Real-World Applications of Stochastic Programming
Part I
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The Rising Cost of Natural Disasters

Natural disasters reported 1900 - 2010

EM-DAT: The OFDA/CRED International Disaster Database - www.emdat.be - Université Catholique de Louvain, Brussels - Belgium
The Rising Cost of Natural Disasters

Estimated cost of natural disasters 1975-2011

Source: EM-DAT: The OFDA/CRED International Disaster Database
Hurricane Irene

- Category 3
  - August 21-28, 2011
- Fatalities
  - 49 direct (+ 7)
- Damages
  - About $15 billion
Hurricane Sandy

A DAUNTING RECOVERY
Power Failures and Transportation Systems Crippled by Storm May Take Days to Repair

Spread of Power Failures Across the Northeast

10/29 2 p.m.

10/29 10 p.m.

10/30 8 a.m.

Customers without power

10,000
100,000

10,000
100,000

10,000
100,000

10,000
100,000

Pascal Van Hentenryck, 2015
San Diego Blackout

- **Causes**
  - Tripping of a line between Arizona and California
  - Cascading effect (not supposed to happen)

- **Effects**
  - >4 millions people without power, Sept. 8-9, 2011

- **Economic Losses over US$ 100 million**
  - Opportunity losses: $70 million
  - Overtime workers: $20 million
  - Spoiled food: $18 million
Tohoku’s Tsunami

March 11, 2011
Tohoku’s Tsunami [Holguín-Veras, 2012]

- Severe Difficulties in Post-Disaster Relief
  - Both widespread and localized disaster
  - Severity of the tsunami
  - Duration (due to the nuclear thread)

- Catastrophic response
  - No relief for 6 days, many issues subsequently

- Relief Logistics
  - Regional DCs, City DCs, and Refugee Centers (RCs)
  - No plan for a global disaster
  - Private logistics companies “saved the day”
  - Donors exacerbated the issues
The Role of Optimisation

- **Pre-Katrina**: DHS focused on providing situational awareness (i.e., what is going to happen?)

  "The Federal government **must develop** the capacity to conduct large-scale logistical operations." (p 56)

- **Post-Katrina**: The need for decision support is recognized (i.e., How can we mitigate negative effects and use resources more effectively?)

- **2010-2011**: First deployment of optimization technology for hurricane mitigation in DHS through LANL
Disaster Management: Inputs

Infrastructure

Tracks (Weather Simulation)

Damages (Fragility Simulation)
Disaster Prediction

NHC Advisories and County Emergency Management Statements supersede this product. This graphic should complement, not replace, NHC discussions. If anything on this graphic causes confusion, ignore the entire product. For full info, see http://my.sfwmd.gov/sfwmd/common/images/weather/plots.html
Explicit Scenarios

Infrastructure

 Threats

 Disaster Scenarios