

# **GIS and statistical analysis of local business responses of flooding events along the Mohawk River valley in Amsterdam, New York**

**Scott R. Lakeram, Daniella K. Chernoff, Tom R. Pascucci, and Antonios E. Marsellos**

Department of Geology, Environment and Sustainability, Hofstra University, Hempstead, NY 11549

## **Introduction**

Obstacles such as bridges and dams impede the flow of the river triggering floods upstream. During winter ice collects on these obstacles forming ice dams which constrain the flow of the river (Foster et al., 2011). Amsterdam, New York is located along the banks of the Mohawk River in Upstate New York, between Rome and Cohoes. The city is situated on both sides of the river and encompasses numerous businesses and residential areas, which are prone to flash floods during heavy rain events. In late August 2011 Hurricane Irene caused a flash flood giving rise to catastrophic damage to the local area, destroying a museum, numerous businesses and homes (Leyden 2011). The relative frequency of flooding and flood related damages of Amsterdam increase the demand for a mobile application to gauge the future events giving residence adequate time to prepare. In the past, LiDAR data taken from the Mohawk River has been used in conjunction with a geographical information system software (GIS) to reconstruct past flood events through 3D-simulation (Sisti et al., 2016). In order to circumvent future damage and possible loss of life, it is necessary to not only reproduce, but determine subsequent areas of high risk prone to flood events and alert residents. A statistical and GIS analysis of surveys was conducted for businesses located at various elevations and distances from the river including various obstacles (e.g. bridges, dams) at the Mohawk River in the greater Amsterdam area to assess the preparedness and interest of the local community for an online warning system.

## **Methodology**

A questionnaire of ten questions was created; each designed to evaluate different aspects pertaining to the preparation, response and recovery from a flood event in the targeted area. The questions itself were constructed with various responses to allow the most flexibility of answers while simultaneously providing a firm guideline on a scale of 1 to 5. In the majority of questions a response of 1 signified “Not Interested” or “Strongly Disagree” and a response of 5 signified “Very Interested” or “Strongly Agree”.

Amsterdam was chosen as an average representation of development on both sides of the Mohawk River. Using publicly available listed addresses from Whitepages and other online sources, a call list was created encompassing businesses within the greater Amsterdam city area along the Mohawk River. Businesses of various distances, ranging from 112 m to 634 m from the river were chosen. Using GIS software the distance from the center of the river was measured in meters to each business. The phone numbers were called using a university phone and every responder was presented with the same scenario describing the project, university affiliation, desire for flood data and security of anonymity. The locations of businesses and their responses were collated into a data sheet and further analyzed in a geographical information system software (ArcMap by ESRI). The questions of the survey are as listed below:

## **Survey Questions**

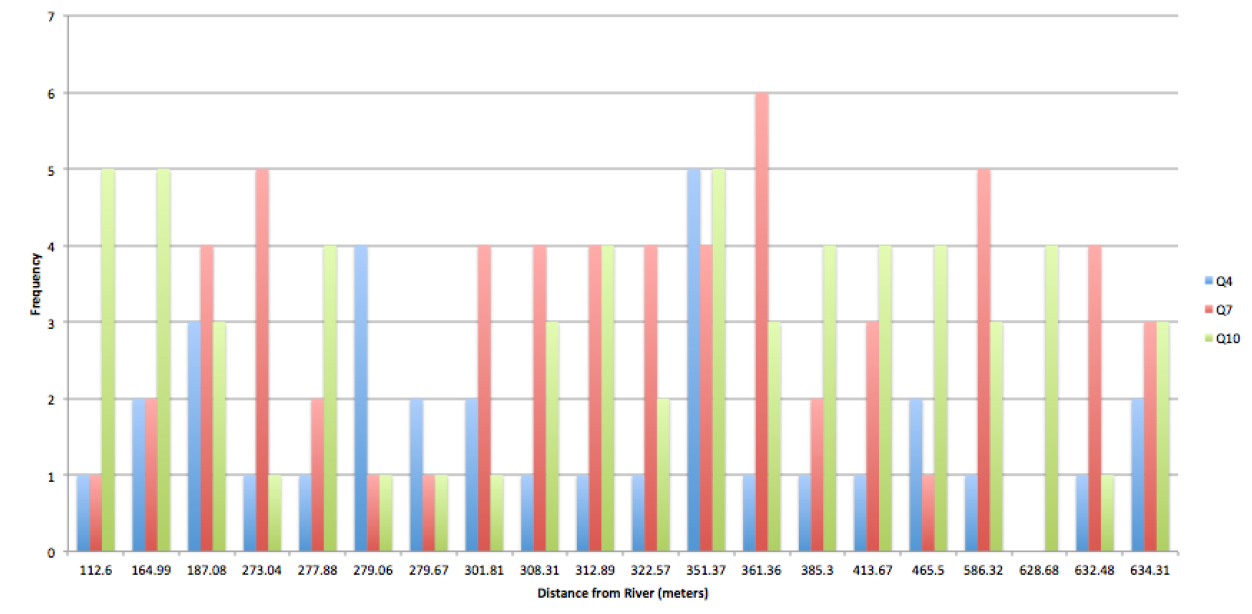
- 1) How many times has your property been affected by a flood event at the past?
- 2) Do you think that your area could be affected by a future flood event?
- 3) Did flood warning information reach you in advanced time?
- 4) How much money were spent at the past 5 years for flood prevention or/and mitigation in your property?
- 5) During a flood how dependent are you on major roads in your town?
- 6) There is a need for an application that would automatically notify emergency responders during a flood hazard?
- 7) I am interested in an app that provides a real time evacuation route during a flood.
- 8) There is a need for an easily accessible application that says how much and how far the flooding will affect the area?

