PISTACHE

Parallel and Interactive Simulation of Traffic and Air in Cities on Hpc Environments

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GIS BASED MULTILAYER INTEGRATED MODEL FOR URBAN TRAFFIC SIMULATIONS SERVING PARTICIPATIVE MANAGEMENT AND SUSTAINABLE DEVELOPMENT GOALS

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CONTEXT

Dramatic increase of urban road traffic in developing countries raises public health issues

Large cities in developing countries (like the ones used as case studies for this project: Dakar and Marrakech) are rapidly growing, undergoing deep transformations while the purchasing power of their inhabitants is increasing. They offer more and more facilities, which contribute to changes in people's livelihoods, aspirations and activities and, above all, mobility habits (Banos 2005). These changes, combined with a poor urban planning, lead to a spectacular increase of urban road traffic which, among other issues, begins to have severe consequences on public health due to the exposure of the population to new forms of air pollutants produced by vehicle exhaust (Fosset 2016). For instance, several African cities face the emergence of new pulmonary diseases (Kelly 2015).

Lack of data and models: a key challenge for evidence-based policy making

This problem is central for cities such as Marrakech or Dakar. In these two cities, public authorities have already acknowledged the problem but they struggle to find the most adequate solutions; development of public transportation (e.g., buses or urban railways), new regulations (e.g., tolerated emission of vehicles, restrictions on traffic) or adaptation of the infrastructures (e.g., design of larger roads) are some of the possible options to choose from. But political decision suffers in these cities from three major problems: (1) **the lack of reliable empirical data** on both traffic and air pollution; (2) the **difficulty to predict** the impact of public policies on a quickly changing situation; (3) the **difficulty to mobilize** the population in the design of solutions. In these conditions, the achievement of SDG-11 (United Nation, 2017) on "making urban spaces more inclusive, safe, resilient and sustainable", as well as other related goals such as SDG 3 on health, appears out of reach unless a dedicated effort is undertaken to tackle these problems together, which is precisely what we propose in this project.

Fig. 1: Dense traffic and pollution in Dakar (Photo by Florence Fournet, 2005 and Mireille Cavaleyra, 2007)

OBJECTIVES

The overall objectives of the project are as follows:

1. Couple the traffic model with models of particles emission, local dissemination and global propagation at different scales;
2. Use these coupled models in participatory setups, allowing end-users to explore different traffic management policies and their impact on air pollution in real-time;
3. Feed these coupled models with real-time traffic and atmospheric data (gathered by dedicated networks of sensors);
4. Calibrate the model according to the two case studies.

APPROACH AND LESSONS LEARNED, ZOOM ON MARRAK'AIR

The project proposes to address these three issues using an integrated simulation-based approach that has already been used, in a preliminary proof of concept, in the Marrak'Air project. From traffic counter data, Marrak'Air is able to produce a traffic map over all the city of Marrakech. It is based on an Agent Based Model called SCAUP. The latter has been successfully validated by a case study in French city (Dijon) from which large amount of traffic and pollution data have been collected and are now available (Emery, 2016). Marrak'Air adds interactivity to the SCAUP model. It has been deployed in Marrakech for air-pollution education along the COP 22 (United Nations Climate Change Conference).

This preliminary project has shown the undeniable interest of the approach in terms of prediction and education of the public to traffic-induced air pollution, but it has also allowed us to discover its limits.

1. Lack of data that limits studies about Southern cities. Low-cost sensor networks connected to models is an approach to collect data, validate models and test actuals applicative scenarios.
2. Drastic simplifications to keep enough velocity to interact with the simulation. Produced results show impacts of a politic on an interactive map but cannot be used to produce statistics.
3. Model calibration according to the studied city to take into account local urban traffic dynamic and local vehicle specificities.

PISTACHE generalizes what has been already done in Marrak'Air, by confronting the approach to two case studies and addressing the computational and methodological limits present in this project.

