UCM-HUMLOG
HADS: Last Mile Distribution of Humanitarian Aid
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Global Logistic Cluster
Complutense University of Madrid, Spain

- Public university
- The biggest university in Spain (~ 80,000 students), 3rd in Europe
- Strong relationships with Latin America
- Destination for students of many countries (Erasmus, China...)

[Image of the Complutense University of Madrid]

UNIVERSIDAD COMPLUTENSE MADRID
Faculty of Mathematical Sciences

- Biggest Faculty of Mathematics in Spain

- Highlights:
  - 3 departments
    - Algebra, Geometry and Topology
    - Mathematical Analysis and Applied Mathematics
    - Statistics and Operational Research
  - Applied orientation
  - Institute of Interdisciplinary Mathematics: Research Institute
  - Master in Disaster Management: joint with Technical University of Madrid.
    - 18 centres (energy, civil engineering, medicine, architecture, sociology, psychology, topography, physics, geology, telecommunications, nursing...)
UCM-HUMLOG: Decision Aid Models for Logistics and Disaster Management (*Humanitarian Logistics*)

- New decision aid models for logistics, Humanitarian Logistics
  - Working on humanitarian logistics problems since 2001
  - 11 members: 3 associated professors, 3 lecturers, 5 early stage researchers
  - Current funded projects:
    - Decision Aid Models for Humanitarian Logistics in Disaster Management. Spain
    - Development of a model for staff shifts. Mapal Software S.L.
  - Test cases repository for Humanitarian Logistics models
  - Cooperation for development since 1994 (Mozambique, El Salvador, Peru...)

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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.


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Warehouse 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 decision-making

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

 перемещение

HADS: Distribution of Humanitarian Aid
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 be useful for involved organizations

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

Case Study: Pakistan Floods 2010

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

Case Study: Haiti Earthquake 2010

Transportation, Energy and Production
Different sectors problems addressed over time:
- Green vehicles networks design
- Power generation planning
- Railway transport
- Agriculture/Farm planning
- Orientation problems

- Models developments for companies
  -Empresas, Kerry, Metro
  -Integrated with information systems to support decision making
  -Based on Operational Research

General Logistics
- Mathematical programming, metaheuristics...


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HADS: decision aid model for last mile distribution

- **Name:** Humanitarian Aid Distribution System (HADS)

- **What is it?:** decision aid models for logistic operations, focused on specific transportation problems appearing in humanitarian aid distribution

- **Mathematical models** considering different criteria (time, cost, equity, reliability, security...)

- **Test cases repository:** [www.mat.ucm.es/humlog](http://www.mat.ucm.es/humlog)
Last mile distribution problem

- Last stage in humanitarian aid distribution
  - Last stage of transportation
  - Secondary movements: delivery to multiple destinations in a limited area
    - From warehouses to EDP (Extended delivery points)
    - From central warehouses to warehouses on the field
    - From warehouses to beneficiaries

- Dependent of the phase and environmental conditions:
  - First phases (first and second phases MIRA):
    - high uncertainty: demand, state of infrastructure, resources
    - scarcity and dispersion of resources
    - high time pressure (short runtime and input data: information shared, GIS)
  - Mission oriented: each agency defines its goals over time (long and short term)
  - Short-term distribution: operation for only one tour of lorries (one “shot”)

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Last mile distribution models: Input data

- **Logistic map (GIS):**
  - Nodes: pick-up, connection or delivery.
  - Links: Length, Average speed, Reliability (status), Security

- **Relief goods** (water, food, household goods, medical...)
  - Supply at each pickup node
  - Demand at each delivery node

- **Vehicles:**
  - Characteristics: Capacity, Speed, Costs (variable/fixed), Compatibility
  - Availability and location (Log cluster DLCA, own fleets)

- **Mission goals:**
  - Global quantity to be distributed in the operation (sometimes less than available because of demand, other compromises or repetition)
  - Budget

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Last mile distribution models: Criteria

