Transboundary Water Management Adaptation in the Amudarya Basin to Climate Change Uncertainties

PEER project report on position

4.1 Preparing software product

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Introduction

The report contains PEER project results on position 4.1 “Preparing software product”. The following work was done:

- Planning zone model was developed,
- Series of simulation were conducted for different scenarios,
- A manual was developed.

The work was fulfilled by T.Kadyrov under supervision of A.G.Sorokin.

The planning zone optimization module is 2 MB and consists of:

- Optimization model,
- Script to export DB,
- Script to export data from optimization model to DB,
- Script to run optimization model

1. Objective and tasks

The objective is developing a module to optimize crops, by criterion of minimum deviation from the food basket for the food security scenario (FSD), and by criterion of maximum added value for the export-oriented scenario (ESA), with capability to read data from DB and further export results to the same DB.

Tasks:

A) Developing optimization module
B) Developing DB
C) Implementing infrastructure to enable “interaction” of the module with DB

2. Scope of work

Crop optimization module with the capability to read data from DB and script to export module's output to DB were developed.

Module functionality:

- Data import/export
- A range of controlled boundary conditions for optimization
- Capability to integrate the module into interface to input data and output the results in form of tables and graphs.

For optimization, MINOS5 solver is used; it supports solution of linear and non-linear programming tasks. This solver uses very efficient and reliable method to seek extremums – the gradient descent method, which makes use of advantages of sparse models. For models with non-linear restrictions, the iterative Lagrange projection algorithm is used. It iteratively solves sub-tasks with linear restrictions. This iterative method ensures search of optimal solution.

2.1 Required tools:

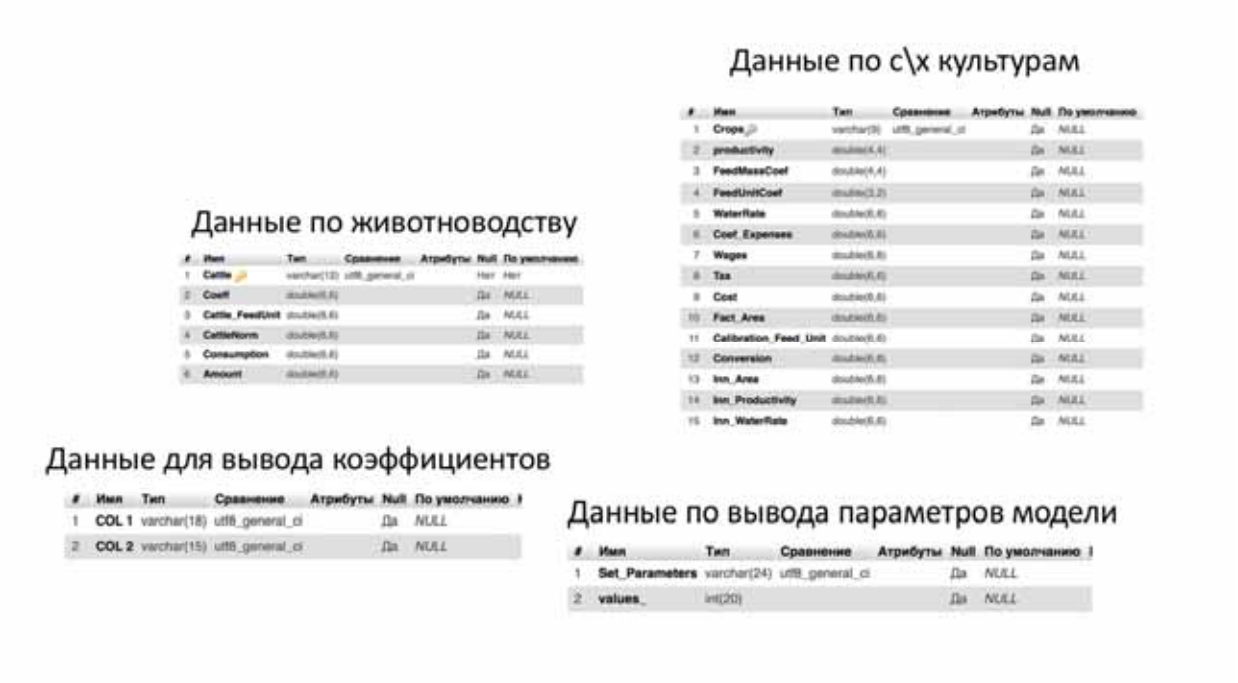
- Algebraic modeling language GAMS 24.5.6
- MySQL DBMS 4.1 and later versions
- Driver to connect to DB - Connector/ODBC

