Flood Hazards In Jamaica With Special Emphasis On The Yallahs River Watershed – Climate Change , Future Flood Risk And Community Awareness.

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WCRP VAMOS/CORDEX WORKSHOP ON LATIN AMERICA AND THE CARIBBEAN – CORDEX LAC : PHASE II, THE CARIBBEAN

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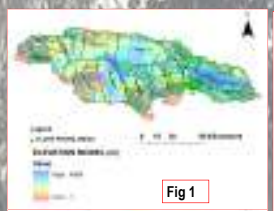
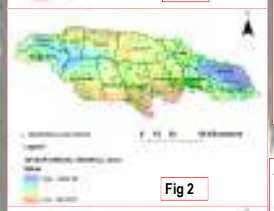
INTRODUCTION

Jamaica, the third largest island of the Caribbean is vulnerable to severe flooding from short duration, high intensity rainfall associated with hurricanes, tropical storms, fronts and troughs. Flood hazards in Jamaica have shown a significant increase in the decade 2000-2010 with major flooding in the years of 2004, 2007, 2008, 2009, 2010 and 2012. Flooding in the eastern and north-eastern sections of the island are primarily dominated by terrestrial flooding owing to the presence of steep topography (>30 degree slope), high intensity of rainfall and river system as well as less sub-surface infiltration due to presence of impermeable bedrocks (figures 1 and 2) . Among the watersheds in eastern Jamaica the Yallahs river watershed (figure 3) is one of the major affected one with significant damages from flooding leading to collapse of the major bridge in 2004 following hurricane Ivan . The Intergovernmental Panel on Climate Change (IPCC) outlook for climate change in Jamaica shows an increasing likelihood of more intense hurricanes, which would result in increased frequency of flooding due intensive rainfall. Hence this necessitates research on watersheds most affected with creation of new and improved flood innundation maps for present and future scenarios. **The present project thus aims to fulfil this for the Yallahs watershed which lacks a flood inundation map since 1988.**





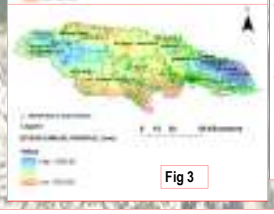


Figure 1. Map of Jamaica showing the flood prone areas superimposed on the topography of the island. Rivers are marked by blue lines.

Figure 2. Map of Jamaica showing the 30Yr mean annual rainfall and reported flood events.

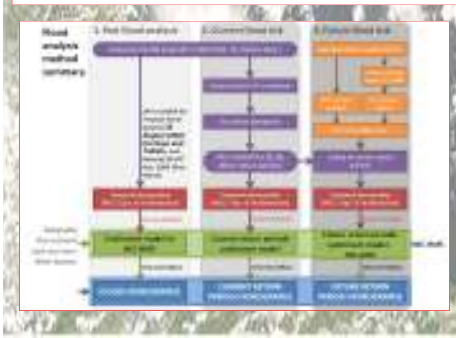
Figure 3 . Map of Jamaica showing the 30Yr mean annual rainfall , reported flood events and watersheds. (Data from WRA, ODPEM, CEAC)

AIM :

- **Analysis of floods and extreme events in Jamaica.**
- **Create present and future flood innundation map for the Yallahs river watershed. Future maps driven by climate models.**
- **Community awareness and knowledge assessment to flooding in the Yallahs watershed.**

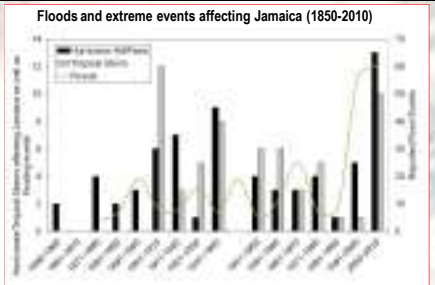
METHODOLOGY :

- **Historical analysis of floods and associated weather systems. Monthly and yearly pattern of floods and rainfall. Statistical relationship of floods with rainfall, storms, hurricanes, fronts and troughs.**
- **Statistical downscaling of 24 hour rainfall return period depths to hourly data using the NRCS Type II method. Similar process of downscaling is done for the 24 hour rainfall for tropical storm Gustav.**
- **Flows generated from rainfall data using USDA – Soil Conservation System Curve Number method for Loss estimation in HEC HMS for extreme event (tropical storm Gustav) and for different return periods .**
- **Flows from HEC-HMS routed through the LISFLOOD-FP model to predict inundation extents and depths.**
- **Climate model conditioned on rainfall. Models of catchment hydrology and flood hydraulics. Percentage difference between baseline climate (PRECIS) and future climates (ECHAM, 2040-2070 and 2070-2090) calculated for rainfall events down to 24-hour. HEC-HMS run for future return periods and flows routed through the LISFLOOD-FP model to predict inundation extents and depths.**
- **Community meetings conducted to create awareness for flooding and climate change. Dissemination of knowledge to communities affected.**

