CARIWIG Case Study Report
Scenarios of discharge for the Hope River Watershed in response to variable tropical cyclone characteristics

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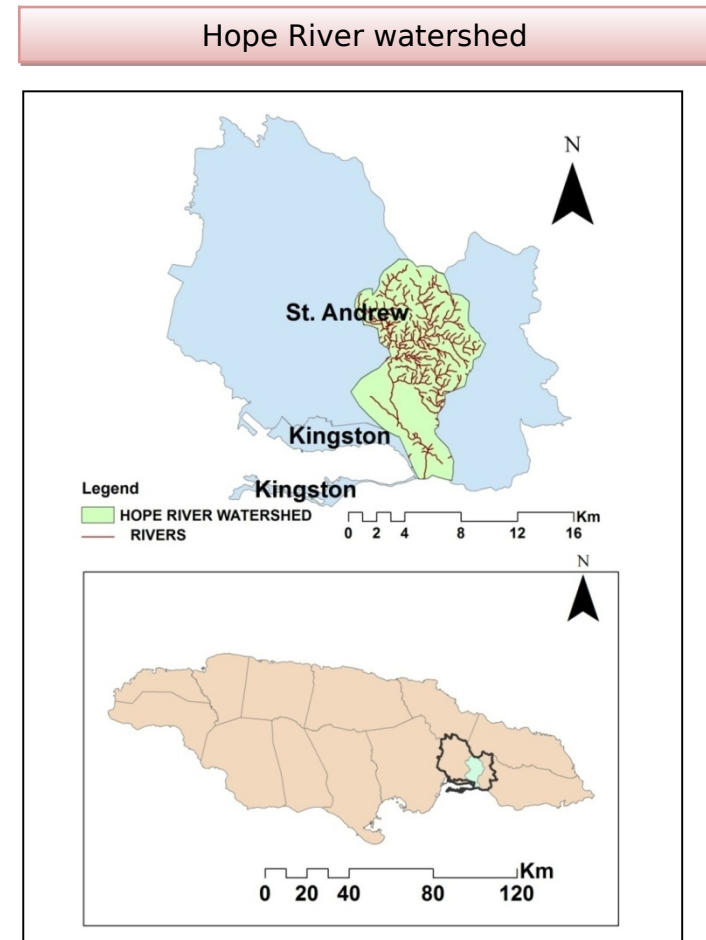[1]Department of Geography and Geology, UWI Mona.
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Aim and objectives

- Six scenarios of discharge from the Hope River Watershed in eastern Jamaica investigated.
    - Range of 3 tracks and 2 speeds
    - Hurricane Ivan at category 5.

- Rainfall rate obtained from the CARIWIG Simple Model for Advection of Storms and Hurricanes (SMASH)
    - Used as input to The HEC HMS model

- Hope watershed chosen due to its vulnerability to flooding from repeated severe events in the past. These were hurricane Ivan, tropical storm Gustav, hurricane Dean, tropical storm Nicole and Sandy.

Hope River watershed

Which tools were used? How & why?

- SMASH used to define the track, name of hurricane, category

Track 1 **Track 2**

Track 3

1	2	3	4	5	6
7 8	9	10	11	12	13	14
15	16	17	18	19	20	21	22
23

•Three tracks defined across Jamaica and the grid boxes for which rainfall series may be viewed or downloaded. Hope River is located in grid box 20.

Advection of Storms and Hurricanes

Which tools were used?

