ASSESSMENT OF INLAND FLOOD EVENT APPLYING MONITORING AND REGRESSION ANALAYSIS

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1. INTRODUCTION

Inland flooding is one of the most frequent disasters that cause contaminant and pathogen exposure, significant property damage, and traffic jam problem or other urban critical systems in many cities around the world. Inland flooding is occurred due to intense or prolonged rain that results from the exceedance of natural or engineered drainage capacity (Falconer et al., 2009). Most of the cities especially in the case of particularly low lying areas, near the coast and tidal river suffers inland flooding due to not only the inadequate drainage system to receive the large amount of storm water but also directly or indirectly affected by tidal or wave effects of receiving water bodies (Pervin et al., 2019).Conventional approach to identify the inland flood event is applying simulation models to check the impact of climate changes, and the drainage capacity (Russo et al., 2015). Actually, the data collection for simulation models such as land use data, elevation data and drainage network data are difficult to get in some of the cities in developing countries. Regression analysis is the effective tool to develop the flood prediction model and to evaluate flood risk assessment in urban catchments (Zhou et al., 2019). In this paper, I propose to identify the mechanism of inner flood base on inner flood monitoring data and regression analysis without applying simulation model.

2. MATERIALS AND METHODS

Yangon (16°48'19.01"N, 96°9'22"E) is former capital city of Myanmar and situated at the Yangon river bank. It has average annual rainfall of 2500mm during the monsoon period of mid-May to October. The study area is located city's central business district of Yangon and severe flood occur frequently in every monsoon season. The total area is about 2.62 km², the land is basically flat, nearly 100% urbanized and the elevation of marina border is less than 1.0 meter. The storm drainage consists of 73 km of conduit length, 609 nodes and 16 outfalls are shown in **Fig. 1**. The drainage system of Yangon is constructed more than 80 years ago and some parts are deteriorated. There is no pump and rely on gravity drainage system. Yangon river water level is directly related with astronomical tide conditions and the tidal gate are closed for certain hours during the high tides to prevent backwater effects.

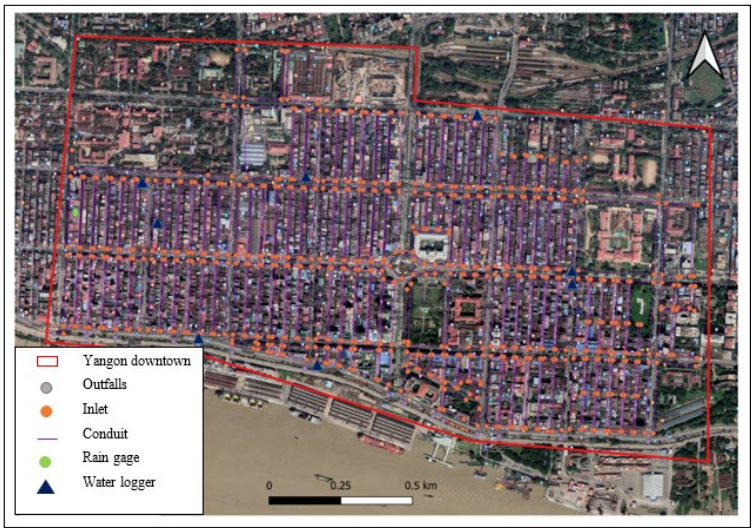

Fig. 1 Storm water drainage and water logger locations in Yangon

2.1 SENSING INLAND FLOODING

We deployed water level loggers (Onset, HOBO U20L-01), installed at 8 locations in storm drainage system of study area and at the bank of Yangon River (1 location). Conventional flood monitoring methods like resident gage and chalk gage cannot support the accurate inland flood frequency and duration. Monitoring systems with sensors are more practical than manual measurements because they provide continuous water fluctuation, flood duration, flood frequency and give more accurate results (Tashrio and Min, in review). Rainfall was measured at hourly intervals in the study area by a tripping bucket-type rain gauge with 0.5 mm resolution (Climatec, Inc., CTFK-1) connected to a pendant data logger (Onset, HOBO CO-UA-003-64). Water depth and rainfall data were collected from June to December and total monitoring periods is about 200 days during the monsoon season of 2019. During this gauging period, a total of nearly 1920 mm of rain was recorded. The heaviest rainfall recorded was 41.5mm / hour on October 10, 2019. I designate the flood occurrence means water overflow at the flood level rim of storm drainage channel in this case study.

