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Modelling farm vulnerability to flooding: A step toward vulnerability mitigation policies appraisal

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Abstract Recent catastrophic flood events such as Elbe in 2002 or Rhône in 2003 have shown limits of flood management policies relying on dykes protection: worsening of flood impacts downstream, increased damage by dykes rupture. Those events, among others, contributes to radical changes on the philosophy of flood prevention, with the promotion of new orientations for mitigating flood exposition. Two new trends may have a significant impact on rural areas: floodplain restoration and vulnerability mitigation.

The Rhône River program, which is an contract of objectives signed between French Government and local collectivites, is highly illustrative of these new trends and their impact on agricultural sector. In this program, it appears that areas to be concerned by floodplain restoration are agricultural ones, because their supposed vulnerability to flood is expected to be less important to urban areas. As a consequence, agricultural sector is particularly concerned by planned actions on mitigation of assets vulnerability, an important part of the program (financial support of European Union of 7.5 Million euros). Mitigation of agricultural assets vulnerability reveals particularly interesting for two following reasons. Firstly, it is a way to maintain agricultural activities in floodplains yet existing, without promoting flood protection. Secondly, in case of floodplain restoration, vulnerability mitigation is a way for local authorities to compensate over-flooding impacts. In practice, local authorities may financially support farmers for implementing measures to mitigate their farm vulnerability.

On the Rhône River, an important work has already been done to identify farm vulnerability to flooding, and propose measures to mitigate it. More than 3 000 farms exposed to flood risk have been identified representing 88 690 ha of agricultural areas which is estimated to generate damage between 400 and 800 Million euros depending on the season of occurrence for a catastrophic flood. In the case of farm activities, vulnerability mitigation consists in implementing measures which can be: physical (equipment or electric power system elevation), organizational (emergency or recovery plan) or financial (insurance). These measures aim at decreasing the total damage incurred by farmers in case of flooding. For instance, if equipment is elevated, it will not suffer direct damage such as degradation. As a consequence, equipment will be available to continue production or recovery tasks, thus, avoiding indirect damage such as delays, indebtedness...

The effects of these policies on farms, in particular vulnerability mitigation cannot be appraised using current methodologies mainly because they do not consider farm as a whole and focus on direct damage at the land plot scale (loss of yield). Moreover, since vulnerability mitigation policies are quite recent, few examples of implementation exist and no feedback experience can be processed. Meanwhile, decision makers and financial actors require more justification of the efficiency of public fund by economic appraisal of the projects. On the Rhône River, decision makers asked for an economic evaluation of the program of farm vulnerability mitigation they plan to implement. This implies to identify the effects of the measures to mitigate farm vulnerability, and to classify them by comparing their efficacy (avoided damage) and their cost of implementation.

In this presentation, we propose and discuss a conceptual model of vulnerability at the farm scale. The modelling, in Unified Modelling Language, enabled to represent the ties between spatial, organizational and temporal dimensions, which are central to understanding of farm vulnerability and resilience to flooding. Through this modelling, we encompass three goals:

- To improve the comprehension of farm vulnerability and create a framework that allow discussion with experts of different disciplines as well as with local farmers;

- To identify data which are needed to implement the model and to collect them, specifically using the focus group method;
- Based on the conceptual model, to program a mathematical model which will be used to simulate damage (direct and indirect) on farm due to flood.

This last objective should enable us to appraise policy to mitigate vulnerability which is planned to be implemented on Rhône River at the individual and regional scale. Finally, we discuss the possibility to use the UML modelling to develop a multi-agent system approach which could be interesting to take into account ties between farmers (solidarity, loan of equipment) or systemic effects due to the damage incurred by economic partners (loss of market share).

Keywords vulnerability, UML modelling, farming systems, flood, mitigation policy, economic valuation