Modelling Post-Eruption Casualty Rescue, Transport and Treatment

EARTH OBSERVATORY OF SINGAPORE
An autonomous institute of Nanyang Technological University

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I. Background

The speed at which emergency services respond following a volcanic eruption plays a vital role in determining the survivability of casualties. Residents in impacted zones exposed to a pyroclastic density current will suffer severe burns and will require intensive treatment and care. However most hospitals have very limited capacity to treat burn victims and therefore the management of casualties can have a large impact on their survivability. Mitigation plans need to be enforced to enable swift access to vital equipment such as ventilators.

This poster will explore how to quantify the impact of casualty rescue and treatment on casualty survivability. The selected study area is the island of Guadeloupe, where the populated area of Basse Terre and Saint Claude are in close proximity to the La Soufrière volcano.

Rescuers carrying casualties burned by dilute pyroclastic density currents from Merapi volcano on 5 November 2010. Photo source: Boston.com, 2010.

Pyroclastic Density Current from Soufrière Hills Volcano as seen from Fort Ghaut, Montserrat on 04 August 1997. Photo source: theatlantic.com, 2013

II.What affects casualty survivability?

- Severity of injuries
- Age and health conditions
- Time to recieve medical treatment
  - Overloading at hospitals
  - Modes of rescue (helicopter / ambulance)
  - Location of treatment facilities
  - Damage to transportation systems
- Availability of medical equipment
- Area of Impact : Number of casualties affected

III. Modelling Approach

- Wide Variety of parameters affecting rescue operations
- Identify which parameters are critical and how changes influence survivability
- Use of an Agent Based Modelling approach to simulate post disaster casualty rescue , transport and treatment
  - Allows scenario testing with ease
  - A visual interpretation of post-disaster rescue

Netlogo Agent Based Modelling environment

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GIS Locations of infrastructure (medical facilities, roads etc) and casualties

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Python Offers a wide variety of packages that can be implemented to improve model accuracy

IV. What parameters are considered in the model

Ambulances:
Speed
Capacity
No of ambulances
Alternative Routes

Helicopters:
Speed
Capacity
No of Helicopters

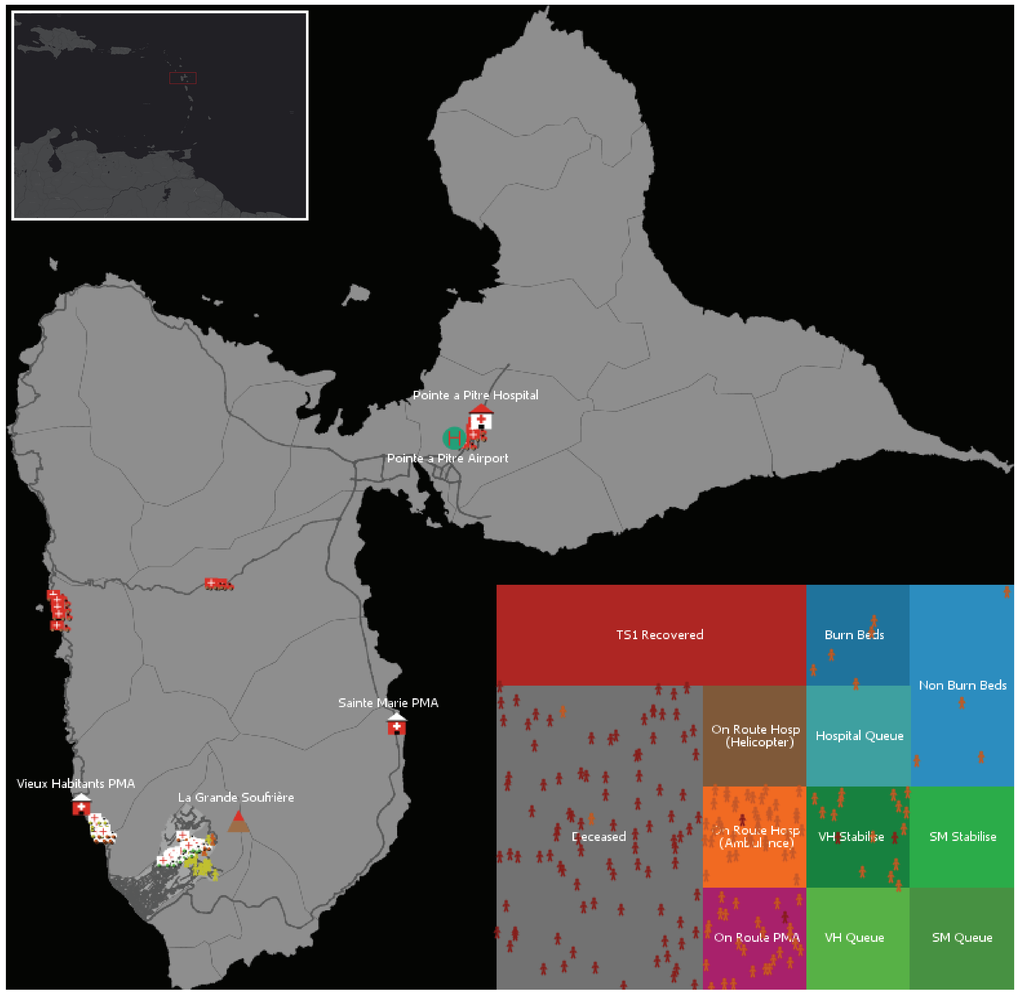
Casualties:
Trauma Scale (TS) : 1,2,3

Hospital:
Availability of equipment (Burn / Non- burn beds)

