Appendix B: Assess the Problem

B.1. Vulnerability Assessment

Contents

Introduction: Why is this important?

Physical risk[1] of flooding is only one factor in the overall vulnerability[2] of any site to flooding. As communities in Greece, Parma and Hilton, New York have learned from past flooding events, areas with high concentrations of built structures, economic activity and vulnerable residents have an increased vulnerability to flood devastation. In order to provide a more accurate representation of overall flooding vulnerability in this study area, a comprehensive vulnerability assessment that explicitly includes social, economic and structural factors of flooding susceptibility[3], in addition to physical flooding susceptibility, is set forth here. These measures

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[1] Flood risk is the product of the probability of a flood event occurring and what's exposed to that flood event.
[2] Vulnerability can be defined as the diminished capacity of an individual or group to anticipate, cope with, resist and recover from the impact of a natural or man-made hazard.
[3] Susceptibility refers to all elements of the human system, the built environment and the natural environment that are exposed to flooding in a given area that influence the probabilities of being harmed at times of hazardous floods (Balica, et al, 2009)."

of susceptibility have been combined into an overall composite score that indicates areas particularly vulnerable to flooding impacts. Results of the comprehensive vulnerability assessment can help inform policy recommendations and public investment to maximize concurrent benefits to floodplain conservation, flood abatement, water quality and ecosystem services in these communities.

Methods

A broad set of geographic data was gathered and analyzed to provide a spatially discrete overall flooding vulnerability score for all points within the study area of Greece, Parma and Hilton, New York. Multiple variables were used to determine a unique relative vulnerability score for each of these four components: 1) *physical susceptibility*, which measures the hydrological, topographic and soil conditions that make a location more physically prone to flooding or ponding of water; 2) *structural susceptibility*, which is based on the number of structures in areas physically susceptible to being flooded and the prevalence of key structural characteristics that increase the likelihood of flooding damage; 3) *economic susceptibility*, measured by the value of structures and their contents as well as the productivity of local workers and businesses; and 4) *social susceptibility of local residents*, which is measured by socioeconomic factors that indicate a higher susceptibility of residents being impacted by flooding, weighted by population density. Each variable was analyzed using distinct methods. All variables and component scores were projected as raster layers comprised of 30m grid cells covering the entire surface of the study area using ESRI ArcGIS software. As no explicit weighting scheme was applied, all four component scores were factored equally into the final composite flooding vulnerability score assigned to each 30m pixel in the study area.

Physical Susceptibility to Flooding

Three separate variables of soil and topographic conditions were used to measure the relative physical flooding susceptibility across the study area, including areas beyond the flood zones delineated in the Federal Emergency Management Agency's (FEMA) flood insurance rate maps (FIRM).

The first factor scored was the flooding frequency of soils as given by the Soil Survey Geographic (SSURGO) Database from the Natural Resource Conservation Service (NRCS) of the United States Department of Agriculture (USDA). The flooding potential of soils is an important indicator of physical susceptibility as the physical and chemical composition of soils near streams can make areas more susceptible to flooding impacts from overbank flows. SSURGO data provides the annual probability of flooding for the dominant soil of each unique map unit surveyed. These probabilities are grouped into the following frequency classes: Rare= 1%-5% annual chance of flooding; Occasional= 5%-50% annual chance of flooding; and Frequent= 50%-100% annual chance of flooding. A unique score was assigned to each flooding frequency class as a relative measure of flooding vulnerability based on likelihood of soils being flooded, where Rare(1%-5%) = 1; Occasional(5%-50%)=2; and Frequent(50%-100%)=3.

The ponding frequency of soils, also provided in NRCS SSURGO data, was the second variable used in the physical susceptibility component score. This provides an estimate of the annual likelihood that ponding will occur on the soil surface due to ground water or surface water accumulation. SSURGO breaks down ponding frequency into three classes: Rare=1%-5% annual chance of ponding; Occasional=5%-50% annual chance of ponding; and Frequent=50%-100% annual chance of ponding. A unique score was assigned to each ponding frequency class as a relative measure of the vulnerability to flooding from surface water accumulation, where Rare(1-5%)= 1; Occasional(5%-10%)= 2; Frequent(50%-100%)= 3.

