

Modelling the integrated management of organic waste at a territory scale

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Abstract: Modelling integrated management of organic waste at a farm level is still a key challenge, but one can find several works in the literature. However, the shift to a larger (*e.g.* area, district or county) scale is even more complex. Consequently, associated modelling work is still considerably under-developed. Here we use the UPUTUC model (french acronym of Production Unit, Transformation Unit, Consumption Unit) to examine fluxes of organic matter residues within the Territoire de la Côte Ouest (TCO), on the west of Réunion Island.

UPUTUC is an agent-based model and is developed using the AnyLogic platform. This platform is a multi-method modeling environment and allows for the combination of discrete event models, agent-based models and system dynamics models. It also provides spatial features in order to use information coming from GIS. UPUTUC uses three agents. These agents are: (i) *production units* that produces organic matter or waste (for example: pork, poultry breeding and sludge produced by a wastewater treatment plant), (ii) *transformation units* that produces compost or fertilizer with organic matter coming from the production unit, and (iii) *consumption units* that uses transformed organic matter from the transformation unit or organic matter coming directly from the production unit (for example: a sugar cane field, a market gardening and a grassland). State variables of *production units* are a production rate, a stock, and all times and distances to the *transformation units* and *consumption units* in the model. State variables of *transformation units* are a production rate, equations the transform organic matter into compost or fertilizer, a transformation time, a stock, capacity of trucks that delivers products to consumption units, and finally, all times and distances to *consumption units* in the model. State variables of *consumption units* are an area, compatible fertilizers with the unit, fertilizer requirements, and periods during which fertilization is possible. In addition, the agents are spatially situated based on GIS information. The French Land Parcel Identification System (LPIS) and the Farmers' block from the European Common Agricultural Policy provide this information. Moreover, as Réunion Island is a volcanic island, the roads are very rough and consequently the logistic dimension is crucial in the model. Therefore, as the dynamic of logistic characteristics of the associated road network is not simulated (for example, the time for a vehicle to transport organic matter from a production unit to a transformation unit) these variables are pre-computed off line in a previous step and are considered as parameters. In UPUTUC, there are 51 *production unit* agents, 2272 *consumption unit* agents and, finally, only 4 *transformation unit* agents. Several scenarios are tested. First, the current situation in order to check how the model behave. Second, the introduction into the first scenario of a new *transformation unit* (called UT1) that takes as inputs only litter, manure and crushed green wastes and combines them into a specific compost used by all the *consumption units*. Third, the introduction into the second scenario of two new *transformation units*: the first one (called UT2) takes as inputs only poultry dropping, vinasse and crushed green wastes and combines them into a specific compost, and the second one takes as input compost from UT1 and UT2 and produces granulates with them.

Keywords: Agent based model, GIS, AnyLogic, organic waste management, Réunion Island