SYSTEMS APPROACH TO IMPROVE DISASTER PREPAREDNESS BASED ON CASE STUDIES

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Degree of Master of Science

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Thesis submitted in partial fulfilment of the requirements for the degree
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DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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The above candidate has carried out research for the Master's thesis under my supervision.

Names of the supervisor: Professor W. P. S. Dias

Signature of the supervisor: ……………. Date: …………………………

Names of the supervisors: Dr. C. S. A. Siriwardana

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ABSTRACT

Systems approach to improve disaster preparedness based on case studies

Preparedness planning for a disaster is an essential component in the process of the Disaster Risk Reduction (DRR), which is adhered by many disaster management professionals and authorities globally and locally. There, the question rises 'up to which extent of the disaster should the preparedness planning be done?'. To answer this question, knowledge on the extent of the disaster and its impact should be quantitatively established. When the impacts are considered, there will be impacts which have affected different components of given systems, due to the interrelations that exist within systems and its subcomponents. The spreading of impacts from one system to another due to these interrelations are called as the cascading effect. To identify the cascades and the components of systems, Emergency Operations Procedures (EOPs) and resilience frameworks are used in this study, and to quantify the cascade relationships as a proof of concept, a case study is used.

The chosen case study area is Kaduwela Divisional Secretariat Division (DSD), for the 2016, 2017 and 2018 floods. Kaduwela DSD was severally hit by all three events, as Kelani river is running by the boundary of the DSD. For these floods, data on flood impact such as the number of affected people, establishment of relief camps, supply of food and dry rations and payment of compensation were gathered, as well as the data on flood hazard extent and the exposure such as flood extent maps, elevation maps of the Kaduwela area and the building footprint were gathered. Preliminary interpretations of the data revealed patterns and relationships that define the human behaviour after a flood, and more importantly, the rationales behind initiating the relief requirements were understood, along with the monetary requirements to satisfy those requirements.

Furthermore, mathematical analyses were carried out to identify the regression relationships which predicted the human movement from the flood characteristics in a disaster. The tests were conducted on comparing the Pearson correlations and the multi criteria analysis, between the dependant and independent variables. The analyses revealed that there was more than one model to capture the effects to the humans having various inputs representing the flood characteristics. Therefore, all of the possible models were evaluated, by comparing the results from the models with the original data from the case study. By this, the best model to estimate the number of affected people and families was chosen and it was used as the quantifying relationship from flood characteristics to the human movement.

The aforementioned mathematical relationships are then summarised in to the overall cascading effect diagram, which made the cascade diagram a cascade model. This cascade model is having the flood inundation area as the input parameter which is a flood characteristic. Therefore, now this quantified cascade model could be used to identify the number of people and houses affected, number of relief camps formed, expected costs of number of required facilities, number of security officials and healthcare officials required per relief camp, number of cooked food parcels, dry ration parcels and relief items required and the costs for those which are the output parameters of the cascade model. Furthermore, the model consists with the relationships to estimate the amounts for compensations for building structural and content damage in a disaster.

Keywords: Quantifying flood damages, Cascading effect, Inundation area, Compensations, Damage prediction,

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AFCOMP	Affected Families from Computation
AFCORR	Affected Families from Correlation
APCOMP	Affected Population from Computation
APCORR	Affected Population from Correlation
CI	Critical Infrastructure
CLD	Causal Loop Diagrams
CRF	Community Resilience Framework
CRIP	Climate Resilience Improvement Project
DEM	Digital Elevation Mapping
DM	Disaster Management
DMC	Disaster Management Centre
DRR	Disaster Risk Reduction
DS	Divisional Secretariat
EOP	Emergency Operation Procedure
FES	Flood resilience supportive Eco-System Service-delivery
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
GND	Grama-Niladhari Division
GN	Grama-Niladhari
GO	Government Organisation
LiDAR	Light Detection and Ranging
MCDA	Multi-Criteria Decision Analyses

MDG	Millennium Development Goals
SD	System Dynamics
SDG	Sustainable Development Goals
SMEs	Small and Medium Enterprises
UDA	Urban Development Authority