Title of the project: Modeling and simulation of socio-hydro-system: When water flows over the sugar scape.	
Assignment no.: 02.15	**Internal/external:** External
Head graduation committee: Dr. M.S. Krol	**Daily advisor:** Dr. B. Bonté Dr. M.F. Brugnach
Name(s) of participating companies or institutes: IRSTEA, G-EAU Team, Montpellier, France	**Start of the project:** Asap

General Issue

The study of natural resources management implies to consider several dynamic processes interacting among each other. It is intrinsically a multidisciplinary task involving, physics, biology, ecology, management sciences among other disciplines. The multi-agents system paradigm (MAS), describes the world as a set of agents interacting with each-other and eventually with an environment and the objects of the environment [1]. With this paradigm, the various disciplines involved can be used to build so called artificial societies, which, once implemented on appropriate simulators, can be used as artefacts in order to feed theoretical discussions about resources management. In this MSc project we choose to work on the basis of the sugar scape model. In this model, simple agents interact by harvesting a shared spatially defined renewable resource [2].

The proposed work consists in (1) adding new components (institutional and hydrological) to the sugar scape model so it is able to better represent the complexity of a socio-hydro-system, and (2) analyzing the resulting model. A first step has already been done with the creation of a version of a sugar scape including states and territories [3].

Objectives

Specifically, the work will consist in adding the water resource to the sugar scape model. This would be done through the inclusion of a distributed hydrological model in sugar scape and the implementation of a simple relationship between resources regrowth and water availability. Afterwards, the work will consist in analysing the results obtained with the two resources systems (with / without considering water). This analysis will be made in two steps. First a diagnosis of the two systems will be performed using the IAD framework [4,5]. For this first part we will use the MAIA framework [6] as a support and check if the new sugar scape model can be described with the MAIA meta-model. Then an experimental plan will be performed on the model to compare it with the first diagnosis using the methodology proposed by Craig Auman [7].

Optional developments are to consider also flooding and dams and to use the SES robustness analysis framework [8] developed by Marty Anderies and Marco Janssen (this framework is an adaptation of the IAD framework for analyzing SES robustness to various disturbances).

Context

The internship is part of the MAGIC research project (Multi-Scale Adaptation to Global change and Impacts in Coastal areas, www.magic-project.org). It will be performed at IRSTEA in the G-EAU research team. The first model is implemented in the CORMAS multi-agents modeling and simulation platform [9] (see cormas.cirad.fr and cormas.cirad.fr/en/applica/sugarScape.htm). The intern will receive an internship fee.

References

[1] J. Ferber, *Multi-agent systems: An introduction to distributed artificial intelligence*, 1st ed. Addison-Wesley Professional, 1999.
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[3] Abrami, G., Bonté, B., Kistemaker, L., Rousseaux, F., and Schmitt, C., "Unpublished Educational Paper on the Implementation of SugarScale," Seignosse, France, Proceedings of MAPS 7 workshop, Jul. 2014.
[4] E. Ostrom, "A General Framework for Analyzing Sustainability of Social-Ecological Systems," *Science*, vol. 325, no. 5939, pp. 419–422, 2009.
[5] E. Ostrom, "A diagnostic approach for going beyond panaceas," *Proc. Natl. Acad. Sci. U. S. A.*, vol. 104, no. 39, pp. 15181–15187, 2007.
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[7] G. A. Aumann, "A methodology for developing simulation models of complex systems," *Ecol. Model.*, vol. 202, pp. 385–396, 2007.
[8] J. M. Anderies and M. A. Janssen, "Robustness of social-ecological systems: Implications for public policy," *Policy Stud. J.*, vol. 41, no. 3, pp. 513–536, 2013.
[9] F. Bousquet, I. Bakam, H. Proton, and C. Le Page, "Cormas: Common-Pool Resources and Multi-agent Systems," in *IEA/AIE '98: Proceedings of the 11th International Conference on Industrial and Engineering Applications of Artificial In telligence and Expert Systems*, London, UK, 1998, pp. 826–837.