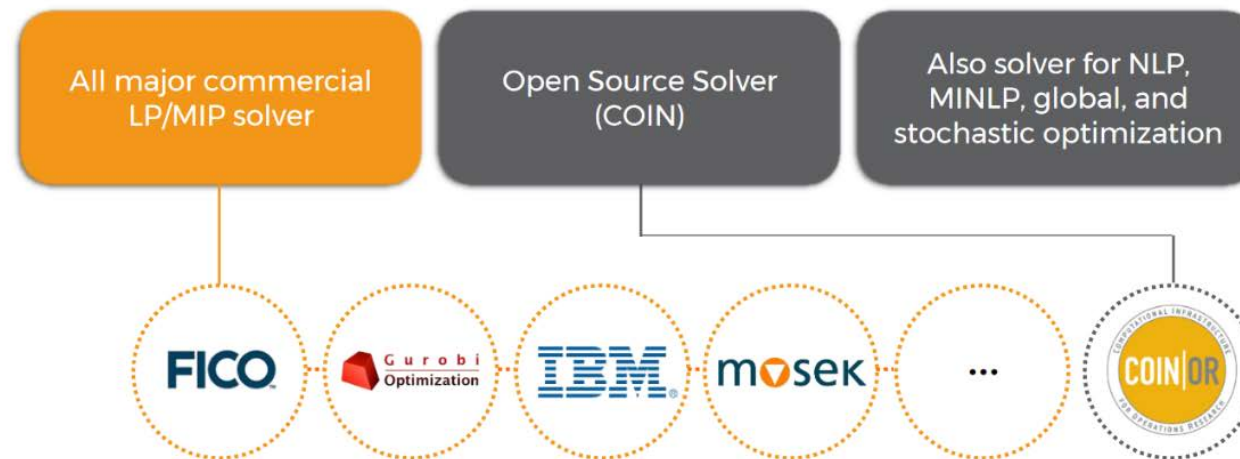
June 16, 2025

- What is GAMS?
- General structure of the MAgPIE Model
- **The magpie folder:** Components of MAgPIE, the structure of modules and realizations, and the full.gms file
- Coding etiquette: Variable and parameter naming
- Brief exercise

What is GAMS?

- › MAgPIE is written in the **General Algebraic Modeling System (GAMS)** language

*“GAMS is a high level modeling system for **mathematical programming** and **optimization**. It consists of a **language compiler** and a range of associated **solvers**.”*



Useful links:

GAMS at a glance: <https://www.gams.com/products/gams/gams-language/>

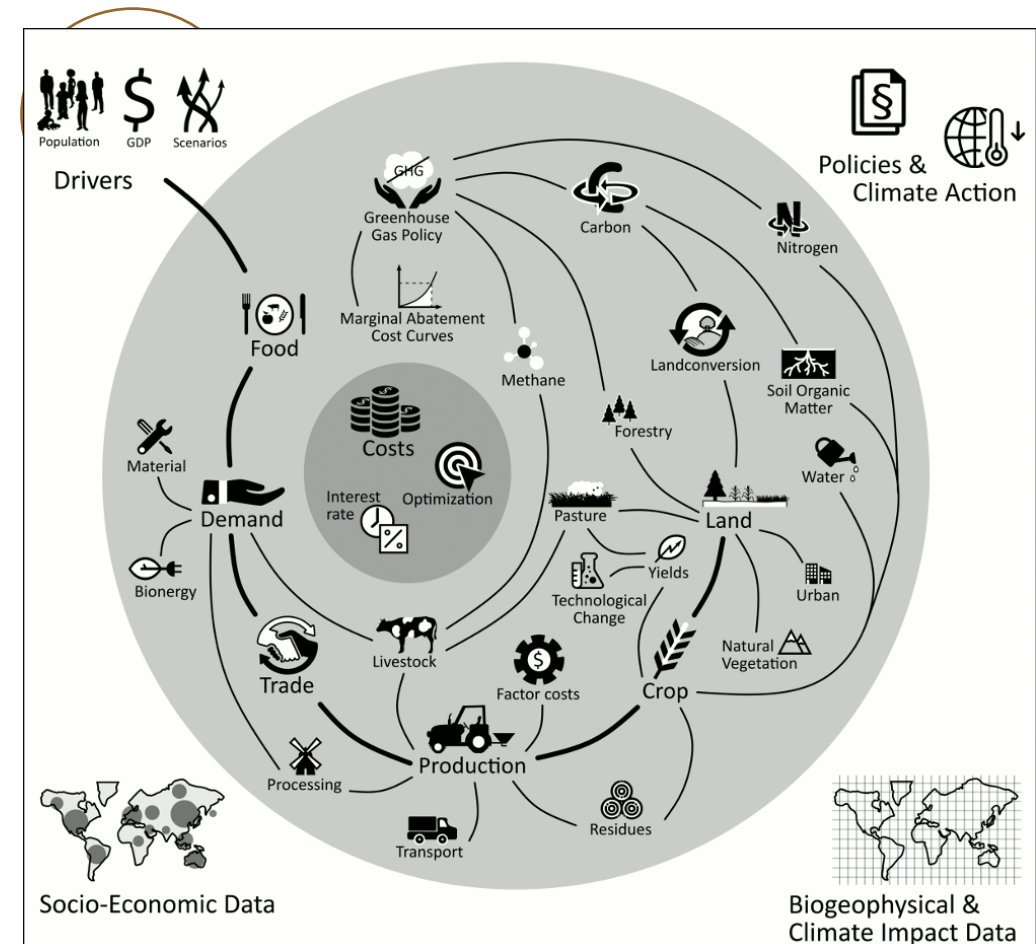
GAMS documentation: <https://www.gams.com/latest/docs/>