The third and final variable integrated into the physical susceptibility component score was the wetness index, as calculated and provided by the Natural Heritage Program in GIS raster layer format (at a 10m resolution). The wetness index is based on topography and emphasizes areas close to streams that both receive runoff waters from large upslope areas and have low slopes and therefore have an increased susceptibility to flooding.[4] With the wetness index provided by the NHP, the following steps were performed to provide a relative wetness index score. First, the mean wetness index for the study area was calculated as 7.5. Pixels where the wetness index exceeded the mean value were extracted into a separate file. Second, the kernel density function of ArcGIS was performed on this file (using a 100m search radius) to produce a “heat map” of areas with a high concentration, or density, of lands with relatively high wetness indices. Next, this wetness index “heat map” was clipped to the Active River Area (ARA) derived by The Nature Conservancy (TNC).[5] Third, all pixels meeting these criteria were reclassified by the calculated wetness index density into three quantile classes, and scored on a 1-3 scale.

These three scored variables were then summed to produce a normalized score of physical susceptibility to flooding across the study area. To do so, each was converted to a raster layer of 30m resolution, overlaid and spatially aligned in the same extent and projected coordinate system (NAD 1983, Universal Trans Mercator Zone 18N). The three layers were then summed and normalized on a 0-100 scale using the Raster Calculator of ArcGIS.

Structural Susceptibility to Flooding

Four separate variables comprise a score of relative flooding susceptibility of the structural environment in the study area. These factors represent areas that are densely developed or

[4] The wetness index is calculated as, $W = ln\ \frac{A_s}{\tan\beta}$, where A_s is the upslope contributing area and β is the slope (Tomer et al., 2003).

[5] The TNC ARA delineates land where interactions with streams, in their natural state, are possible, or areas involved in the stream’s basic ecological and physical processes, including flooding. Therefore, areas without a real potential for stream flooding were excluded by clipping the derived wetness index density layer to the base zones of the ARA (this excludes “material contribution zones”, or lands included in the ARA, not due to flooding susceptibility , but by their potential for debris and vegetation to accumulate in the stream).

have buildings with key structural characteristics that heighten flooding susceptibility. The scoring of structural susceptibility was limited to areas where the physical susceptibility score explained above is greater than zero. Thus, this calculated component score underscores physically susceptible areas (including land beyond official FEMA floodplains) where flood damages to structures are more concentrated, probable and would be relatively more destructive.

The first variable of structural susceptibility scored was a density measure of primary structures in areas prone to flooding which are more likely to be damaged by flooding, weighted by the relative susceptibility of the flood prone area they intersect. Here, the locations of all primary structures that lie within FEMA floodplains, or parcels identified by local stakeholders as being flood prone based on past experience, were digitized manually in ArcGIS using aerial imagery. The following weights were assigned to structures intersecting each type of flood prone area: within the NHP's delineated Riparian buffer[6] =0.5; within the 500-year floodplain with a 0.02% annual chance of flooding =1; within the 100-year floodplain with a 1% annual chance of flooding =2; within flood prone parcels identified by municipal representatives =3. This weighting scheme was applied to a density calculation of these structures, using the kernel density function of ArcGIS and a 100m search radius.

The second scored factor, similar to the first, was a density measure of separated secondary structures in floodplains. Although not as impactful as primary structure flooding, impacts to secondary structures still lead to time or other resource investment by property owners, and debris from impacts can cause downstream damage. Here, a weighted score of 0.5 was applied to all structures determined to intersect the FEMA 100-year floodplain from a manual overlay of aerial imagery and FEMA digital Flood Insurance Rate Maps (FIRMs). Then, this weighting scheme was applied to a density calculation of these structures, using the kernel density function of ArcGIS and a 100m search radius.

