Multicriteria Models for a Humanitarian Logistics Problem: An Integral Approach

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PROJECT SUMMARY

MAIN OBJECTIVE

To propose an integral approach to the problem of determining shelter and distribution center location, prepositioning humanitarian aid, evacuation plans of the population and distribution of the aid to shelters in case of floods through a multicriteria optimization model in the preparedness phase and a metaheuristic in the response phase.

MAIN QUESTIONS

- How to coordinate different humanitarian operations in an integral approach during the preparedness and the response phases of a disaster?
- Which methodologies are useful to plan and to respond during disasters (especially during floods)?

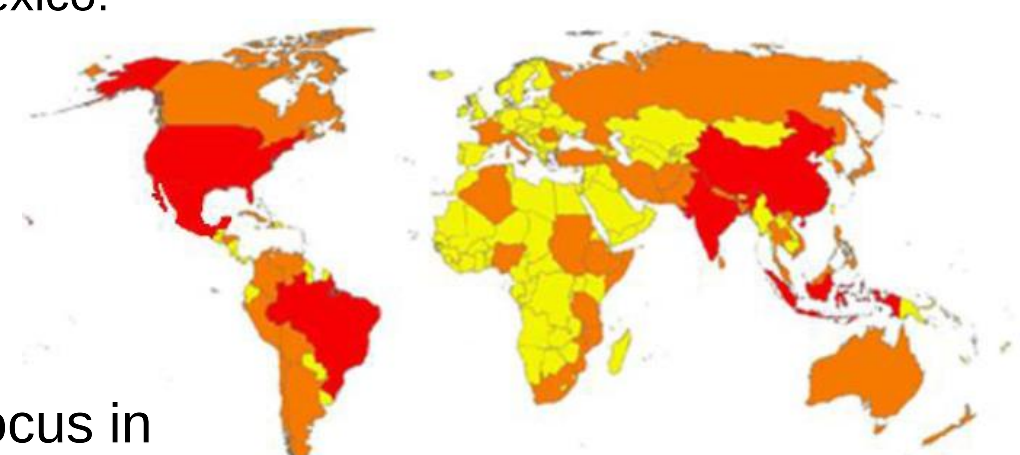
Major Activities and Findings include:

- A multicriteria model and metaheuristic that integrates the main humanitarian operations is proposed
- The solutions found by the model/heuristic are based on scenarios obtained by the use of GIS
- Efficient sets are built combining exact methods or using SSPMO heuristic (Molina et al, 2007)
- The models are validated considering the worst flood scenario occurred in Mexico and a set of scenarios is built from three key factors in humanitarian logistics

MOTIVATION AND INTRODUCTION

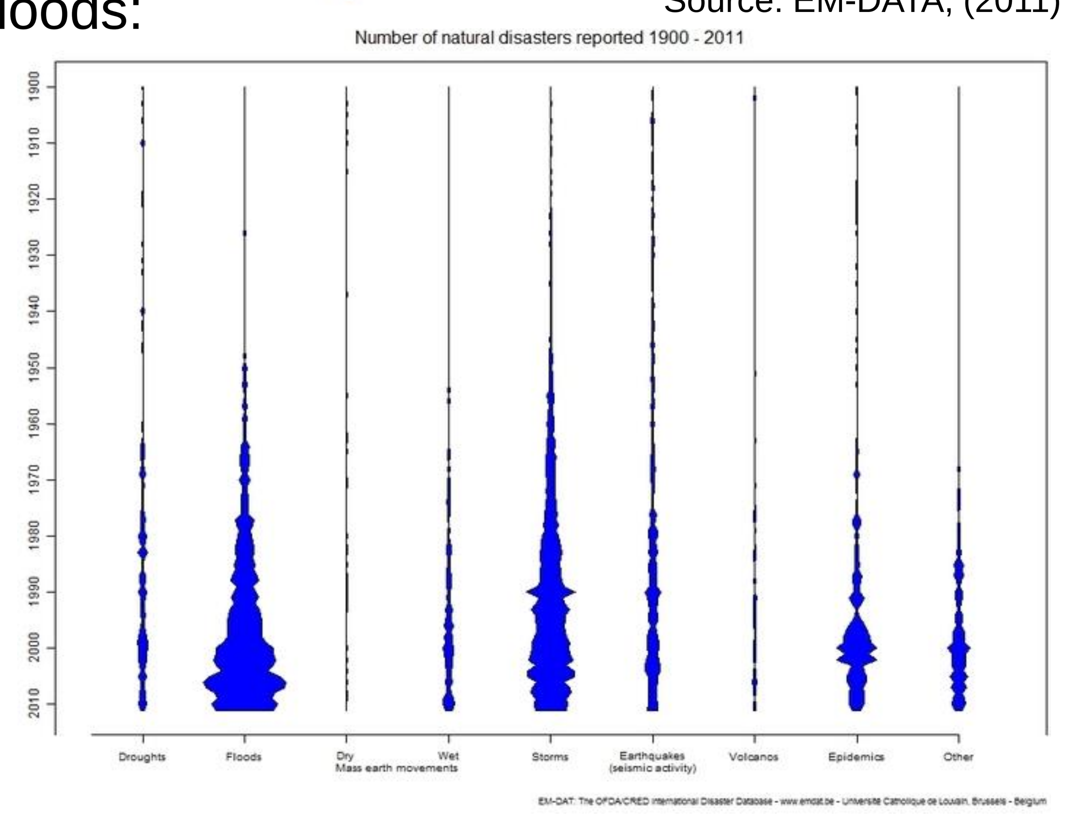
Focus in two phases:

