UCM-HUMLOG Decision Aid Models for Logistics and Disaster Management (Humanitarian Logistics)

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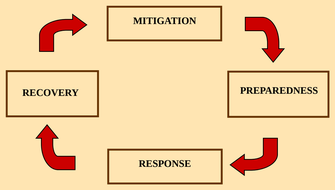


This poster shows the activities of our research group, "**HUMLOG Decision Aid Models for Logistics and Disaster Management (Humanitarian Logistics)**". Currently, the group's work is mainly devoted to the development of decision aid models in humanitarian logistics and disaster management, but also maintains activity in general logistics. The widest context for humanitarian logistics application is disaster management but it also appears in other contexts, such as the case of humanitarian operations not linked to a specific disaster (World Food Programme, vaccination campaigns) or development projects providing basic services. However, it is in disaster management where the application of humanitarian logistics is more complex and difficult and where more differences with business logistics appear.

Ferrer JM, Martín-Campo FJ, Ortuño MT, Pedraza-Martínez AJ, Tirado G, Vitoriano B.(2018) Multi-criteria optimization for last mile distribution of disaster relief aid: Test cases and applications. EJOR 269 501-515

Vitoriano, B., Montero, J., Ruan, D. (2013) Decision Aid Models for Disaster Management and Emergencies. Atlantis Press.

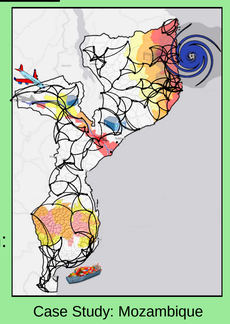
Vitoriano, B., Rodríguez, J.T., Tirado, G., Martín-Campo, F.J., Ortuño, M.T., Montero, J. (2015) Intelligent Decision-Making Models for Disaster Management. HERA 21(5), 1341–1360.

Preparedness & Early Response

Warehouses location and prepositioning

Preparedness decisions with different time horizon:
- **Strategic**: warehouses location & sizing
- **Tactical**: prepositioning, yearly budget
- **Operational:** scenarios to be taken into account evaluating decisions

Model characteristics
- GIS Integration
- Scenarios generation
- Multiobjective and stochastic optimization: unmet demand, deterministic and stochastic cost.
- Case studies: Mexico floods decisions in emergency; Mozambique preparedness



Case Study: Mozambique

Rodríguez-Martínez, A., Escudero, L., Monge, J.F., Ortuño, M.T., Vitoriano, B. (2017) *A stochastic optimization model for warehousing location and dimensioning in the preparedness for disaster response*, POMS2017.

SEDD: Assessment of disaster consequences

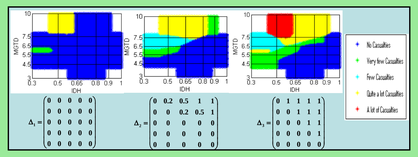
Disaster consequences → needs of the affected population → requirements of relief operations

Just when a disaster strikes:
- uncertainty about what's happening;
- urgent strategic decisions to be taken.

FUZZY BIPOLAR CLASSIFICATION

Matrix	%CC	%NC	%TC	%ERROR	COST	PRED	VAR	P_DIF
No dissimilarity	54,15	0	54,15	45,85	1,4534	1,0415	0,0708	0,8497
Asymmetric linear order	**55,18**	**0**	**55,18**	**44,82**	1,0699	1,5518	0,7965	0,4093
Avoid underestimation	50,52	0	50,52	49,48	**0,9689**	**2,0181**	**1,339**	**0,2176**

Rodríguez, J.T., Vitoriano, B., Montero, J. (2012*) A general methodology for data-based rule building and its application to natural disaster management,* Computers and Operations Research 39, 863-873.



Forest fires prevention/mitigation

Fuel load and breaks management:
- Fuel-breaks location (ZAL)
- Prescribed burning

Characteristics
- Uncertainty
- Propagation
- Networks connectivity
- Multiple criteria
- Risk management
- Environmental issues
- Resources allocation
- Metaheuristics

León, J., Reijnders, V., Hearne, J., Ozlen, M., Reinke, K. (2019) *A Landscape-Scale Optimisation Model to Break the Hazardous Fuel Continuum While Maintaining Habitat Quality.* Environmental Modeling & Assessment 24, 369-379
Rodríguez-Martínez, A., Vitoriano, B. (2020) *Probability-Based Wildfire Risk Measure for Decision-Making*, Mathematics 8(4), 557

Staff scheduling for emergency services

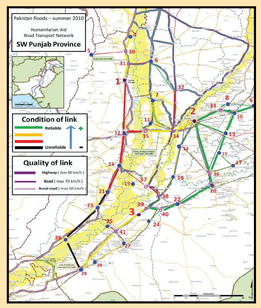
Creation of long-term staff scheduling pre-disaster, and modification after disaster strikes minimizing the deviation to the schedule (disruption management)

Model characteristics:
- Multiple criteria
- Uncertainty
- Using historical risk assessment data

Granda, B., Vitoriano, B. (2020) *Staff scheduling for emergency services. A review.* EWG-ORD Magaliesburg (*online*)

Response

HADS: Distribution of Humanitarian Aid

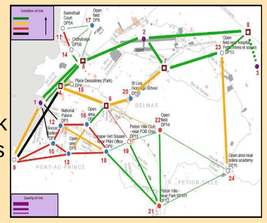


Case Study:
Pakistan Floods 2010

Different attributes: Cost, equity of distribution, priority of a location, time of response, reliability (state of roads), security