The relative density of structures that were built prior to regulatory current flood damage prevention standards also was weighted and factored into the structural susceptibility score since these structures might be more prone to flooding impacts. This was done using the year built attribute given by local tax parcel data to select parcels with structures built before the year of the first FIRM maps delineated for each municipality (Greece=1980; Hilton=1981; Parma=1978), or before updated building standards for New York State requiring the lowest

[6] The riparian buffers were generated by the Natural Heritage Program applying the model used in Abood & Maclean (2011). Essentially, the 50-year flood height from observed USGS stream gauge data was delineated on a 10m Digital Elevation Model. It then incorporates NWI wetlands and certain soils that are contiguous to the riparian buffer. Given the sizeable extent of the riparian buffer, not all structures within the buffer were manually digitized. Instead, developed parcels with over 33% of their area falling within the riparian buffer were assumed to hold a structure intersecting the riparian buffer. This percentage was used as it was calculated to be the average percentage lot area within the floodplain for parcels where structures were found to intersect floodplains from a manual inspection of aerial imagery. Points representing the sites of riparian structures used in this calculation were located in the centroid of the portion of the parcel falling within the riparian buffer.

elevated floor of a floodplain structure to be built at an elevation two feet above the base flood elevation, which took effect in 2007. The following weighting scheme was applied to points at parcel centroids representing the location of these structures: built 2007 or later (Low susceptibility) = 0; built after municipality's FIRM map, but before 2007 (Moderate Susceptibility) = 1; built before FEMA's FIRMs delineated municipality's flood zones (High Susceptibility = 2). This weighting scheme was then applied to a density calculation of these structures, using the kernel density function of ArcGIS and a 100m search radius.

Lastly, as structures with basements are more susceptible to groundwater intrusion or inundation by surface flows, the density of all structures with basements in physically vulnerable areas was integrated into the structural environment vulnerability. All structures with any type of basement located in areas with a calculated physical vulnerability score were weighted equally and applied to the kernel density function of ArcGIS using a 100m search radius.

Before summing all four of these variables to produce a relative flooding vulnerability score of structures for the study area, all weighted layers were first clipped to the extent of land where the physical susceptibility score calculated in this assessment is greater than zero. Then, each layer was converted to a raster layers of 30m resolution, overlaid and spatially aligned in the same extent and projected coordinate system (NAD 1983, Universal Trans Mercator Zone 18N). The four layers were then summed and normalized on a 0-100 scale using the Raster Calculator of ArcGIS.

Economic Susceptibility to Flooding

Locations with high concentrations of valuable buildings, material contents, businesses, labor force and economic output signify areas where flooding would result in broadly-felt negative economic impacts that would extend beyond areas directly damaged by flooding. Four variables comprise the relative score of economic susceptibility to flooding measured here: structure value; value of contents (inventory, equipment, and personal belongings); productivity of local businesses; and labor intensity.

Areas with high property values per acre indicate where development is particularly valuable and/or dense and thus more susceptible to costly flooding damage. Using the kernel density function of ArcGIS the assessed dollar value of each structure was spread over a 100m search radius and summed with values from overlapping parcel surfaces. Values were calculated in dollars per acre.

Valuable items within structures damaged by flooding would be susceptible and may be in need of repair or replacement. A ratio of content value to structure value was developed for each property type by referencing multiple public documents and resources provided by the U.S. Army Corps of Engineers and the Minnesota Department of Public Safety that are intended to provide general estimates of content-structure value ratios (CSVRs) by property type. The CSVR was set by NAICS code for commercial parcels (given by Reference USA business database, 2015), and by property class for residential parcels (given by Monroe County Tax Parcel Data, 2014). Assigned CSVRs were multiplied by structure value to estimate the value of contents in each structure.