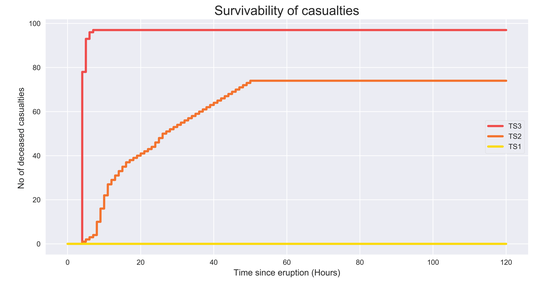
PMA:
Capacity
Opening time
No of doctors
Location

PDC:
Area Impacted

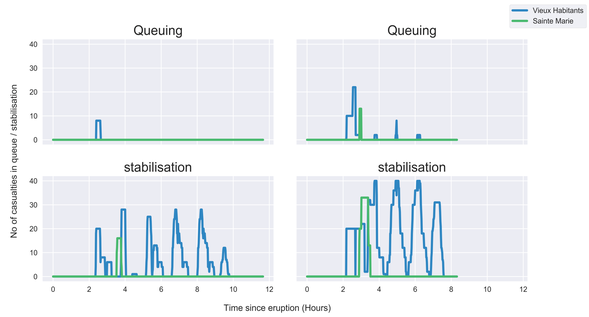
VI. Casualty Rescue, Transport and Treatment Model



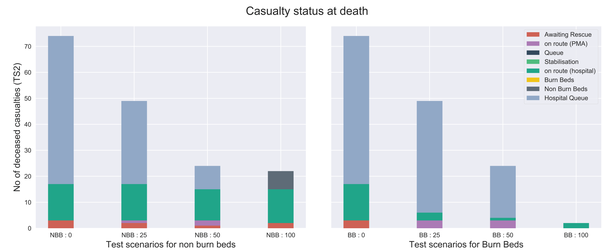
VII. Results



Variation of Deceased casualties for each trauma scale category, over a period of 5 days since impact.

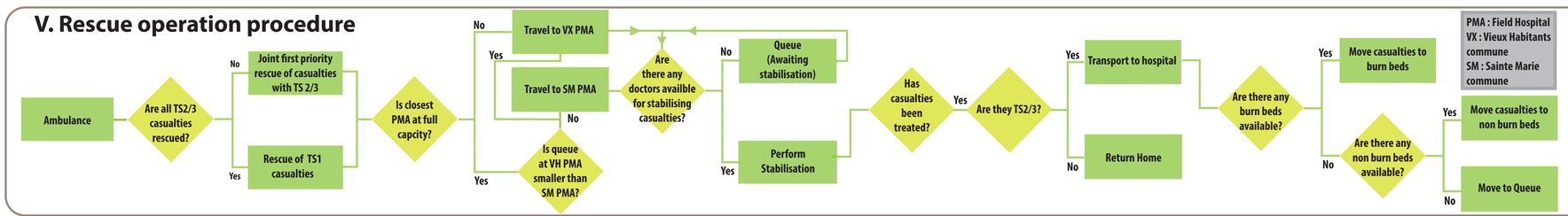


How availability of medical proffessionals at PMA affect queuing and stabilisation of casualties.
Parameters for simulation 1 (left): Ambulance Capacity = 2 casualties, PMA capacity 20 & 60 ,Time to stabilise = 15mins
Parameters for simulation 2 (Right): Ambulance Capacity = 3 casualties, PMA capacity 20 & 40 , Time to stabilise = 30mins



How availability of medical equipment (burn Beds / non burn beds) affect the survivability of trauma scale 2 casualties.
BB : Burn Beds, NBB: Non Burn Beds

V. Rescue operation procedure



VIII. Next Step : Sensitivity testing

The key next step will be to further test the effect of different impact and rescue, transport or treatment scenarios on casualty survivability over time. This will help to identify the optimum response for different impact scenarios. Parameters to test include:

- Impact: Different pyroclastic density current runout extent and areas, durations and temperatures;
- Rescue: Different modes of rescue, e.g. helicopter, self-evacuation, higher capacity ambulances;
- Transport: The effect of ashy roads, or bridge or building collapse on transport speed and route;
- Treatment: Evacuation to mainland US or France; increased equipment and capacity at PMAs and hospitals, as well as the addition or change in location of PMAs.

References cited: Boston.com, 2010. Images available from the authors and at http://www.boston.com/bigpicture/2010/11/mount_merapis_eruptions.html (Last accessed 05/12/12), Atlantic.com, 2013, Images available from the authors and at https://www.theatlantic.com/photo/2013/05/soufriere-hills-volcano/100509/

The EOS is funded by Singapore´s National Research Foundation (NRF), the Ministry of Education (MOE) and Nanyang Technological University (NTU) as a Research Centre of Excellence, and is an autonomous institute at Nanyang Technological University (NTU).

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