Keywords: Inland flooding, lowland urban area, water depth logger, regression analysis, rainfall intensity, tidal river
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2.2 REGRESSION ANALYSIS

Regression analysis is a conceptually simple method to investigate functional relationships between dependent variable and explanatory variables. I apply regression analysis to determine which parameters are more influence factors for inland flood events.

3. RESUTLS AND DISCUSSIONS

In the study area, 18 inland flood events occurred in the rainy season at the logger locations. I evaluated the correlation between the inland floods and variable parameters based on monitoring results and rain gage data.

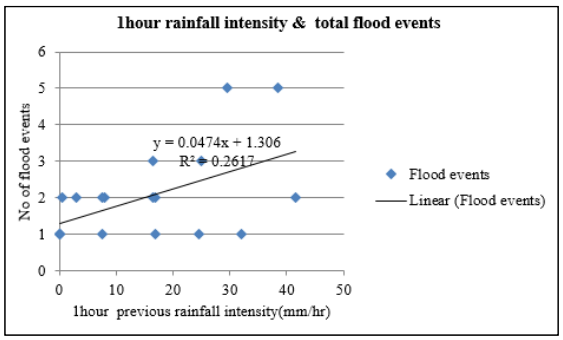

Fig. 2 Total Flood events vs 1hr previous rainfall intensity

Firstly, the variables which I aim to analyze are 1hour previous rainfall intensity, 3hour previous rainfall intensity, rainfall duration, total rainfall volume, rainfall interval, flood interval, and river level. After screening, the 21 relationships among these 7 variables, then I chose 1hour previous rainfall intensity and flood events that is the most significant relationship among other relationships. Then I divided the flood events into two groups, closed tide gate conditions and open tide gate conditions.

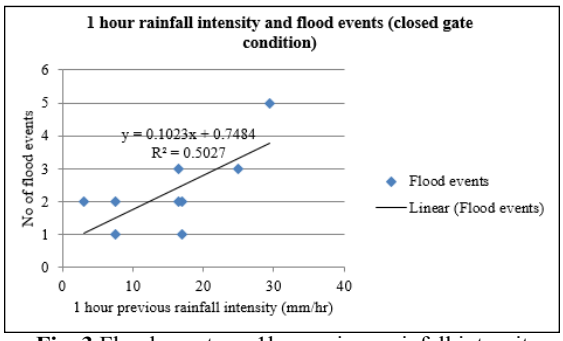

Fig. 3 Flood events vs 1hr previous rainfall intensity (closed gate condition)

According to the regression analysis results, 1hour previous rainfall intensity and total flood events have weak relationship and statistically significant (R^2= 0.267, $p<0.05$) is shown in **Fig. 2**. The relationship of 1hour previous rainfall intensity and flood events" open gate condition" have weak relationship and statistically insignificant (R^2= 0.24, $p>0.05$), but 1hour previous rainfall intensity and flood events" close gate condition" have medium relationship and statistically significant (R^2= 0.5, $p<0.05$) is shown in **Fig. 3**. So, inland flood events in Yangon are directly related not only 1hour previous rainfall intensity but also the condition of tide gate closure and river level. Actually, the intense rainfall and increase receiving water bodies are the main drivers for inland flooding, but the regression analysis results highlights only medium relationship between them. So, there is another prominent driver for inland flooding problem in study area. So, we also need to consider the garbage blockage and sediment deposition problem in this area that can reduce hydraulic capacity of storm drainage system and cause severe flood events.

4. CONCLUSION

In this study, we presented the effective monitoring system and regression analysis to demonstrate the relationship between influence parameters and inland flood events. The observation data of water loggers are invaluable to identify inland flood events and effective to assess for flood mechanism and characteristics. Regression analysis is also clearly to determine the relationship between inland flood and the rainfall intensity and water level situations. We need to consider these effects are the prominent drivers for inland flood events when prepare the inland flood mitigation measures.

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