Building realistic test cases: difficult but very important task to validate models and to be useful for involved organizations

Different versions:
- *Simplified:* double flow
- *Dynamic*: explicit control of timing and vehicle routes
- *For unsafe environments:* scheduling of vehicles, that travel together in convoys for security reasons



Case Study: Haiti Earthquake 2010

Vitoriano, B., Ortuño, M.T., Tirado, G., Montero, J. (2011) *A multi-criteria optimization model for humanitarian aid distribution*, JOGO 51, 189-208.
Tirado, G., Martín-Campo, F.J., Ortuño, M.T., Vitoriano, B. (2014) *A lexicographical flow model for relief operations*, IJCIS 7(1), 45-47.
Ferrer, J.M., Ortuño, *dynamic* M.T., Tirado, G. (2016) *A GRASP metaheuristic for humanitarian aid distribution*, Journal of Heuristics, 22(1), 55-87.
Ferrer, J.M., Ortuño, M.T., Tirado G. (2020) *A New Ant Colony-Based Methodology for Disaster Relief,* Mathematics, 8(4), 518

Human evacuation

Evacuation of people from affected areas to safe places and distribution of basic commodities

Characteristics of the model:
- Multiple criteria
- Joint human evacuation and commodities distribution
- Consideration of the gravity of the affected people

Resolution: Lexicographical goal programming with two priority levels:
1. Evacuation time of people in a critical state
2. Total evacuation time & operational cost

Emergencia en el Salvador, Cesal.org

Mejía, C., Gaytán, J., Caballero, R., Molina, J., Vitoriano, B. (2018) *Multicriteria optimization approach to deploy humanitarian logistic operations integrally during floods*, ITOR, 25, 1053-1079.
Flores, I., Ortuño, M.T., Tirado, G., Vitoriano, B. (2020) *Supported Evacuation for Disaster Relief through Lexicographical Goal Programming*, Mathematics 8(4), 648

Forest fires: fire suppression

Resources allocation and propagation:
- Uncertainty
- Networks connectivity

Model characteristics:
- Multiple criteria
- Dynamic model
- Multistage Stochastic programming
- Simulator integration? Library?

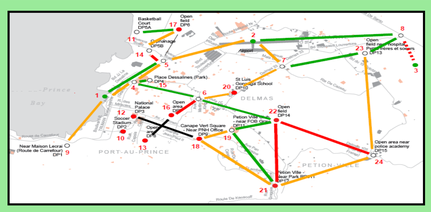
Urrutia-Zambrana, A., Tirado, G., Mateos, A. (2021) *Variable neighborhood search to solve the generalized orienteering problem.* International transactions in Operations Research 28, 142-167.

Recovery & Development

REC-HADS: Recovery Operations

Links under some reliability level are considered unavailable
Joint infrastructure recovery and distribution flow model with:
- Recovery budget
- Criteria: Demand satisfied, time, security, reliability

Criteria aggregation: Hierarchical Compromise Programming
Applications: Response phase during and after emergency



Case Study: Haiti Earthquake 2010

Liberatore, F., Vitoriano, B., Ortuño, M.T., Tirado, G., Scaparra, M.P. (2014) *A hierarchical compromise model for the joint optimization of recovery operations and distribution of emergency goods in Humanitarian Logistics,* Computers and Operations Research 42, 3-13.

Development: Photovoltaic Rural Electrification

- Remote areas: photovoltaic electrification
- Providing basic service (fee for service)
- Maintenance service by energy companies
- Planned: preventive maintenance
- Uncertainty: corrective maintenance, collecting fees

Model:
1. Estimating cost and sizing
2. Obtaining simple rules for cost and sizing estimations

León, J., Martín-Campo, F.J., Ortuño, M.T., Vitoriano, B. , Carrasco, L.M., Navarte, L. (2020) *A methodology for designing electrification programs for remote areas*. Central European Journal of Operations Research 28, 1265-1290.

General Logistics

Transportation, Energy, Production…

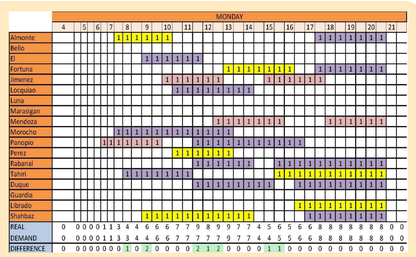
- **Green vehicles networks design**
- **Power generation planning**
- **Railway transport**
- **Agriculture/Farm planning**
- **Orienteering problems**
- **Safety and Security**
- **Reliability**
- **…**

- Development of models for companies/institutions over time:
  - Iberdrola, Endesa, Renfe, Metro Madrid, ADIF, Tekia…
- Integrated with information systems to support decision making
- Based on Optimisation:
  - Mathematical programming, metaheuristics…
  - Special treatment of uncertainty (fuzzy, stochastic programming…)
- Including data science for better decision making

Tirado, G., Hvattum, L.M. (2017) *Improved solutions to dynamic and stochastic maritime pick-up and delivery problems using local search.* Annals of Operations Research 253, 825-843.

Decision Aid Models and Data Science in the Catering Sector

- Demand forecasting
- Restaurants staff rosters: challenging logistical problems (Flexibility, labour regulations, large demand variations, contract restrictions, different roles…)
  - Short term scheduling (weekly): half an hour schedule over a week
  - Medium term planning (monthly): combines weekly planifications
  - Long term planning (yearly): hiring, holidays, daily plan…



MAPAL software (2016): in operation

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