



HAL
open science

Massive population evacuation in an urban context

Pierrick Tranouez, Eric Daudé, Patrick Taillandier, Guillaume Czura,
Géraldine del Mondo

► **To cite this version:**

Pierrick Tranouez, Eric Daudé, Patrick Taillandier, Guillaume Czura, Géraldine del Mondo. Massive population evacuation in an urban context. UrbanSys 2018, Sep 2018, Thessalonike, Greece. hal-02111135

HAL Id: hal-02111135

<https://hal.science/hal-02111135>

Submitted on 25 Apr 2019

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

MASSIVE POPULATION EVACUATION IN AN URBAN CONTEXT

AN AGENT-BASED MODELING AND SIMULATION

PIERRICK TRANOUEZ

EA LITIS, Université de Rouen Normandie, France, Pierrick.Tranouez@univ-rouen.fr

ÉRIC DAUDE

UMR CNRS IDEES, Université de Rouen Normandie, France

PATRICK TAILLANDIER

MIAT, University of Toulouse, INRA, France

GUILLAUME CZURA

Laboratoire Territoire et Mobilités, Métropole Rouen Normandie et UMR CNRS IDEES, Université de Rouen Normandie, France

GÉRALDINE DEL MONDO

EA LITIS, INSA Rouen Normandie, France

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 MOSAIIC to model the car traffic, both in normal and extraordinary situations.

In MOSAIIC 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 MOSAIIC to study theoretical all-car evacuation of the city of Rouen.

Furthermore, since MOSAIIC, 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.

REFERENCES

- Czura, G. et al., 2015. *MOSAIC: City-Level Agent-Based Traffic Simulation Adapted to Emergency Situations*. Proceedings of the International Conference on Social Modeling and Simulation, plus Econophysics Colloquium
- Daudé, E. et al., 2009. *Spatial risks and complex systems: methodological perspectives*. From System Complexity to Emergent Properties
- Drogoul, A., Amouroux, E., et al., 2013. *GAMA : multi-level and complex environment for agent-based models and simulations*. International Conference on Autonomous Agents and Multi-Agent Systems
- Hawe, G.I. et al., 2012. *Agent-based simulation for large-scale emergency response*. ACM Computing Surveys, 45(1)
- Del Mondo, G. et al., 2010. *A Graph Model for Spatio-temporal Evolution*. Journal of Universal Computer Science, 16(11)
- Nabaa, M., Zeddini, B. & Tranouez, P., 2007. *Approche décentralisée pour résoudre le problème du transport à la demande*. In MajecSTIC.
- Tranouez, P., Daudé, E. & Langlois, P., 2012. *A multiagent urban traffic simulation*. Journal of Nonlinear Systems and Applications, 3(3-4)
- Tranouez, P. & Dutot, A., 2009. *Different goals in multiscale simulations and how to reach them*. Understanding Complex Systems-
- P. Tranouez, E. Daudé, G. Czura, P. Langlois, et P. Taillandier, 2013 *How does traffic react to industrial disaster? an agent-based simulation in urban context*. UrbanNet
- Vo, D.A., Drogoul, A. & Zucker, J.D., 2012. *An operational meta-model for handling multiple scales in agent-based simulations*. RIVF 2012.

ACKNOWLEDGMENT

This work is supported by the ANR ESCAPE project, grant ANR-16-CE39- 0011-01 of the French Agence Nationale de la Recherche.

This work was supported by the ERDF Normandy project MADNESS