Likewise, if crops on agricultural lands are flooded, a farm would have to withstand economic losses if crops cannot be harvested. Therefore, dollar value of cropland, measured by annual sales per acre according to crop type, was also included in the content value variable. To do so, USDA's 2014 Cropland Data Layer (CDL), which gives the spatial extent of certain crop types, was cross-referenced with USDA's 2012 Census of Agriculture which can be used to find a county average cropland value per acre, as the Census provides the number of acres harvested and the dollar value of sales for crops grown in Monroe County. The calculated cropland values were assigned by crop type to all agricultural land cover in the CDL to produce a raster layer (30m) of cropland value per acre. These values were added to the value of contents in buildings using ArcGIS' Raster Calculator to give a comprehensive content value raster layer across the study area in dollars per acre.

Businesses damaged by flooding will endure lost productivity if forced to temporarily shut down to repair or replace items essential to their operations. To factor for this variable in the economic vulnerability score, output per business per day was estimated for businesses in the study area using industry and business employment data from Reference USA database and cross matching this with output per employee per day estimated for all industries using 2013 data from IMPLAN, an economic input-output modeling software. Daily output values were assigned by each business, and plotted as points on the map to produce a business productivity layer measuring daily dollar output per acre using the kernel density function of ArcGIS with a 100m search radius.

Employees of local businesses in the study area could reduce their employer's productivity if their homes are impacted by flooding. To factor for this possibility in the economic vulnerability score, a point was created at the approximate home location for each employee in the study area.[7] Each employee point was weighted by the average daily wage in Monroe County for that employee's industry category, found from the U.S. Census Bureau's Quarterly Workforce Indicators annual average wage (2014) reported by 2-digit NAICS code. Applying these weights, the point file was entered into the kernel density function of ArcGIS to produce a labor intensity surface in daily dollar output per acre.

As two of these variables are expressed in units of dollars per acre (structure value and the value of contents), whereas the other two are measured in daily dollar output per acre, each set of two comparable variables was summed and normalized independently before being combined with the other set of variables measured in different units. Therefore, the structure value and contents value variables were summed and normalized on a 0-100 scale to give a comprehensive score of relative property value density across the study area. Similarly, the business productivity and labor intensity variables were summed and normalized separately to give a comprehensive relative score of daily economic output. Then, these two normalized scores (economic output, property value) were summed together and normalized on a 0-100 scale using ArcGIS Raster Calculator.

Social Susceptibility to Flooding

Social susceptibility can be viewed as "the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist, or recover from the impact of a hazard" (Wisner et al., 2004). Research approaches to social vulnerability analyses, pioneered by Cutter et al. (2000), typically investigate an established set of social and demographic factors that signal a higher susceptibility that residents will be adversely impacted if a natural hazard, such as flooding, were to occur. Typically, these studies employ a principal component analysis (PCA) to produce relative social vulnerability scores across a given geographic area by transforming individual variables into *principal components* that account for redundancy in related socioeconomic variables, typically using U.S. Census data at the tract or county level, to explain correlations between individual variables and the ultimate social vulnerability score.

[7] This was done by clipping Census LODES data (2013) which gives the number of employed workers residing in each census block to parcels classified as any type of residence, as given by property class codes of Monroe County Tax Parcel data.

The social vulnerability analysis methodology established by Cutter et al. (2000) and further developed by others was modified here to be easily conveyed to public stakeholders and to better fit within the broader comprehensive flooding vulnerability assessment methodology. First, the most recent census estimates on 33 individual socioeconomic variables prevalent in previous social vulnerability analyses were gathered at the block group level for the entire study area. Then, these discrete variables were classified into four categories of social vulnerability characteristics, based on the principal components commonly found from published social vulnerability analyses. These four categories are: Income, Education and Employment; Household Type and Race; Housing Characteristics; and Special Needs Population. The variables included in each category of social vulnerability factors are explained below.