Research tested in Mexico:



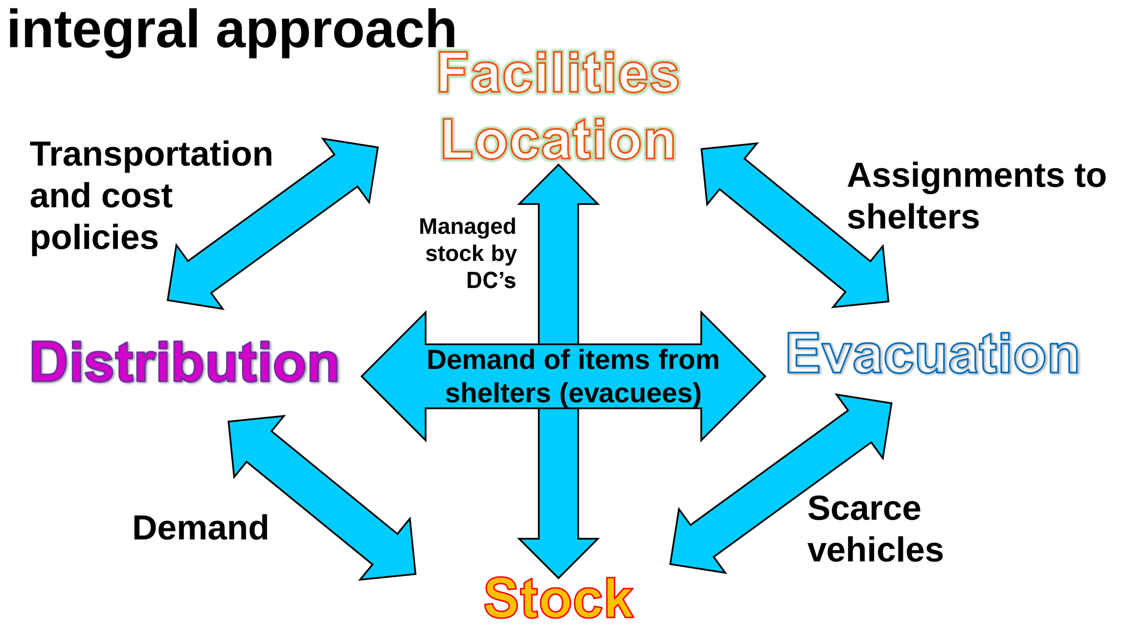
Focus in floods:

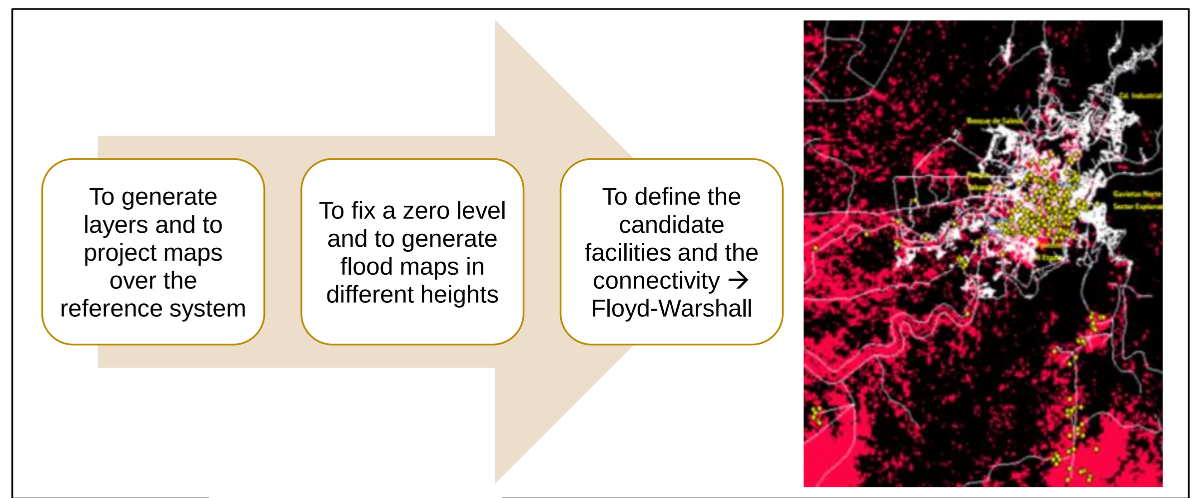
Source: EM-DATA, (2011)

