Integrating cognitive models of human decision-making in agent-based models: an application to land use planning under climate change in the Mekong River Delta

Mots clés :

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- Unité de recherche : Unité de modélisation mathématique et informatique de systèmes complexes
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- Domaine scientifique principal: Divers

Résumé du projet de recherche (Langue 1)

CONTEXT: All reports indicate that the Mekong Delta, in Vietnam, is amongst the areas with the potential to be the most severely impacted by climate change in a close future (UNFCCC, 2007; Wassmann et al. 2004). Local, regional and national authorities are facing the challenge of organizing the adaptation to its threats in an urgent manner, notably by designing adequate and sustainable land use policies to cope with the massive land cover changes expected (Trung, N. H., 2009; Nguyen, P. K., 2009).

PROBLEM: When it comes to design models and simulations that could support decision makers in forecasting and assessing the effects of these policies, the existing capacity of research in relation to these issues is quite low (Castella, J. C. et al. 2005; Parker, D. C. et al. 2001). As a matter of fact, in their vast majority, experts rely on a limited set of global models (McRae B. H. et al. 2008) that appear to be clearly insufficient as they tend to: 1) Neglect or average the spatial heterogeneity that characterizes the Vietnamese Mekong Delta 2) Minimize the role and the drivers of human behaviour in land use, whereas it is a key component of its change

PROPOSAL: To specifically address the problems raised above, this PhD proposal aims at designing innovative models of land use dynamics that could be used as a basis for improved environmental decision support systems, helping identify the most suitable points for policy intervention. The methodology that will be followed by the candidate will consist in the coupling, at multiple scales, between two modelling approaches: Cognitive ABMs (Agent-Based Models) and GIS (Geographical Information Systems). ABMs (Drogoul, A. et al., 2002) are especially suited to represent the fact that the most critical elements in land use dynamics are human agents (Gilbert, 2008; Taillandier, P et al., 2012). It is these agents (individuals, households, or institutions) that take specific actions according to their decision rules, beliefs, plans or strategies, which allow them to adapt to, but also to drive, land-cover changes. Realistic scenarios need to take into account this cognitive dimension of social actors (Adam, C. et al., 2011), as their agenda may for instance conflict with the agenda of other actors, influences the decisions they take or change the way decisions are actually implemented (Gil-Quijano J. et al., 2007). It is also a way to take into account the fact that social actors reason at different scales of time and space: whereas institutional actors usually deal with long-term visions and commitments, it is barely the case for households The introduction of this cognitive component in ABMs will be one of the expected outcomes of the research. GIS, on the other hand, will allow these models to rely on spatially explicit land-cover information, as derived by remote sensing (Bouvet, A. 2009; Minh, V. Q., 2012), for example, and to explore the impacts of policies in realistic scenarios. By combining topography maps, land use maps and administration maps with socio-economic, salt-water intrusion dynamic models, sea level rise and temperature models (Trung N. H., 2009), the use of GIS will allow the candidate to create a number of plausible scenarios that will represent the “background” of several simulations. The combination of the two techniques will then allow to represent the different actors involved on these realistic “backgrounds” and how they change them, effectively allowing to test alternative hypotheses on land use policies, and suggesting sets of possibilities to deciders. The models will be built upon the GAMA simulation platform (Taillandier, P. et al., 2010), developed by the IRD and Can Tho University, which already allows combining ABM and GIS data. It is expected that the cognitive control architecture named BDI (for “Belief – Desire – Intentions”), quite popular in Distributed Artificial Intelligence, will form the basis of the cognitive components that will be developed in GAMA for these models. VALIDATION: As part of the ongoing research work undertaken by the College of Environment and Natural Resources, a number of case studies will be available for testing and validating this approach. Two of them are likely to be implemented, as they are representative of the spatial heterogeneity of the Delta. The first site will be the province of Can Tho, which constitutes a perfect example of the interplays between the action of man (growth of the built environment, etc.) and the changes that will be due to climate change (intrusion of the salted water, inundations, etc.) on land cover and land use. The second site, Ben Tre, is an example of a coastal province, where the changes will be this time mainly driven by the climate, and where dramatic consequences are foreseen by all global models.