General structure of the MAgPIE Model



- Future **population** and **GDP** are the main drivers (different **scenarios**).
- **Food consumption** patterns lead to **demand** for primary agricultural products.
- **Trade** patterns lead to regional **production**.
- **Production and biophysical** yield and water availability data shape **cropping patterns**.
- **Cropping patterns** drive **land use** decisions.

These interactions and calculations are described in the modules of MAgPIE.



More info at: <https://rse.pik-potsdam.de/doc/magpie/4.10.1/>

The magpie folder: Components of MAgPIE



After you have **cloned the magpie folder** (*git clone <https://github.com/magpiemodel/magpie.git>*) from the repository, you will find :

Name	Date modified	Type	Size
.git	15 Jun 2025 15:55	File folder	
.github	15 Jun 2025 15:55	File folder	
config	15 Jun 2025 15:55	File folder	
core	15 Jun 2025 15:55	File folder	
modules	15 Jun 2025 15:55	File folder	
renv	15 Jun 2025 15:55	File folder	
scripts	15 Jun 2025 15:55	File folder	
standalone	15 Jun 2025 15:55	File folder	
.codeCheck	15 Jun 2025 15:55	CODECHECK File	1 KB
.gitattributes	15 Jun 2025 15:55	Text Document	1 KB

literature.bib	15 Jun 2025 15:55	Bibtex Document	100 KB
logo.png	15 Jun 2025 15:55	PNG File	6 KB
main.gms	15 Jun 2025 15:55	GMS File	16 KB
Makefile	15 Jun 2025 15:55	File	2 KB
output.R	15 Jun 2025 15:55	R File	8 KB
README.md	15 Jun 2025 15:55	MD File	12 KB
start.R	15 Jun 2025 15:55	R File	4 KB

Name	Date modified	Type
projects	15 Jun 2025 15:55	File folder
default.cfg	15 Jun 2025 15:55	CFG File
scenario_config.csv	15 Jun 2025 15:55	Microsoft Excel Comma...
scenario_config_emulator.csv	15 Jun 2025 15:55	Microsoft Excel Comma...

14_yields	15 Jun 2025 15:55
15_food	15 Jun 2025 15:55
16_demand	15 Jun 2025 15:55
17_production	15 Jun 2025 15:55

The configuration settings are set in the 46 modules and the include.gms file (or in the start scripts).

Each folder within the modules folder represents a component of the model and contains different realizations (approaches to that component).

Structure of the modules

Each module (within the modules folder) **has a similar structure:**

MAGPIE Workshop 2025 > WS25 model version > magpie > modules > 38_factor_costs

Name	Date modified	Type
input	15 Jun 2025 15:55	File folder
per_ton_fao_may22	15 Jun 2025 15:55	File folder
sticky_feb18	15 Jun 2025 15:55	File folder
sticky_labor	15 Jun 2025 15:55	File folder
module.gms	15 Jun 2025 15:55	GMS File

Input folder with input files for all realizations

Realization folders containing the source code of each realization

The modules.gms file with the module description and listing of all realizations

New realizations can be added by keeping the same structure. In that sense, MAGPIE is easily extendable.

