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# MASSIVE POPULATION EVACUATION IN AN URBAN CONTEXT

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AN AGENT-BASED MODELING AND SIMULATION

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Increasing urban sprawl all over the world leads to an increase of vulnerabilities, as greater numbers of goods and people are exposed to hazards, both natural (flood, quakes, fires, tsunami, epidemic) and industrial (factories, plants). Population evacuation features amongst the tools political managers can use to mitigate these risks. When evacuations are decided, managers must strike a fine balance between displacing all the people needed to avoid injuries and fatalities, and not evacuating people that would finally not be struck by the hazard. Evacuated populations convoys must furthermore not lead to a sub-crisis where they become new vulnerabilities, or through disorder and density prevent the management of other vulnerabilities. There is regrettably a scarcity of tools to help risks manager make this kind of decision. We present here our works on such tools.

Most risk management policies focus on a planar, continuous conception of space. Seveso Directives for example use different radius around the hazard center, a plant for example, to find which housings and business will be affected at which degree. We described in our presentation for UrbanNet 2013 how this approach was found lacking for handling road networks, both as vulnerabilities of the direct hazard, and as the means for a successful crisis management. In order to overcome this obstacle we proposed a city-wide agent based simulation called MOSAIC to model the car traffic, both in normal and extraordinary situations.

In MOSAIC each driver is capable of strategical, tactical and operational planning and decision making. They have a list of destinations they try to reach, and choose a path to get there using their knowledge of the network. They accelerate, brake, change ways depending on their surroundings and personality. They choose alternative solutions if trapped in traffic jams or when facing a road networks altered from their initial knowledge.

In this follow-up article we would like to discuss the data and its analysis we used to calibrate and validate simulations built with MOSAIC to study theoretical all-car evacuation of the city of Rouen.

Furthermore, since MOSAIC, we started a new project, ESCAPE (Exploring by Simulation Cities Awareness on Population Evacuation), which aims at simulating massive evacuation:

- against different sort of hazards (not only industrial disasters as in MOSAIC, but also natural disasters such as floods or tsunamis),
- in various settings: fully urban (Rouen, France and Hanoi, Viet-Nam, both urban yet very different settings), and along a valley mixing urban and rural (Val d’Authion, France); and
- using multimodal transport (buses, cars, bikes and pedestrians).

Using micro-simulation at this scale requires innovative thinking on the handling of the different spatial and temporal scales implied in the complex urban system. Formal organization such as police or emergency services can be modelled beforehand, but emergent organization such as traffic jams or panicked mobs must also be detected and managed in the simulation. Spatial knowledge is in constant evolution, as road networks and buildings get increasingly affected by the hazards, and must be individualized as agents in the simulation meet or are affected by these transformations, while others who do not, remain ignorant of them and can still plan according to a former state of the urban space.

Nonetheless, ESCAPE is not an academic-only project. We are partners with BRLi, an engineering firm specialized in helping cities design documents mandatory under French Law called Plans Communaux de Sauvegarde (city safety plans). ESCAPE is also designed to help authorities write, test, and evaluate their PCS, which often have to include population evacuation.

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