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Hydrodynamic and Water Quality Modeling using EGI FedCloud

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The framework of this development is the collaboration of our center within the European LIFE+ project ROEM+ where a Spanish SME, Ecohydros, is addressing the problem of modeling Water Quality in a water reservoir (Cuerda del Pozo in Soria) that is supplying drinking water to an small city in Spain.

Understanding the Water Quality model requires a complete simulation of the processes that affect the water, and then validating this simulation with real data.

Our group at IFCA has worked together with Ecohydros for the last five years, first to implement a near real time data acquisition system that provides this data directly to an offline data management system, and more recently, using a well-known software suite, Delft3D, to model the physical, chemical and biological conditions of the water.

The key process to be modeled is Eutrophication, a process caused by the excess of nutrients in the water reservoirs leading to an increase in vegetation and other organisms and microorganisms, in particular algae, deriving in algae bloom when combined with certain conditions of solar radiation and water temperature. The following depletion of oxygen in the water leads to the death of many microorganisms and in general to a large reduction of life in it, and their impact is important in water reservoirs used for urban supply. The final aim of the project is to develop an early warning system for this reservoir that allows policy makers and authorities to know when an algae bloom is going to happen, in order to take actions.

The work here presented is centered in the deployment in a Cloud infrastructure, FedCloud environment in this case, of the different components required by the model, and its execution with different parameters and conditions to get predictions that when contrasted with real data allow the validation of this model.

Delft3D is an Open Source software suite that works over a mesh made from a map of the modeled water body, in our case Cuerda del Pozo reservoir in Soria (Spain). The program runs with 2D and 3D meshes with a number of layers that can be edited by the user. Hence mesh resolution is an important factor for program performance. With a low or medium resolution mesh (cells larger than 250x250 meters with few vertical layers) execution can be successfully accomplished with standard PCs. However, when a detailed simulation is required, as it is the case to model the complex conditions'leading to eutrophication, the resolution has to be increased (e.g. 100x100 meter cells with more than 30 vertical layers) and more powerful computers are needed. Given our project requirements in CPU (>=2.5Ghz, few cores), memory (>12Gb) and disk (up to a few Terabytes), we need a Cloud services provider like EGI FedCloud which allow us to manage the entire workflow of data processing and analysis. Also, given the needs for the output we need a service able to support the storage of few terabytes and let us to transfer it using an easy and fast way.

Eutrophication is a problem that impacts directly in water quality and human health. This project will provide as overall result an optimization of the eutrophication management, but it will also provide tools for the integrated management of the watershed to assess in terms of ecological status the combined effects of different natural processes and pressure, including climate, land use, agricultural and forestry management, etc.

As the LIFE+ project presents its results, new platforms for new water reservoirs may be implemented (this is happening already now in another water reservoir at Avila, with similar problems) and the same model can be implemented. But the key point is to understand, thanks to this model, the main reason for the eutrophication to happen, and if it is due to human activity (like farming near the water) propose and adopt the measures to reduce or eliminate it.

From EGI point of view, this project is a good example of the use of a cloud infrastructure in the research following the initiative of an SME. For small and medium consultancy companies in the environmental field, a data analysis platform that can manage a workflow of a complex model and a large amount of data provides a competitive point. Also Cloud opens the door for providing also graphical results to the researchers via Web Apps or streaming of desktops, storing a big amount of data in the Cloud itself and provides companies resources that they do not have.

For biology and other type of researchers that do not often have enough knowledge in informatics, a ready-to-launch image can be set up that contained every component needed to execute a model using Delft3D Software Suite. Researchers would thereby be able to select the required configuration of the virtual machine they need

in terms of CPUs, memory and storage and, using a cloud infrastructure, and select the image that contained Delft3D ready to process. That way installation and configuration process is avoided and researchers would be able to run a model more quickly and more efficiently and delete the virtual machine once their models are finished.

For further information please read the attached file.

Primary author: AGUILAR, Fernando (CSIC)

Co-author: MARCO DE LUCAS, Jesus (CSIC)

Presenter: AGUILAR, Fernando (CSIC)

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