Structure of realizations



As with the modules folders, the **realizations files (.gms) and folders are similarly constructed**. The source code is distributed over several gms-files to ensure the correct order of calculations during the optimization:

MAGPIE Workshop 2025 > WS25 model version > magpie > modules > 38_factor_costs > sticky_feb18		
Name	Date modified	Type
input	15 Jun 2025 15:55	File folder
declarations.gms	15 Jun 2025 15:55	GMS File
equations.gms	15 Jun 2025 15:55	GMS File
input.gms	15 Jun 2025 15:55	GMS File
postsolve.gms	15 Jun 2025 15:55	GMS File
preloop.gms	15 Jun 2025 15:55	GMS File
presolve.gms	15 Jun 2025 15:55	GMS File
realization.gms	15 Jun 2025 15:55	GMS File
scaling.gms	15 Jun 2025 15:55	GMS File
sets.gms	15 Jun 2025 15:55	GMS File

Note that not every gms-file is needed in every realization.

gms.file	function
declarations.gms	Declares all variables, equations, and parameters for the realization.
equations.gms	Contains functional relationships that have to be fulfilled within the optimization.
input.gms	Loads input from <code>any_module/input</code> or <code>any_module/a_realization/input</code> .
sets.gms	Lists sets that are used (mainly) within this realization or are needed for interfaces defined within this realization.
preloop.gms	Includes calculations to be executed before the time-step loop starts.
presolve.gms	Includes calculations to be executed for each time step before the optimization process.
postsolve.gms	Includes calculations to be executed for each time step after the optimization process and defines output.
nl_fix.gms	Fixes non-linear behaviour to linear behavior.
nl_release.gms	Releases restrictions imposed during non-linear fixes.
scaling.gms	Lists the expected order of magnitude of specific variables calculated in this realization to improve the efficiency of the run.
not_used.txt	Lists interfaces (declared in other modules) that are not used within this realization, but in other realizations of the same module.

Coding etiquette: Variable and parameter naming



```
1  *** | (C) 2008-2025 Potsdam Institute for Climate Impact Research (PIK)
2  *** | authors, and contributors see CITATION.cff file. This file is part
3  *** | of MAGPIE and licensed under AGPL-3.0-or-later. Under Section 7 of
4  *** | AGPL-3.0, you are granted additional permissions described in the
5  *** | MAGPIE License Exception, version 1.0 (see LICENSE file).
6  *** | Contact: magpie@pik-potsdam.de
7
8  equations
9  q38_cost_prod_labor(i)      Regional labor input costs for crop production (mio USD17MER)
10 q38_cost_prod_capital(i)    Regional capital input costs for crop production (mio USD17MER)
11 q38_investment_immobile(j,kr) Cellular immobile investments into farm capital (mio USD17MER)
12 q38_investment_mobile(j)    Cellular mobile investments into farm capital (mio USD17MER)
13 ;
14
15 positive variables
16 vm_cost_prod_crop(i,factors) Regional factor costs of capital and labor for crop production (mio USD17MER per yr)
17 v38_investment_immobile(j,kr) Investment costs in immobile farm capital (mio USD17MER per yr)
18 v38_investment_mobile(j)      Investment costs in mobile farm capital (mio USD17MER per yr)
19 ;
20
21 parameters
22 p38_labor_need(t,i,kr)        Labor input costs per unit of output (USD17MER per ton DM)
23 p38_capital_need(t,i,kr,mobil38) Capital requirements per unit of output (USD17MER per ton DM)
24 p38_capital_immobile(t,j,kr)  Preexisting immobile capital stocks before investment (mio USD17MER)
25 p38_capital_mobile(t,j)       Preexisting mobile capital stocks before investment (mio USD17MER)
26
27 p38_capital_cost_shares_iso(t,iso) Capital shares of factor costs on iso level (1)
28 p38_capital_share_calibration(iso) Summation factor used to calibrate calculated capital shares with historical values (1)
29 pm_factor_cost_shares(t,i,factors) Capital and labor shares of factor costs on regional level (1)
30
31 p38_croparea_start(j,w,kr)     Agricultural land initialization area (mio. ha)
32
33 i38_fac_req(t_all,i,kr)        Factor requirements (USD17MER per tDM)
34 ;
35
36
37 ##### R SECTION START (OUTPUT DECLARATIONS) #####
38 parameters
39 ov_cost_prod_crop(t,i,factors,type) Regional factor costs of capital and labor for crop production (mio USD17MER per yr)
40 ov38_investment_immobile(t,j,kr,type) Investment costs in immobile farm capital (mio USD17MER per yr)
41 ov38_investment_mobile(t,j,type)     Investment costs in mobile farm capital (mio USD17MER per yr)
```

q_ Equations

v_ Variables

p_ processing parameters

i_ input parameters

o_ output parameters

Prefixes are extended using either **m** (used in multiple modules/core code) or a **two digit number** (only used in the current module).