• Several criteria
  – Effectiveness (Mission goals): quantity to be distributed and budget
  – Equity distribution of goods
  – Response Time (time to complete the delivery)
  – Cost
  – Reliability (network state)
  – Security: the more vehicles travelling together less danger (convoys)

• Working with several criteria: Distance to reference point (ideal/targets)
  – Tradeoff between criteria. Not all of them allowed: priorities
    • Hard constraints higher priority (available resources, convoys if needed)
    • Soft constraints for criteria: distances to reference point with priority levels
      Level 1: mission goals (quantity distributed, budget)
      Level 2: fit the other performance criteria to targets/ideal
Last mile distribution models: several approaches (I)

1. Simplified model for resources estimation in first stages

- Travelling in convoys
- Leaving one node all vehicles at the same time
- All criteria can be considered
- Not pre-sizing (number of vehicles or required time of response)
- Not scheduling for each vehicle
- Mathematical model: MIP double static network flow (quantities and vehicles)
- Short runtime

Publications:

- A lexicographical goal programming based decision support system for logistics of Humanitarian Aid. M.T. Ortuño, G. Tirado, B. Vitoriano, *TOP* 19, 2011

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2. Model for planning and scheduling of vehicles

- No security criteria
- No convoys
- Allowed leaving one node at different times
- Pre-size of time of response (discrete time) (based on previous model)
- Not pre-sizing number of vehicles required
- Easy to see planning for each vehicle (but not treated individually)
- Mathematical model: MIP double dynamic network flow (quantities and vehicles)
- Longer runtime, but not too big dimensions model
- Publications:
3. Model for vehicles scheduling in unsecure environments

- Travelling in convoys
- All criteria considered
- Pre-sizing number of vehicles
- Dealing with each vehicle individually: routing of each vehicle
- Mathematical model: MIP routing problem
- Long runtimes
- Metaheuristics (GRASP) for shorter runtimes

Publications:

- Multi-criteria optimization for last mile distribution of disaster relief aid: Test cases and applications. J.M. Ferrer, F.J. Martín-Campo, M.T. Ortuño, A.J. Pedraza-Martinez, G. Tirado, B. Vitoriano. EJOR, 2018
Last mile distribution models: Results and test cases

- Results on realistic test cases
- Test cases key point to achieve validation and credibility
- Building realistic test cases based on information available at the moment: reports, internet sites...
- Preparing case studies: time consuming, many sources
- Our proposal: Data repository for research community:
  - To compare new studies with previous published ones
  - To make easier for researchers new studies (updated data)
- Test cases for last mile distribution currently in the website
  - Niger famine (2005)
  - Haiti earthquake (2010)
  - Pakistan floods (2010)
Case study: Haiti (Hearthquake 2010)
Case study: Haiti (Hearthquake 2010) - Model 2
Niger Famine 2005
Pakistan floods 2010
Work in progress and pending work

Work in progress

• Cases in development: Stan hurricane El Salvador 2005, Syria 2011
• Other problems: warehouse location, prepositioning and purchase
• Case study in Mozambique: preparedness. To be built in situ
• Repository open for all the humanitarian community

Pending work: Interface and systems integration

• Interface: Absolutely required for being useful
• Systems integration: with GIS and agency systems
• Requirements and specification: to be defined with end users

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Cooperation Global Logistic Cluster and UCM-HUMLOG

• UCM-HUMLOG can provide to GLC:
  – Models (tools) for response to be offered to other partners or to provide transportation services itself (LC, WFP)
  – Models (tools) for managing warehouses, budget estimation, prepositioning...
  – A website to provide information especially to Academia (for free), in order to diminish the requests to GLC and other partners
  – Secondments, consulting, education (Master in Disaster Management)

• GLC can provide to UCM-HUMLOG:
  – Cooperation for designing tools defined by end users requirements
  – Information to be displayed in the website
  – Agreement in order to get funds to develop the tools (interfaces, integration) (supporting the group getting funds is easier)

Others?

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