Income, Education and Employment
Lower incomes, educational attainment levels, and higher rates of unemployment can increase the vulnerability of a population to hazards. A PCA was conducted using ACS 5-year estimates (2009-2013) block group data on the following 8 related variables:

- Per Capita Income ($/year)
- Poverty Rate
- % of population living “near” poverty (1.0-2.0x the poverty rate)
- Unemployment Rate
- Labor Force Participation Rate (population 16 years and over)
- % of households with annual incomes less than $100,000
- % of people over 25 without a high school diploma or equivalent
- % of people over 25 with a high school diploma, but no college experience

Household Type and Race
A household’s vulnerability to hazards increases under certain conditions, like if they are renters, single parents, or persons of color. A PCA was conducted using ACS 5-year estimates (2009-2013) block group data on the following 10 related variables:

- % of people that are persons of color
- % of people that are Native Americans
- % of people that are Asian or Pacific Islander
- % of people that are Black or African American Native Americans
- % of people that identify as two or more races
- % of people that identify as some “other” race
- % of people that are of Hispanic ethnicity
- % of households headed by a female
- % of households that are headed by single parents with children
- % of households that are non-family households

Housing Characteristics
A person’s vulnerability to natural hazards like flooding increases under certain housing conditions, like older homes, lower value housing, and mobile homes. A PCA was conducted using ACS 5-year estimates (2009-2013) block group data on the following 8 related variables:

- % of housing units that are occupied by renters
- % of housing units that are in a structure with 10 or more housing units
- % of housing units that are in mobile homes
- % of housing units with more than one person per room
- % of population residing in group quarters (nursing homes, orphanages, etc…)
- % of housing units built before 1950
- Median value of homes
- Median age of owner-occupied housing units

Special Needs Population
Vulnerability to hazards increases if a person is still a child, a senior citizen, has a disability, does not own an automobile, or has other special needs. A PCA was conducted using ACS 5-year estimates (2009-2013) block group data on the following 7 related variables.

- % of population over 5 speaking English less than “well”
- % of population age 1864 that have one or more disabilities
- % of population age 65 and over that have one or more disabilities
- % of households that do not have a personal vehicle available for use
- % of households that receive public assistance income
- % of population age 65 and over
- % of population age 70 and over

A separate PCA was conducted on each of these categories of variables. The series of PCAs transforms each category of variables into a smaller set of uncorrelated principle components. The percentage of variance explained by each of the principle components was multiplied by each principle component score for all block groups across the study area. These weighted principle component scores were then standardized into Z-scores which were then normalized on a 0-100 scale. The weighted z-scores were then multiplied by a derived raster layer of population density[8] to provide a scoring layer for each social vulnerability variable. Each of these four social vulnerability scores weighted by population density were then summed and normalized on a 0-100 scale using the Raster Calculator function of ArcGIS to produce a relative social susceptibility score layer covering the entire study area.

Composite Flooding Vulnerability

The final step was to combine all four component susceptibility scores to produce a comprehensive relative score of flooding vulnerability across the study area. With all four component scores already normalized, the four layers were then summed (with an equal weighting) and normalized on a 0-100 scale using the Raster Calculator of ArcGIS.

[8] The population density raster was found from census population data at the census block level (2010). Census blocks with population data were clipped to parcels classified as any type of residential structure. A point was generated for each resident within these areas, according to the census block population numbers. Then this point file was entered into the kernel density function of ArcGIS to build a population density raster, measured in people per acre.

As an alternative, the process was repeated but limited to areas within the FEMA flood insurance rate maps. This was done to provide municipal representatives with a more targeted measure of comprehensive flooding vulnerability, focusing on areas within the regulatory FEMA floodplains where interventions and investments for flood mitigation by local government are more practical. First, each component vulnerability score was clipped to the extent of FEMA floodplains (including both the 100-year and 500-year floodplain) and normalized again on a 0-100 scale based on the range of scores for points within the floodplains. Then, these four layers were summed (with an equal weighting) and normalized on a 0-100 scale using the Raster Calculator of ArcGIS to give a comprehensive relative flooding vulnerability score for all areas within the floodplain across the study area.