... In other files you will also find:

c_ Switches

s_ Scalars

f_ File parameters

m_ Macros

Coding etiquette: Variable and parameter naming



In other cases, the **prefixes are extended** with **a second letter** to indicate details such as:

?**c_** current time step

```
pcm_land(j,land)
```

?**q_** parameter containing the values of an equation

```
oq10_land(t,j,type)
```

?**v_** parameter containing the values of a variable

```
ov_landreduction(t,j,land,type)
```

Suffixes indicate the **level of aggregation** of an object:

- (no suffix) Highest disaggregation available
- **_setname** aggregation **over set**
- **_reg** **regional** aggregation
- **_glo** **global** aggregation

```
i42_wat_req_k(t,j,k)
```

```
v11_cost_reg(i)
```

```
i32_max_aff_area_glo
```

The full.gms file



Once you have started a magpie run, you can find the full.gms file in the **output folder**.

MAGPIE Workshop 2025 > WS25 model version > magpie > output > weeklyTests_SSP2-NPI2025			
Name	Date modified	Type	Size
renv	15 Jun 2025 21:40	File folder	
.Rprofile	13 Jun 2025 18:14	RPROFILE File	3 KB
2025-06-13T184641_output_check--extra-disaggregat...	13 Jun 2025 18:46	LOCK File	529 KB
av_cropland_0.5.mz	13 Jun 2025 18:14	MZ File	497 KB
av_land_full_t_0.5.mz	13 Jun 2025 18:14	MZ File	4,658 KB
cell.bii_0.5.mz	13 Jun 2025 18:50	MZ File	3,556 KB
cell.conservat_land_0.5.mz	13 Jun 2025 18:46	MZ File	6,658 KB
cell.cropland_0.5_share.mz	13 Jun 2025 18:48	MZ File	42,188 KB
cell.land_0.5.mz	13 Jun 2025 18:48	MZ File	21,689 KB
cell.land_0.5_share.mz	13 Jun 2025 18:48	MZ File	22,902 KB
cell.land_split_0.5.mz	13 Jun 2025 18:48	MZ File	28,155 KB
cell.land_split_0.5_share.mz	13 Jun 2025 18:48	MZ File	29,213 KB
cell.peatland_0.5.mz	13 Jun 2025 18:48	MZ File	3,669 KB
cell.peatland_0.5_share.mz	13 Jun 2025 18:48	MZ File	4,208 KB
clustermat_rev4.119_c200_67420_h12.rds	13 Jun 2025 18:14	RDS File	87 KB
config.yml	13 Jun 2025 18:14	Yaml Source File	16 KB
conopt4.op2	13 Jun 2025 18:15	OPT File	1 KB
conopt4.opt	13 Jun 2025 18:44	OPT File	1 KB
conserv_prio_areas_0.5.mz	13 Jun 2025 18:14	MZ File	4,478 KB
f34_urbanland_0.5.mz	13 Jun 2025 18:14	MZ File	16,013 KB
f50_AtmosphericDepositionRates_0.5.mz	13 Jun 2025 18:14	MZ File	33,757 KB
f50_NitrogenFixationRateNatural_0.5.mz	13 Jun 2025 18:14	MZ File	1,892 KB
f58_peatland_area_0.5.mz	13 Jun 2025 18:14	MZ File	307 KB
full.gms	13 Jun 2025 18:15	GMS File	121,186 KB
full.log	13 Jun 2025 18:46	Text Document	611 KB
full.lst	13 Jun 2025 18:46	LST File	196 KB
fulldata.gdx	13 Jun 2025 18:46	GDX File	564,655 KB
info.txt	13 Jun 2025 18:14	Text Document	2 KB
log_renv.txt	13 Jun 2025 18:14	Text Document	28 KB
lpi_envflow_total_c200.mz	13 Jun 2025 18:14	MZ File	17 KB
lpi_watavail_total_c200.mz	13 Jun 2025 18:14	MZ File	17 KB
lpi_yields_0.5.mz	13 Jun 2025 18:14	MZ File	93,516 KB
LUH2_cropland_0.5.mz	13 Jun 2025 18:14	MZ File	11,163 KB
luh2_side_layers_0.5.mz	13 Jun 2025 18:14	MZ File	193 KB
m15_food_demand_p.gdx	13 Jun 2025 18:44	GDX File	2,155 KB
magpie_y1995.gdx	13 Jun 2025 18:18	GDX File	5,863 KB

 full.gms

13 Jun 2025 18:15

GMS File

Contains the final code used in the current MAgPIE run, based on the selected settings and on one realization per module (done automatically).

Brief exercise



(For online participants: Green tick when you are ready) 

1. Within the magpie folder, find the **14_yield** module.
2. Open the **declaration.gms** file of the **managementcalib_aug19** realization.
3. Find one example of:
 - A parameter used **only** within the current module
 - An equation
 - A processing parameter used **in** this module and the core code/another module
 - An output parameter

Thank you

weindl@pik-potsdam.de