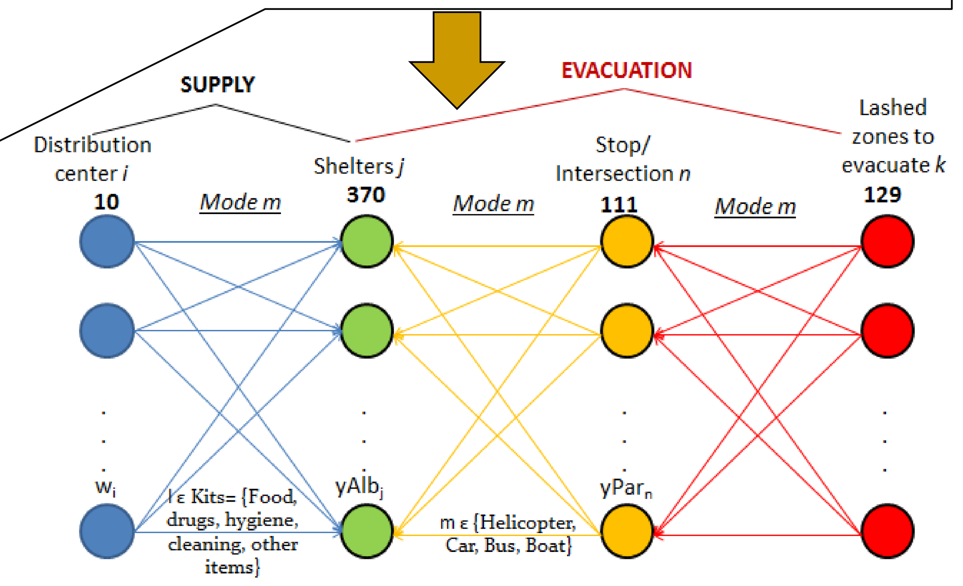


INTEGRAL APPROACH, METHODOLOGY AND RESULTS

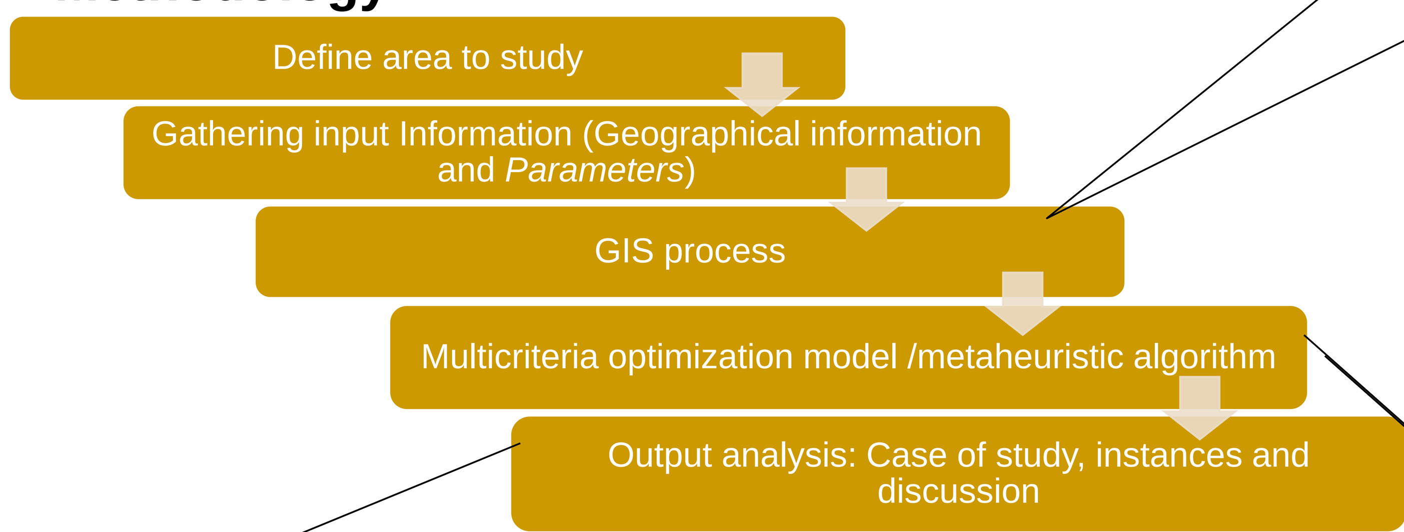
