Urban Flood Risk In Dhaka, Bangladesh

Farzana Mohuya*[1], Claire Walsh[1], Hayley Fowler[1]

School of Engineering (Civil and Geospatial Discipline), Newcastle University, UK

***Corresponding Email: f.a.mohuya2@newcastle.ac.uk**

EGU General Assembly Meeting 2023: Session HS7.5 - Hydro-meteorological Extremes and Hazards: Vulnerability, Risk, Impacts and Mitigation (23 - 28 April 2023; Vienna, Austria)

1. Background: Urban Flooding

Dhaka is one of the rapidly urbanising **megacities** of South Asia, as well as one of the largest and most densely populated cities in this region. Owing to its location, topography, climate, and proximity to rivers, the city is highly prone to **urban** and **river flooding**. Floods of **1988**, **1998,** and **2004** were the most catastrophic flood events in Dhaka (Alam and Rabbani, 2007).

In recent times extreme or heavy rainfall induced **urban flooding** or **water logging** is a recurring phenomenon. Therefore, nowadays this is a major concern in both **Dhaka North City Corporation (DNCC)** and **Dhaka South City Corporation (DSCC)** areas.

2. Aim of the Research

To investigate the research gap regarding the ***Citizen Science* concept** and ***extreme rainfall pattern*** and ***trends*** of Dhaka City and finally develop a novel approach of **Flood Risk Management** with the participation of **both citizens** and different **stakeholders** of **Dhaka** to **manage** the **risk of urban flooding** alongside established and more formal flood risk management of the city.

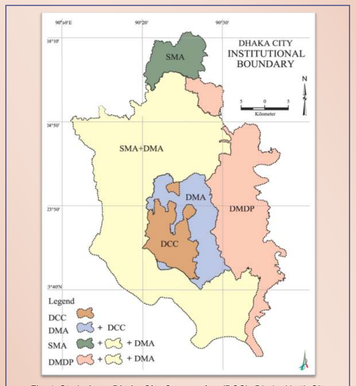

*Fig. 1. Study Area: **Dhaka City Corporation (DCC)**- Dhaka North City Corporation (**DNCC**) & Dhaka South City Corporation (**DSCC**) Areas.*
[Source: Banglapedia (2015)]
[**Note:** Other areas represented in the map- **DMA**: Dhaka Metropolitan Area; **SMA**: Statistical Metropolitan Area; **DMDP**: Dhaka Metropolitan Development Plan]

3. Research Questions

RQ.1 Can **Citizen Science** aid the understanding and management of urban flood risk in Dhaka, and subsequently be incorporated into formal flood risk management?

RQ.2 What **rainfall trends** have been observed in Dhaka City between 1953 and 2019, and are there signals of climate variability?

RQ.3 How will **flooding change** in the future in Dhaka?

4. Methods

RQ.1 Citizen Science Concept

- *Questionnaire Survey*
- *Key Informant Interview (KII)*
- *Focus Group Discussion (FGD)*

RQ.2 Extreme Rainfall Event

- *Historical rainfall trends analysis (1953-2019)*
- *Using the Extreme Precipitation Indices [Climate Change Detection and Indices (ETCCDI)] to investigate the annual and seasonal trends of rainfall between 1953 and 2019.*

RQ.3 Intensity of Flooding

- *Integration of the fieldwork and respective results from the rainfall datasets to set up the hydrodynamic model (**CityCAT Model**) to investigate the flood intensity in Dhaka.*

Photos: Recent Urban Flooding/Water Logging Situation in Green Road (July 2020) and Gulistan Area of Dhaka, Bangladesh (August 2020) [Source: www.bdnews24.com]

5 (a). Results: Questionnaire Survey

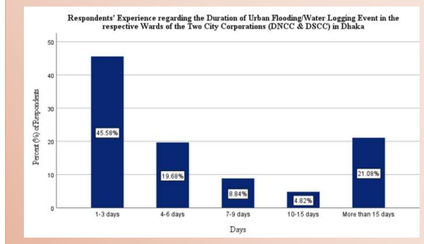

*Fig. 2: Respondents' Experience regarding the **Duration of Urban Flooding/ Water logging** in the Two City Corporations in Dhaka.*

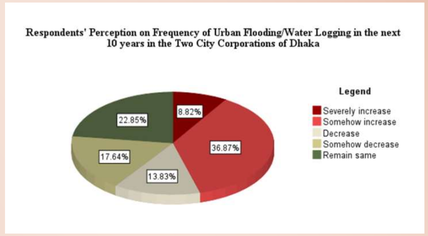

*Fig. 3: Respondents' Perception on **Frequency of Urban Flooding/Water logging** in the Next 10 Years in the Two City Corporations in Dhaka.*