2.2 Software environments:

1) The General Algebraic Modeling System (GAMS) is a high-level modeling system for mathematical optimization. GAMS is designed for modeling and solving linear, nonlinear, and mixed-integer optimization problems. The system is tailored for complex, large-scale modeling applications and allows the user to build large maintainable models that can be adapted to new situations. The system is available for use on various computer platforms. Models are portable from one platform to another.
   GAMS was the first algebraic modeling language and is formally similar to commonly used fourth-generation programming languages. GAMS contains an integrated development environment (IDE) and is connected to a group of third-party optimization solvers.
2) **MySQL** is an open-source relational database management system. The MySQL development project has made its source code available under the terms of the GNU General Public License, as well as under a variety of proprietary agreements. MySQL was owned and

sponsored by a single for-profit firm, the Swedish company MySQL AB, now owned by Oracle Corporation. For proprietary use, several paid editions are available, and offer additional functionality.

3. Structure of links between sheets in MySQL DBMS



Cattle sheet:

	Type	Comparison	Null	By default	Comments
Cattle	varchar(12)	utf8_general_ci	No	No	Identifier of cattle
Coeff	double(6,6)		Yes	NULL	Coefficient of conversion into feed mass
Cattle_FeedUnit	double(6,6)		Yes	NULL	Feed unit
CattleNorm	double(6,6)		Yes	NULL	Feed consumption norm
Consumption	double(6,6)		Yes	NULL	Consumption

Crops sheet:

	Type	Comparison	Comments
Crops	varchar(9)	utf8_general_ci	Crops
productivity	double(4,4)		Yield
FeedMassCoef	double(4,4)		Feed mass coefficient
FeedUnitCoef	double(3,2)		Coefficient of conversion into feed unit
WaterRate	double(6,6)		Water consumption
Coef_Expenses	double(6,6)		Expenses
Wages	double(6,6)		Wages
Tax	double(6,6)		Tax
Cost	double(6,6)		Cost

Fact_Area	double(6,6)		Actual distribution of areas
Calibration_Feed_Unit	double(6,6)		Feed unit when calibrating
Inn_Area	double(6,6)		Innovation area
Inn_Productivity	double(6,6)		Improved productivity coefficient
Inn_WaterRate	double(6,6)		Water consumption decreasing coefficient

Par sheet:

Name	Type	Comparison	Comments
Set_Parameters	varchar(24)	utf8_general_ci	Set of parameters
values_	int(20)		Values

CalibrationCoefs sheet:

Name	Type	Comparison	Comments
Col1	varchar(18)	utf8_general_ci	Set of coefficients
Col2	decimal(11,2)		Values

4. **Optimization module structure**

    1. Database import file gams.sql (gams_new.sql)
    2. gams executive file of the optimization module compute_module.gms
    3. File to export results to database gms2sql.sql
    4. File to run all scripts PEER_COMP_MODULE.bat

Short user manual:

1. Install the driver using this link
2. Activate DB import from the file gams.sql (gams_new.sql)
3. In the executive file Compute_module.gms, in part of data import change the lines like: **parameter** productivity (crops) / $call =sql2gms C="DRIVER=MySQL ODBC 5.3 ANSI Driver; **Server=localhost**; Database=gams; **UID =root**;" Q="SELECT * FROM productivity" O="**C:\Users\tima0\Documents\gamsdir\projdir\productivity.inc**" $include **C:\Users\tima0\Documents\gamsdir\projdir\productivity.inc**

    Server –MySQL DBMS server address

    UID – user name

    O=”path for creation of an export data file from MySQL DBMS**”**

$include - path of the created file with the data from MySQL DBMS

4. In the file **gms2sql.bat**, change pathway to the file **gms2sql.sql**, if necessary change user name in line "- u **root**"
5. In the file **PEER_COMP_MODULE.bat,** make changes as follows:

   5.1. In line cd C:\GAMS\win64\24.5 - path to the **GAMS** Directory;

   5.2. In line gams C:\Users\tima0\Documents\gamsdir\projdir\compute_module.gms, path to executive file **Compute_module.gms**;

   5.3. In line cd C:\Users\tima0\Documents\gamsdir\projdir, path to file **gms2sql.bat**;

6. Run the **PEER_COMP_MODULE.bat** file to make calculations