The integral approach



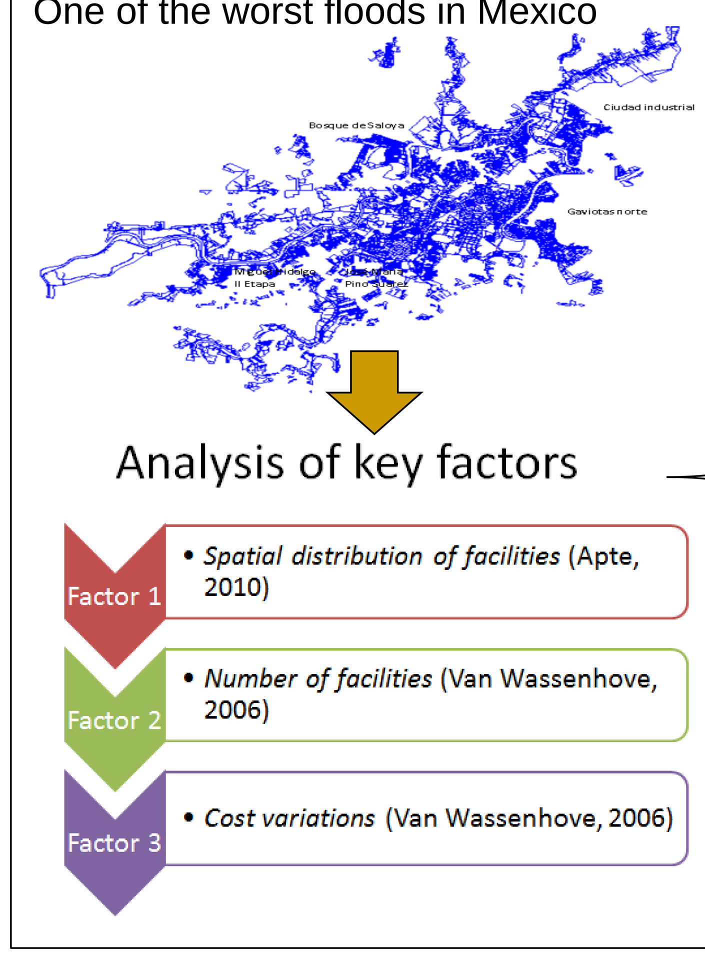


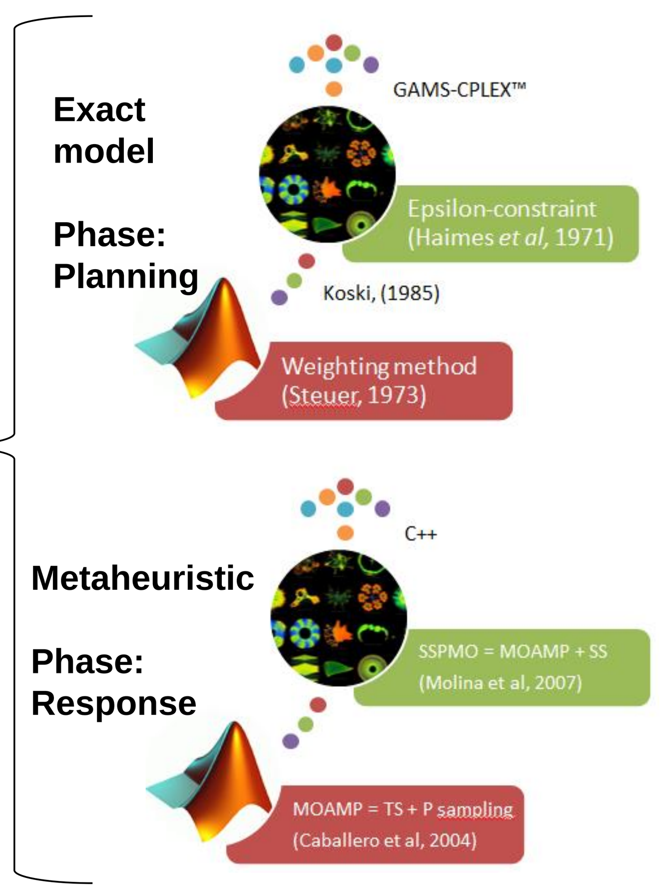


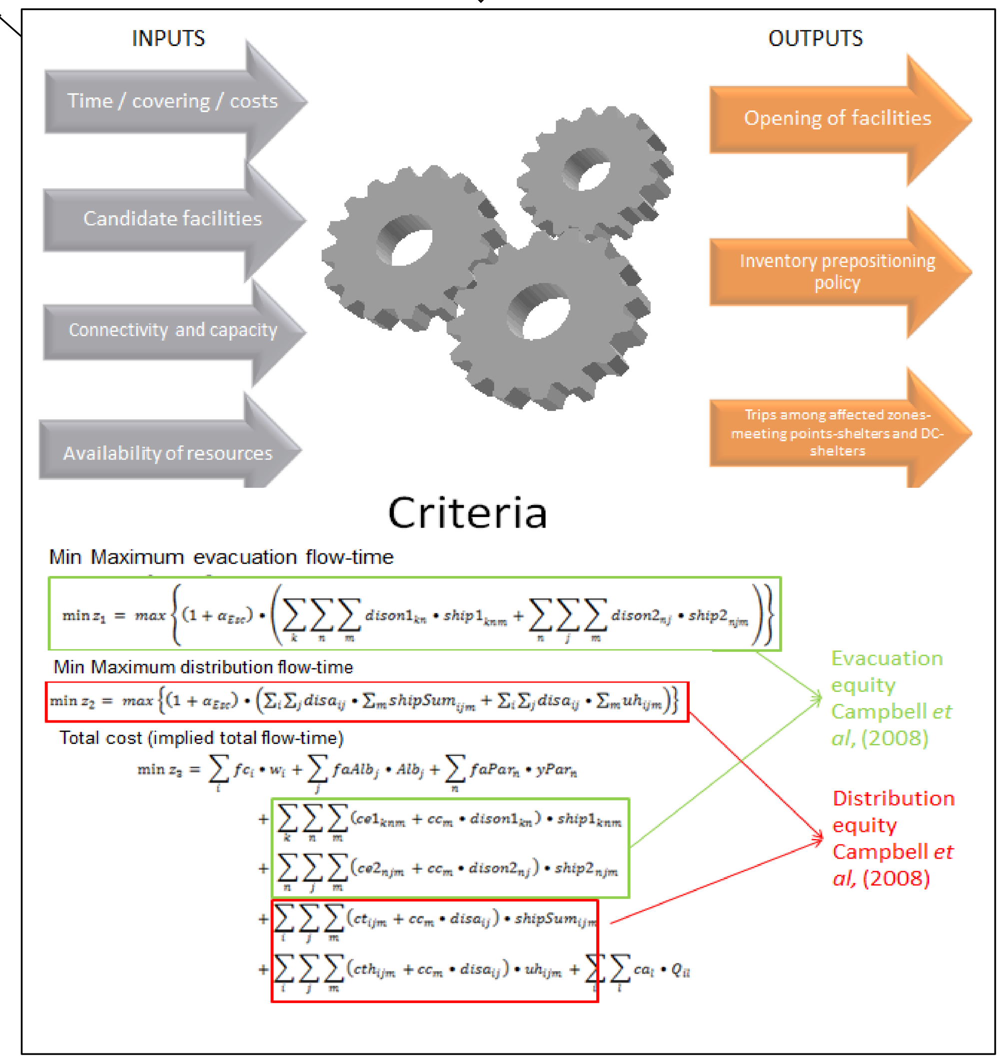