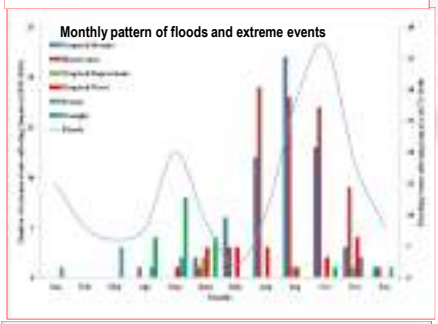


Results - analysis of floods and extreme events affecting Jamaica

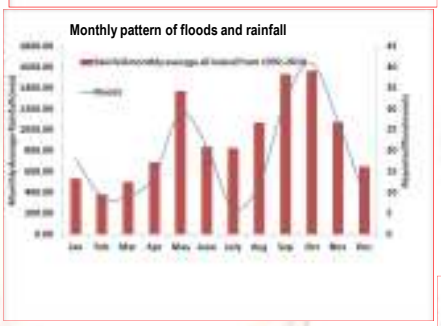
Floods and extreme events affecting Jamaica (1850-2010)

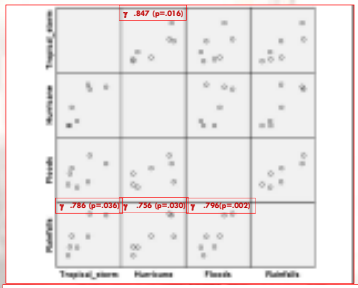


Monthly pattern of floods and extreme events



Monthly pattern of floods and rainfall





Correlation plots of floods, rainfall and extreme events

Spearman's rho (γ) indicate significant correlations Rainfall vs Tropical storm, Hurricane and Flood.

Multiple Linear Regression Backward propagation Statistical Analysis indicate Rainfall and tropical storm are predictors of Flood in the island (Ad. R-Square = 0.889, F = 24.944, p = 0.006)

The empirical equation:

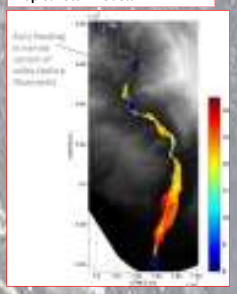
Flood events = 0.056*Rainfall - 1.352*Tropical Storm – 28.225

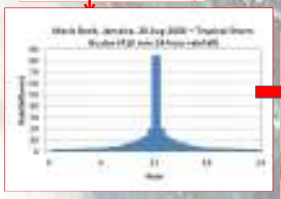
Communities surveyed in the middle and lower section of the watershed as shown in the map above. Results of the

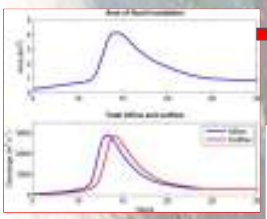
RESULTS : HYDROLOGIC MODEL AND FLOOD INNUNDATION MAPS > PRESENT AND FUTURE.

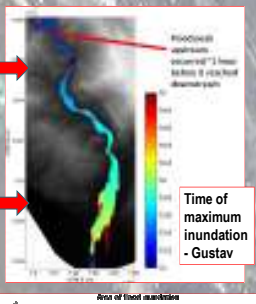
YALLAHS RIVER WATERSHED.

Time of initial inundation- Tropical Storm Gustav

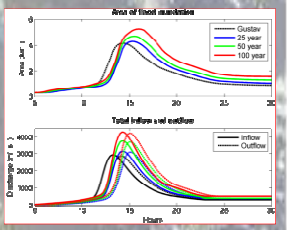






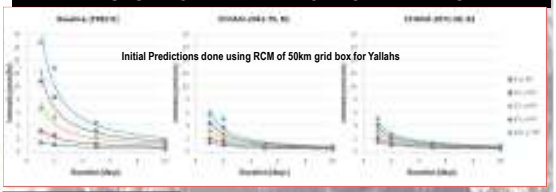


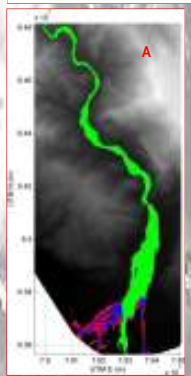
Time of maximum inundation - Gustav

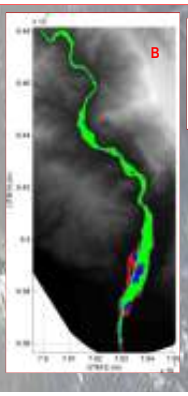


Present return periods (analysis of gauge data)

FUTURE CLIMATE IMPACT FOR YALLAHS







Maps of exceedance probability:
Green: 4% (25 year return period)
Blue: 2% (50 year return period)
Red: 1% (100 year return period)

Present annual exceedance probability. (A)
2070-2099 annual exceedance probability (ECHAM, B1) (B)

CONCLUSIONS :

- **Flood frequencies have increased in the last decade corresponding to increase in extreme events. Significant correlation between floods and rainfall .**
- **Community surveys show a high awareness to flooding and the river being the primary cause. There is also significant awareness about the increase in flooding from future extreme events.**
- **Flood inundation maps created for the Yallahs watershed for tropical storm Gustav show 12-14m of flood depth in the downstream end of the river with only 1 hour difference between the flood peak upstream and downstream.**
- **Future flood inndundation map created with ECHAM (2070-2099)climate data shows no reduction in inundation risk in the valley.**

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