- 9) Would you be interested in knowing the exact level of the groundwater on a daily basis around your area using this mobile app?  
 10) Do you think a mobile application will speed the recovery process after a flood?

**Results**

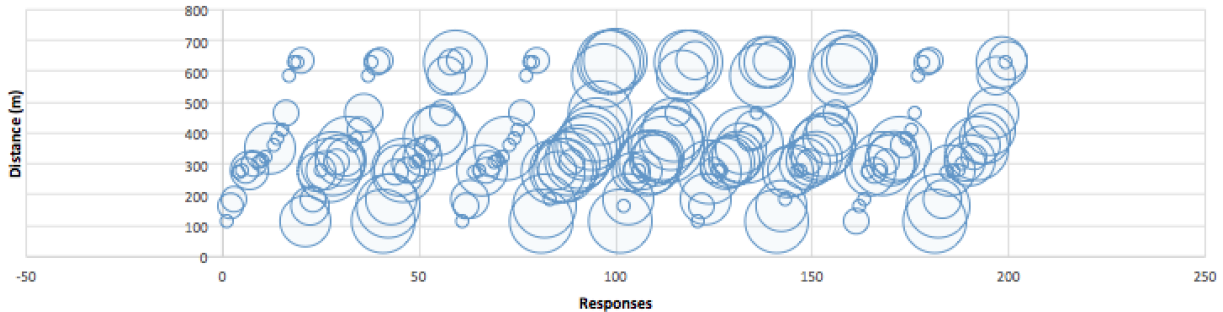


**Figure 1.** A GIS derived map displaying the elevation (using natural breaks classification method of ten classes ranging from 91.73 m to 352.8 m), obstacles in river such as bridges and dams, business responses to Q2 and position of business locality from the Mohawk River in Amsterdam, NY (background image was obtained from US National map Imaginary (NAIP; 1 ft. resolution). Areas located upstream from obstacles show high chance of being flooded (according to local survey responses) whereas downstream areas show low chance of being flooded. B1 shows an ideal location for a business situated between two obstacles (see text for discussion).



**Figure 2.** Response to questions of flood hazard impact accounting distance. Side-by-side bar graph

shows the fourth, seventh, and tenth question (Q4, Q7 and Q10, respectively) versus the distance of businesses from the Mohawk River. The fourth question examined responses of damages incurred from 1-no damage, to 5- more than \$10,000 in damage. The seventh and tenth questions were scaled 1-5 on responder's interest from 1, strongly disagree, to 5 strongly agree; the seventh question examined the need for a dynamic evacuation route during a flood hazard event, the tenth question explored the impact of an application on flood recovery. No bars indicate that the business choose not to respond.



**Figure 3.** Graph depicts the survey responses (x-axis) versus their horizontal distance (y-axis) from the river. X-axis shows intervals of 20-responses from the first question (Q1) to the last question (Q10) of the ten questions survey. Fifth and sixth questions' responses (at the interval 80-120) show how much independent are from the business location to the river distance.

## Discussion

Lower elevated business located upstream from an obstacle area show a greater chance of being flooded than locations downstream (Figure 1). Obstacles seem to affect flood occurrences as previously has been observed or simulated using GIS software (Foster et al., 2011). In our study we have observed that businesses located in areas upstream from the obstacles and at low elevations receive excess water due to this constraint. B1 location in Figure 1 displays a low elevation and a low expectation of a flood occurrence between it is located at the highest possible distance between the two adjacent obstacles along the river.

Out of the entire study group 40% of businesses have been affected by one or more flooding events and received little to no warning prior to these events. Businesses within 400 meters of the Mohawk River received a high frequency of flooding than businesses beyond 400 meters (Figure 2, Q5). During flooding events a majority of businesses rely on major roads for emergency services and the transportation of goods (Figure 3, Q5). Businesses farther from the river strongly agree with businesses closer to the river that there is a need for a mobile application to inform business prior to floods enabling them applicable time to prepare (Figure 3, Q 6). Q5 and Q6 are not affected by the distance, displaying that businesses strongly show a need for a warning system (Figure 3). Numerous businesses rely heavily on roads making a mobile app that plans evacuation routes for businesses and routes for emergency services a necessity.

## Conclusion

Obstacles such as bridges and dams along the Mohawk River constrain the flow of water by aiding in the creation of ice dams. Businesses upstream from these obstacles are flooded as a result. Businesses both far and close to the Mohawk River indicate that a real time flood application would warn local businesses prior to impending floods, provide safe alternate routes for both evacuation and rescue services and allowing business owners with an opportunity for preparedness.

## Cited References

Foster, J.A., Marsellos, A.E., Garver, J.I., 2011. Predicting trigger level for ice jam flooding of the lower Mohawk River using LiDAR and GIS. American Geophysical Union, Abstr. Program H21F-1185, presented at Fall Meeting, AGU, San Francisco, CA, 5-9 Dec.

Leyden, Liz, 01 Sept. 2011. Manor That Has Stood for Centuries Teeters in Storm's Wake." *The New York Times*. The New York Times

Sisti, A., Combs, E., Marsellos, A.E. 2016. Flooding of the Mohawk River at Lock 12 in Fort Hunter, NY, during Hurricane Irene (August 28-29<sup>th</sup>, 2011). Proceedings from the Mohawk Watershed Symposium 2016, p. 45-47, ISBN: 978-1-939968-07-4.

US National map Imaginary. [www.nationalmap.gov](http://www.nationalmap.gov)