Methodology



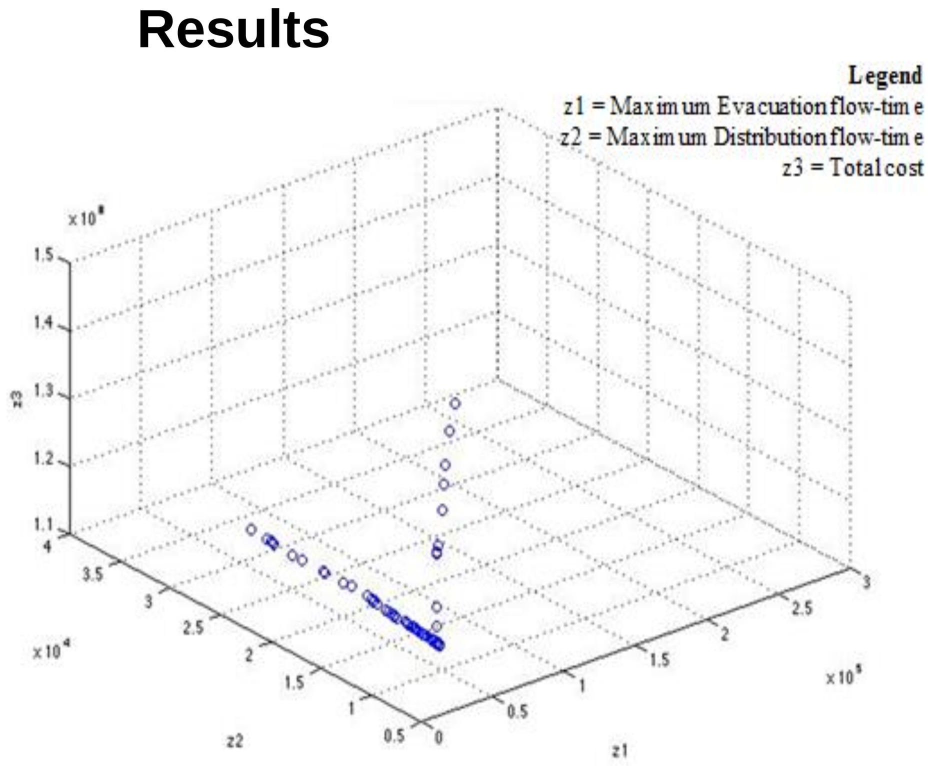
Case of study: Villahermosa, (2007)
One of the worst floods in Mexico