Hydrologic processes representation in HEC-HMS
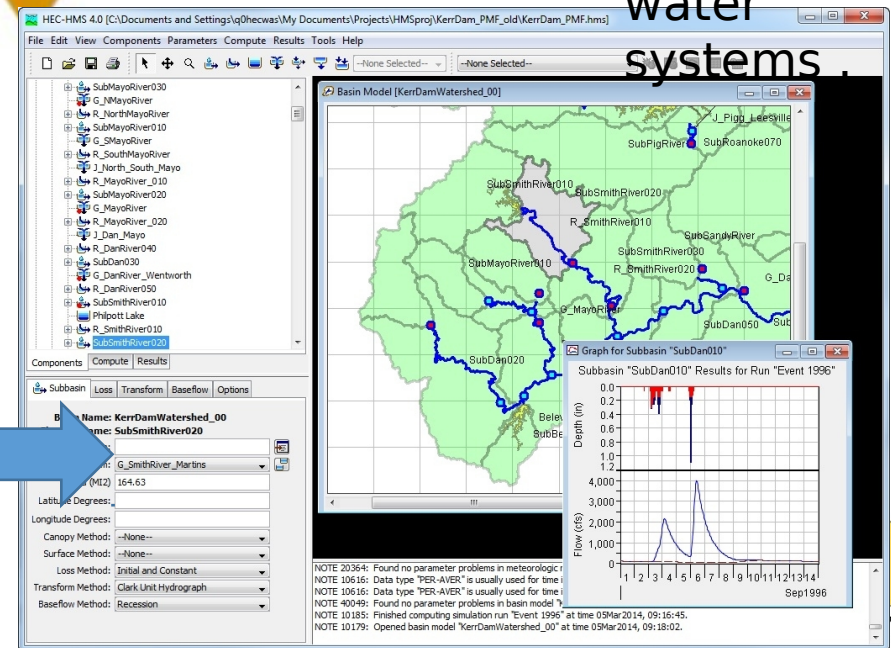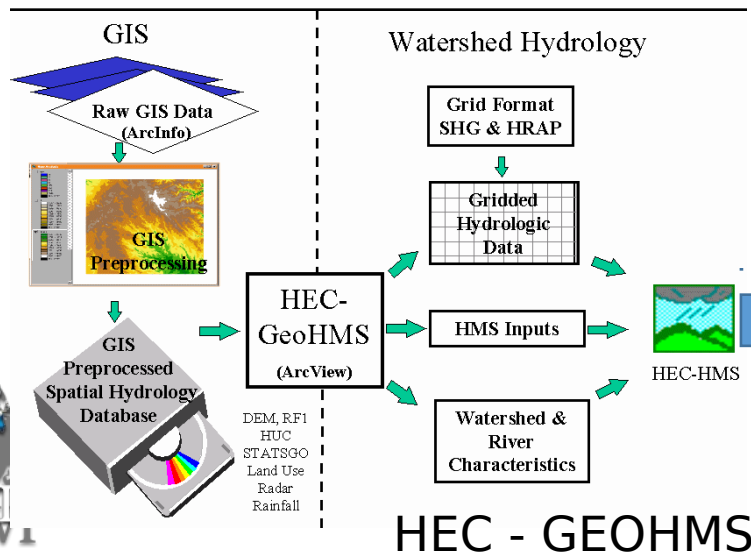

1 • METEROLOGICAL MODEL
• Climatological Data

2 • BASIN MODEL
• Connectivity and Element Data

3 • CONTROL SPECIFICATIONS
• Simulation Duration & Time Steps

HEC -HMS is designed to simulate precipitati on- runoff processes of dendritic water systems .

Overview

GIS | Watershed Hydrology

HEC - GEOHMS

Which tools were used? How & why?

Routing

Precipitation (mm/hr)

Runoff (mm/hr)

Soil properties

Runoff = f(precipitation, soil properties, moisture conditions)

Time

Runoff (mm/hr)

Runoff and Flow

Flow (m³/s)

Flow = f(Runoff, Watershed hydrologic properties)

CARIWIG

The findings

Rainfall Intensity for Track1 at 17km/hr

Rainfall Intensity for Track 1 at 25km/hr

Rainfall Intensity for Track 2 at 17km/hr

Rainfall Intensity for Track 2 at 25k

Note the dual peak in rainfall rates 10 and 12 mm/hr related to both tracks

The findings

Rainfall Intensity for Track 3 at 17km/hr   Rainfall Intensity for Track 3 at 25km/hr

- Track 3 shows a single peak.
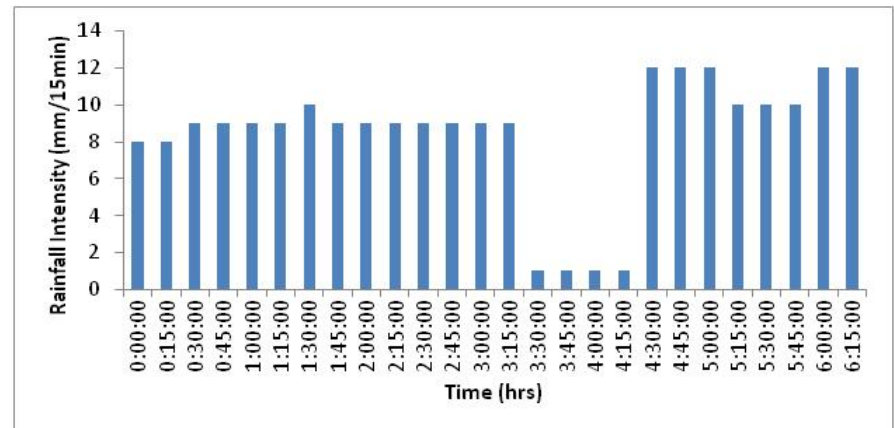- For all tracks there is no change in the amount of peak rainfall but the timing of the peak is earlier at higher speeds.   Therefore higher speeds, less time for peak rainfall.

The findings

Flooding at Kintyre corresponding to Sub-Basin K from tropical storm Gustav, 2008

Basin Model for the Hope river watershed

Bridge over Hope River at Harbour View, Tropical Storm Gustav, August, 2008.