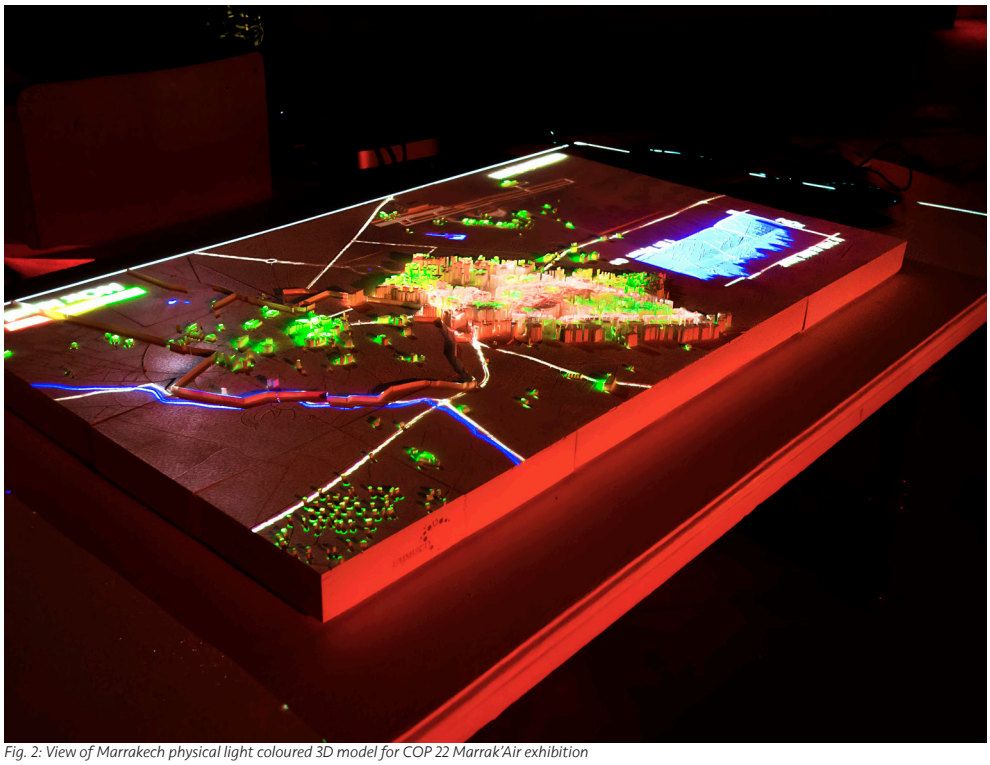

Fig. 2: View of Marrakech physical light coloured 3D model for COP 22 Marrak'Air exhibition

EXPECTED RESULTS

Impacts and benefits in large scale simulations and high performance computing

PISTACHE will provide innovative solutions to technical issues related to complex system modeling by providing live data or data in short delay which are crucially needed to run models and produce useful simulations for decision-making. Advances in High Performance Computing are required to speed up agent-based and coupled simulations and will benefit other research in the simulation domain. Lastly, but not least, PISTACHE will shed light on urban mobility and provide data enabling new scientific and research activities on people's movements and urban planning.

Impacts and benefits in participative modeling

Regular and flexible means of communication and exchanges among team members and stakeholders will be set. Along the project, we want to organize periodic short meetings with local authorities in order to: (i) keep them in touch about project advances; (ii) take their considerations and advices into account; (iii) share with them the model property; (iv) ensure better understanding among stakeholders of scientific results; (v) get confidence and improve the model use.

Impacts and benefits in other domains

Long-term urban management policies are aligned with Sustainable Development Goal SDG11 and related key goals such as SDG3 on health, SDG8 on sustainable economic growth, SDG9 on resilient infrastructures, SDG13 on climate change and SDG17 on revitalizing the global partnership for sustainable development. Observing effects of policies and regulations on fine particle, or modifying urban transport systems can take a long time, be expensive and can be full of uncertainty as well as unexpected knock-off effects. Such innovative project bypasses these barriers by designing realistic scenarios, evaluating urban policies in a short time cycle, and providing new evidences to designed urban planning.

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