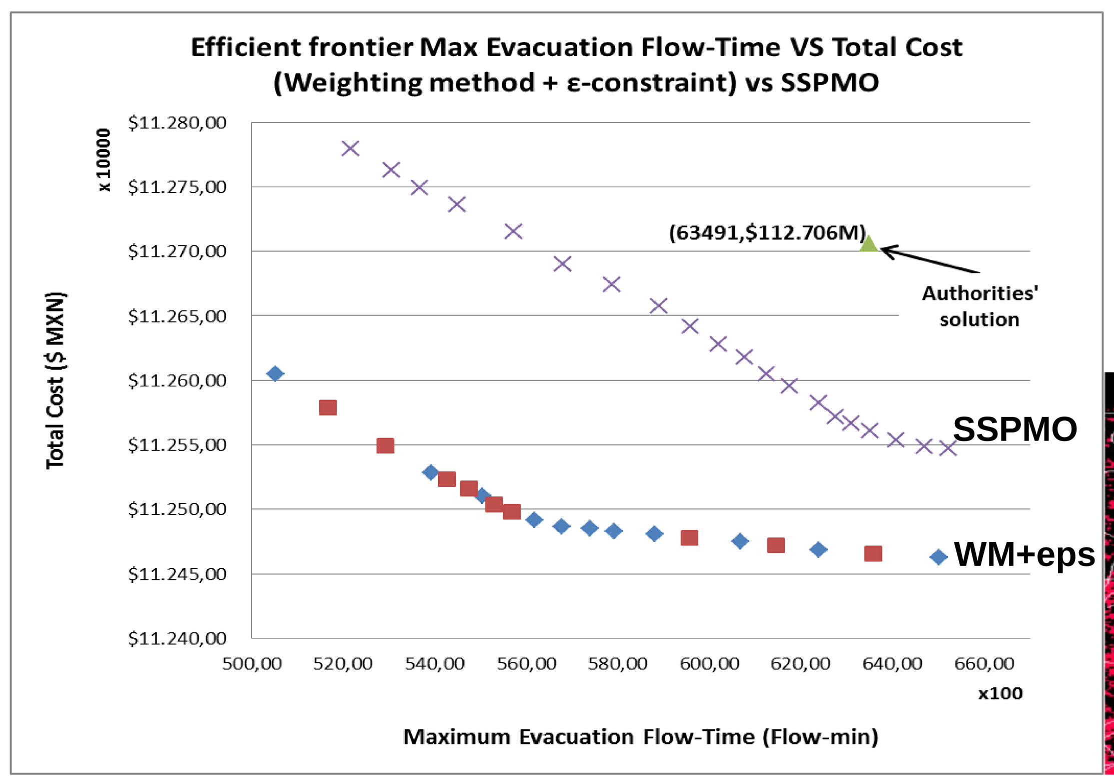




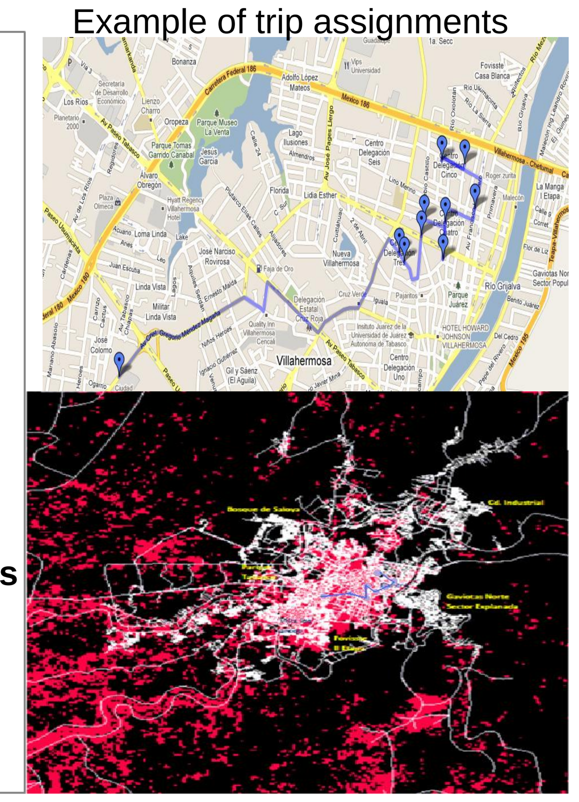


Results





Example of trip assignments



HIGHLIGHTED RESULTS

- As spatial distribution increases (Factor 1), the higher is shelters utilization
- As the number of facilities increases (factor 2), criteria 1 (MINMAX evacuation), and criteria 2 (MINMAX distribution) decrease
- An increase of the number of facilities (factor 2), generates an increase of the total cost (criteria 3)
- A decrease of total cost (criteria 3), produces an increase on the number of required buses
- The lower total travel time, the higher is the use of faster vehicles (helicopters and cars)
- Number of utilized cars in the evacuation is sensitive to cost variations (factor 3)
- The quality of the solutions in SSPMO is worse but the computational time is better than the exact models
- Average evacuation flow-time (z1) → SSPMO: 14.2 minutes per vehicle VS Exact: 12 minutes per vehicle
- Average distribution flow-time (z2) → SSPMO: 9.1 minutes per vehicle VS Exact: 8.3 minutes per vehicle
- The less Planning Budget (PB), the model forces higher facilities utilization and less quantity of opened facilities
- The more PB, higher capacity facilities are opened although they have lower utilization rates
- Streets capacities are not enough for the analyzed scenarios. Isolated regions were detected
- Villahermosa Downtown is a main bottleneck

CONCLUSIONS/CONTRIBUTIONS

- An integral approach based on GIS and optimization models/metaheuristic are proposed to the planning/response phases of Humanitarian Logistics
- Scenarios with real information based on GIS and with mathematical models allow the authorities to anticipate needs during a flood in any of the humanitarian operations
- The proposed methodology improves the actions performed by the authorities for the (2007) Villahermosa case of study and the test problems give additional insight to decision makers
- The methodology can easily extended to another hydrometeorological phenomena that will ocurr in other regions