The findings

In the present work the rainfall data as obtained from the SMASH tool for Tracks 1, 2 and 3 for speeds 17 and 25km/hr was used as input to the hydrological model and the discharge estimated at the above mentioned sub-basins and points of critical infrastructure.

Discharge at Outlet 62 and at sub-basin K from the hydrological model for Track 1, speed 17km/hr.

Peak in discharge of ~ 310 cumecs for Track 1 at speed 17 km/hr

The findings

Discharge at Outlet 62 and at sub-basin K from the hydrological model for Track 1, speed 25 km/hr.

The findings

Discharge at Outlet 62 and at sub-basin K from the hydrological model for Track 2, speed 25 km/hr.

Discharge at Outlet 62 and at sub-basin K from the hydrological model for Track 3, speed 25 km/hr.

The findings

Discharge at Outlet 62 and at sub-basin K from the hydrological model for Track 2, speed 25 km/hr.

Discharge at Outlet 62 and at sub-basin K from the hydrological model for Track 3, speed 25 km/hr.

The findings

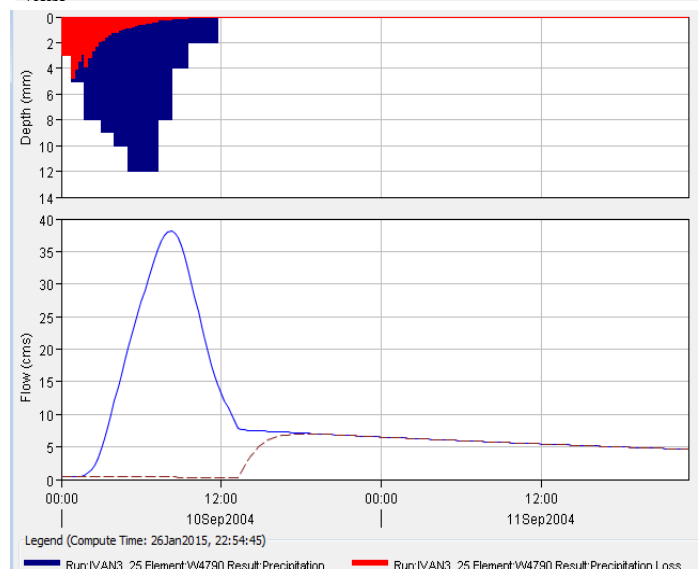|	Forward Speed (km/hr)	Peak discharge (cumecs)	Lag time to peak discharge (hours)
Track 1	17	310	14
	25	250	12
Track 2	17	280	12
	25	200	8
Track 3	17	335	14
	25	280	8

- At higher speeds, slightly lower peak discharge
- At higher speeds, shorter lag time

Findings from Hydrological Model

- Model runs from HEC HMS for Track 1 at speed of 17km/hr shows a peak discharge of ~ 310 cumecs corresponding to 12 hrs from onset of storm.

- Discharges calculated at sub-basin K was found to be 40 cumec at around 12 hours from storm onset .The same model when run with rainfall from Track 1 at speed of 25km/hr shows the similar peak discharges for both the junction corresponding to outlet 62 as well as sub-basin K, with difference being in the time to peak rainfall or a shorter basin lag time.

- In other words it takes less time to flood when you increase the speed of the hurricane .

- Similar trend is seen in results of model runs with tracks 2 and 3 with a shorter lag time at speeds of 25km/hr.

- However it is interesting to note that Track 3 , which has a track similar to Ivan shows the maximum discharge of 350 cumecs for junction near the fording at Kintyre as well as in

Implications for policy & planning

- APPLICATIONS IN WATER AND DISASTER RISK REDUCTION SECTOR

- USER FRIENDLY TOOL, ENABLES STAKEHOLDERS TO VARY SPEED AND TRACK AND ACCESS RAINFALL AND WIND SPEED.

- COMMUNITY AWARENESS TO FLOODING AND VULNERABILITY OF SETTLEMENTS ON THE FLOODPLAIN.

Feedback on the tools

- The SMASH tool is indeed an innovative approach to assessing the possible influence of different categories, tracks and speeds of a hurricane on rainfall intensity at a location and ultimately discharge from a watershed.

- It has a very useful application in conjunction with hydrological models to estimate the runoff from rainfall associated with each grid box. By changing the track we can pass storms over vulnerable watersheds and even orient them to pass over areas frequently affected by flood events.

What more could be done?

- More storm events could be included in SMASH so additional output is available for investigation of flooding. This could lead to the development of and a database of peak discharge and timing in relation to a number of storm scenarios.

- Given that variability in rainfall pattern is quite significant even within a single watershed due to variations in topography, it may be useful to include a module to downscale or extract finer detail rainfall data from the 50 km square grid data. This would aid in creating a long term database of peak flows from which the 1 in 25, 50 and 100 year flows could ultimately be determined. This would assist in better flood management.

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