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Calibration and Execution of SWAT Models over GRID Architecture

Victor Ioan Bacu (1), Denisa Rodila (1), Lukasz Kokoszkiewicz (2), Elham Rouholahnejad (3), Danut Mihon (1), Ann van Griensven (4), Karim Abbaspour (3), and Dorian Gorgan (1)

(1) Technical University Cluj-Napoca, Romania (victor.bacu@cs.utcluj.ro, denisa.rodila@cs.utcluj.ro, vasile.mohon@cs.utcluj.ro, dorian.gorgan@cs.utcluj.ro), (2) CERN - European Organization for Nuclear Research, Geneva, Switzerland (lukasz.kokoszkiewicz@cern.ch), (3) EAWAG, Swiss Federal Institute for Aquatic Science and Technology, Switzerland (elham.rouholahnejad@eawag.ch, karim.abbaspour@eawag.ch), (4) UNESCO-IHE Institute for Water Education, Department of Hydroinformatics and Knowledge Management, Delft ,The Netherlands (a.vangriensven@unesco-ihe.org)

The presentation concerns with key concepts and architectures supporting calibration and execution of SWAT (Soil Water Assessment Tool) [1] models over Grid infrastructures. The Grid capabilities are required due to the large number of runs required in both calibration and execution processes.

The assessment of the sustainability and vulnerability in the Black Sea Catchment is one of the goal of the FP7-funded enviroGRIDS [2] project (April 2009 – March 2013). By developing a Spatial Data Infrastructure for this catchment region, different scenarios based on environmental changes and water quality models will be simulated.

One of the water quality models that will be used is SWAT (Soil Water Assessment Tool). SWAT is a model designed to estimate impacts of land management practices on water quantity and quality in complex watersheds. The SWAT model requires specific information about weather, soil properties, topography, vegetation, and land management practices of the watershed. The information is collected from stations distributed all over the water basin. The density of these stations is closely related with SWAT input data correctness.

The SWAT application will be integrated as a module in the enviroGRIDS portal. This application will allow the calibration of the SWAT models and the execution of different scenarios based on a calibrated SWAT model. The calibration process will use the SUFI2 [3] uncertainty analysis routine. The flow for calibrating a model is the following: randomly generate uncertainty model parameters, run the SWAT model in several iterations until the objective function is meet and extract the required outputs that correspond to the observed data from the model output files. Different scenarios could be developed by hydrologic experts for executing on a calibrated model and the results of executions could be displayed in different outputs and formats depending on the user's requirements.

Both the calibration and the execution require a great number of input and output data files. All the SWAT model files are stored on the Storage Element inside the Grid infrastructure. The input files are uploaded on Storage Element by the hydrologic model developers. The calibration output is used for defining scenarios and for running these scenarios. The visualization and report generation modules use the output data files of the scenario execution.

In order to run the SWAT calibration on the Grid, a parallel approach at the data level should be used. The Grid based approach will speed-up the entire calibration flow of the model [4]. This means that the process could be split in multiple sub-processes that could run simultaneously on Grid nodes. In conclusion, this solution could significantly reduce the total execution time compared to the same process that runs on a single machine that in some cases could take hours or even days. The execution over the Grid infrastructure is done by using Ganga [5] and Diane [6] gLite's software packages. Those packages are used as an upper layer above the gLite middleware and provide useful functionalities in managing and monitoring the jobs submitted on the Grid. The large user community of SWAT inside the enviroGRIDS consortium may greatly benefit from a gridified version of the software.

[1]. Soil and Water Assessment Tool, http://www.brc.tamus.edu/swat/index.html

[2]. enviroGRIDS project, http://envirogrids.net/

[3]. Karim C. Abbaspour, Jing Yang, Ivan Maximov, Rosi Siber, Konrad Bogner, Johanna Mieleitner, Juerg Zobrist, Raghavan Srinivasan, Modelling hydrology and water quality in the pre-alpine/alpine Thur watershed using SWAT, Journal of Hydrology (2007) 333, 413– 430

[4]. S. G.Yalewa, A. van Griensvena, L. Kokoszkiewiczb, Parallel computing of a large scale spatially distributed model using the Soil and Water Assessment Tool, 2010 International Congress on Environmental Modelling and

Software Modelling for Environment's Sake, Fifth Biennial Meeting, Ottawa, Canada
[5]. GANGA software, http://ganga.web.cern.ch/ganga/