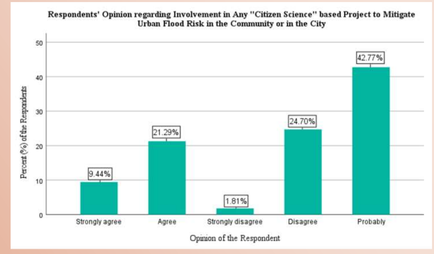

*Fig. 4: Respondents' Opinion on the Involvement of Any **Citizen Science** based Project to Mitigate the **Urban Flooding/Water logging** in the Two City Corporations in Dhaka.*

Acknowledgement

My sincere thanks and gratitude to the **Bangabandhu Overseas Scholarship** scheme of the University of Dhaka, Bangladesh for providing the fund regarding this PhD Research Project. At the same time, I am very grateful to **Newcastle University** and **British Hydrological Society (BHS)** for providing the funding support and all the kind cooperation to attend and participate in the **European Geosciences Union (EGU) General Assembly Meeting 2023**.

5 (b). Results: Rainfall Data Analysis

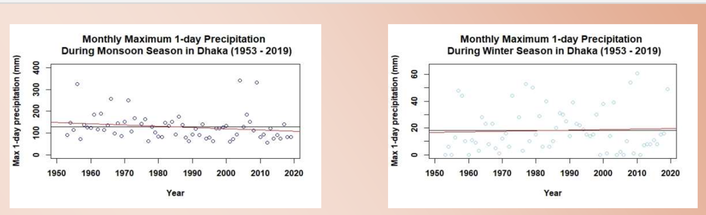

*Fig. 5: Seasonal Extreme Rainfall Indices (**RX1day**- Monthly Maximum 1-day precipitation) Trends in **Dhaka (1953-2019)** during the **Monsoon** and **Winter** Season. Here, Monsoon season indicates a **Decreasing Trend** **(-0.636 mm/year)**; but **statistically significant** as **P value** is **.0168 (<.05)**. Alternatively, the Winter season indicates an **Increasing Trend** **(0.021 mm/year)**.*

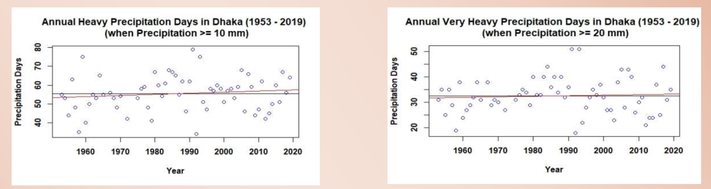

*Fig. 6: Annual Extreme Rainfall Indices **R10 (days)** and **R20 (days)** Trends in **Dhaka (1953-2019)**; both R10 (days) and R20 (Days) indicates an **increasing trend**. For the case of R10 (days), the trend is **(0.077days/year)** and for R20 (days), the trend is **(0.019 days/year)**.*

6. Ongoing Research

- Results from the **rainfall datasets** are now being integrated with the **fieldwork findings** and other **secondary datasets** to set up a **Hydrodynamic Model (CityCAT)** to investigate current and future flood risk in Dhaka in more detail (in particular investigating the Urban **Flood Intensity** and **Flood Exposure Analysis** in Dhaka with the application of **CityCAT** model).

Note: City Catchment Analysis Tool – **CityCAT** is a novel software system. It is a fully coupled 1D/2D **hydrodynamic model**, which includes a 2D overland flow routing model that enables rapid assessment of combined **pluvial** and **fluvial urban flood risk** and effects of different flood alleviation measures (Glenis et al., 2018). As a fully distributed model, CityCAT enables for a realistic simulation of the **urban environment** as **buildings** and **green areas** are explicitly represented capturing roof runoff and infiltration respectively (Bertsch et al., 2022).

The model is developed at Newcastle University by Vassilis Glenis (vassilis.glenis@newcastle.ac.uk).

7. Way Forward…

- It is expected that the outcome of this research will be beneficial for the **co-production of knowledge** to manage this urban hydrological hazard with a holistic risk and emergency management perspective among the **citizens** and **stakeholders** of Dhaka.

Literature Cited

Alam, M., and Rabbani, G. 2007. Vulnerabilities and Responses to Climate Change for Dhaka. *Environment and Urbanization*, 19(1): 81-97.

Glenis, V., Kutija, V. and Kilsby, C. G., 2018. A fully hydrodynamic urban flood modelling system representing buildings, green space and interventions. *Environmental Modelling & Software*, *109*, pp.272-292.

Bertsch, R., Glenis, V. and Kilsby, C., 2022. Building level flood exposure analysis using a hydrodynamic model. *Environmental Modelling & Software*, *156*, p.105490.

Map Reference: Banglapedia. 2015.*The National Encyclopedia of Bangladesh*, Asiatic Society of Bangladesh, Dhaka, Bangladesh.