Vulnerability Assessment

Physical Susceptibililty to Flooding

Assessing the physical susceptibility of these three communities essentially requires determining the locations where hydrological, topographic and soil conditions make a location more physically prone to flooding. As discussed in the Methodology section, three separate factors were analyzed to assess the physical susceptibility of these three communities: flooding frequency of soils (areas subject to flooding based on their position in the landscape are more susceptible to flooding impacts from overbank flows); ponding frequency of soils (areas subject to ponding on the soil surface may be more susceptible to flooding impacts due to ground water or surface water accumulation); and runoff (places close to streams that both receive runoff waters from large upslope areas and have low slopes are more susceptible to flooding). Figure 1 is a composite of these three factors, illustrating those areas that are most physically susceptible to flooding. Not surprisingly, areas closest to the Lake Ontario shoreline rank high with respect to physical exposure to flooding risk as are locations in close proximity to Salmon Creek in the Village of Hilton and the Town of Parma. Areas north of New York State Route 104 (NY 104)/Ridge Road in the Towns of Parma and Greece are also physically exposed to flooding risk.

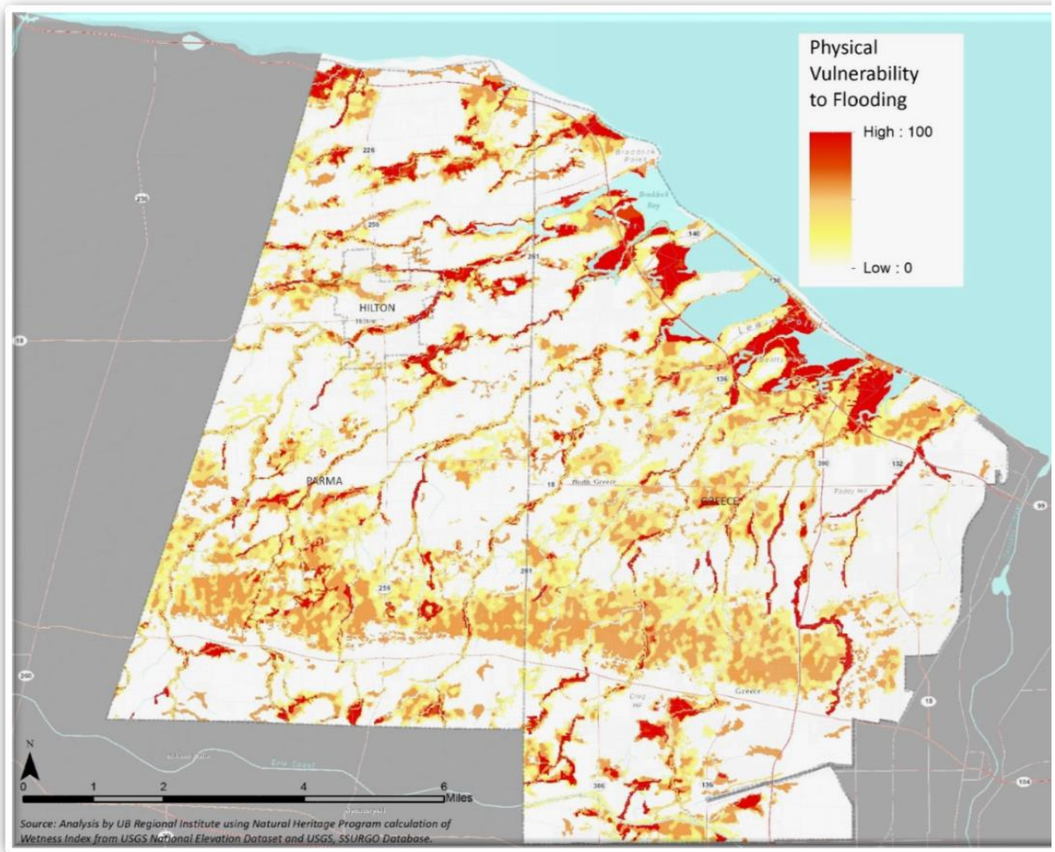

Figure 1. Physical areas susceptible to flooding in Greece, Parma and Hilton

Structural Susceptibility to Flooding

In addition to understanding physical susceptibility, community leaders must also understand how vulnerable the built environment in each community is to flooding risk, as key structural characteristics and dense development in locations prone to flooding increase the susceptibility of built structures to flooding impacts. As noted in the Methodology section, four factors were considered to assess the susceptibility of the built environment: Primary structures in areas prone to flooding (structures that lie in areas identified by municipal representatives as flood prone, or are within FEMA's 100-yr or 500-yr floodplains are more likely to endure flooding); secondary structures in the 100-year floodplain (impacts to secondary structures may cause costly property damage which would make property owners invest time or other resources to repair or replace); whether the structure was built to standards that precede flood damage prevention (structures that were built to lower standards than current flood damage prevention building regulations might be more prone to flooding impacts); and structures with a basement (structures with basements are more susceptible to groundwater intrusion or inundation by surface flows).

Figure 2 illustrates that Greece and Hilton are the communities with built environments that are highly susceptible to flooding risk. This is due to three reasons: 1) these two communities have the highest concentration of primary structures in the floodplain; 2) an older housing stock exists in these two communities, with structures built prior to flood damage prevention standards; and 3) these communities have a large number of residences with basements. Interestingly, secondary structures, such as detached garages, are not as vulnerable to flooding in any of the communities, as illustrated in Figure 3.

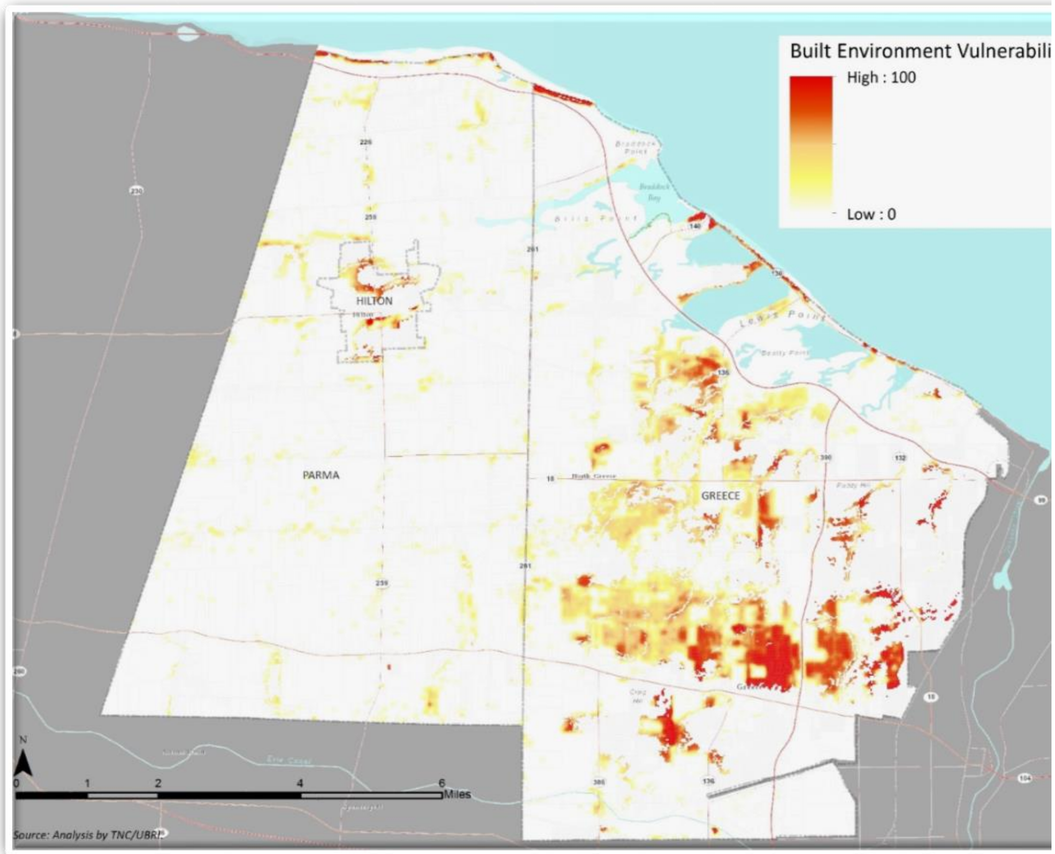

Figure 2. Structural susceptibility to flooding in Greece, Parma and Hilton

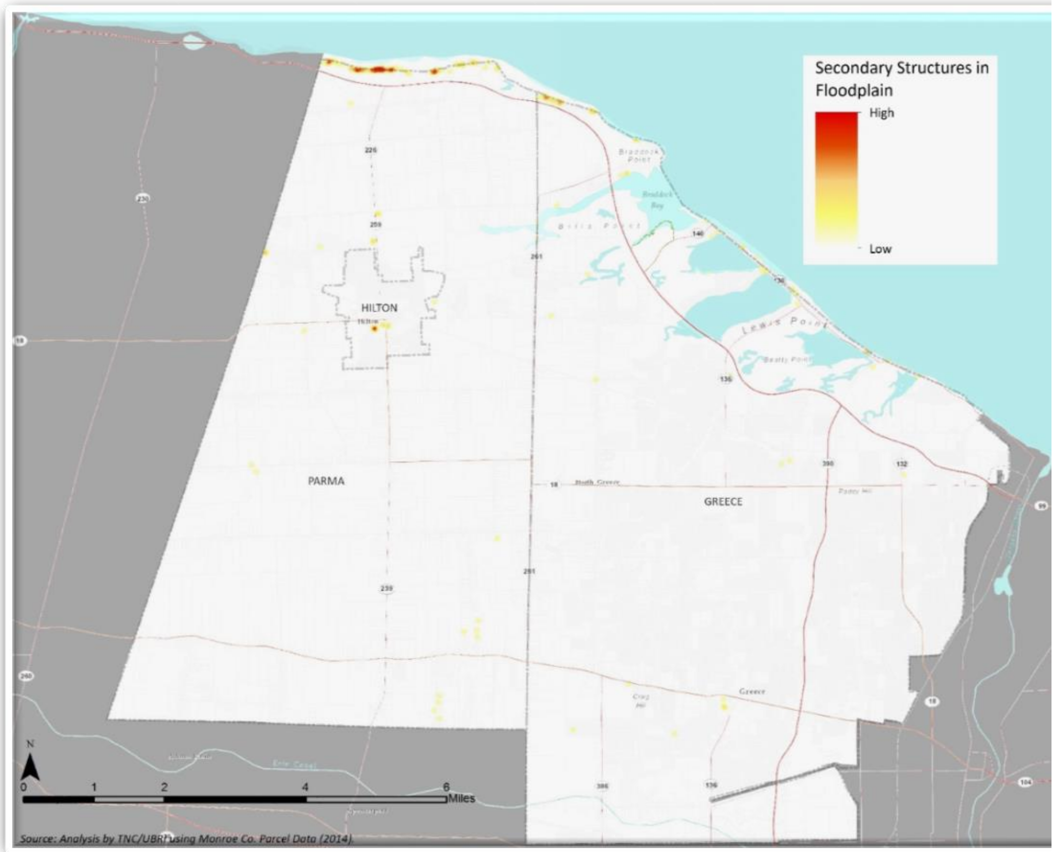

Figure 3. Secondary structure susceptibility to flooding in Greece, Parma and Hilton

Economic Susceptibility to Flooding

As noted in the Methodology section, to assess the economic susceptibility of these three communities, four variables were examined to create a relative score of economic susceptibility to flooding: structure value; value of contents (inventory, equipment, and personal belongings); productivity of local businesses; and labor intensity.

Figure 4 illustrates that Greece and Hilton are the two areas with high values of both structures and contents. It should be noted, however, that while these communities did not have a high concentration of structures with high value there was a high concentration of structures with high values of inventory, equipment and personal belongings.

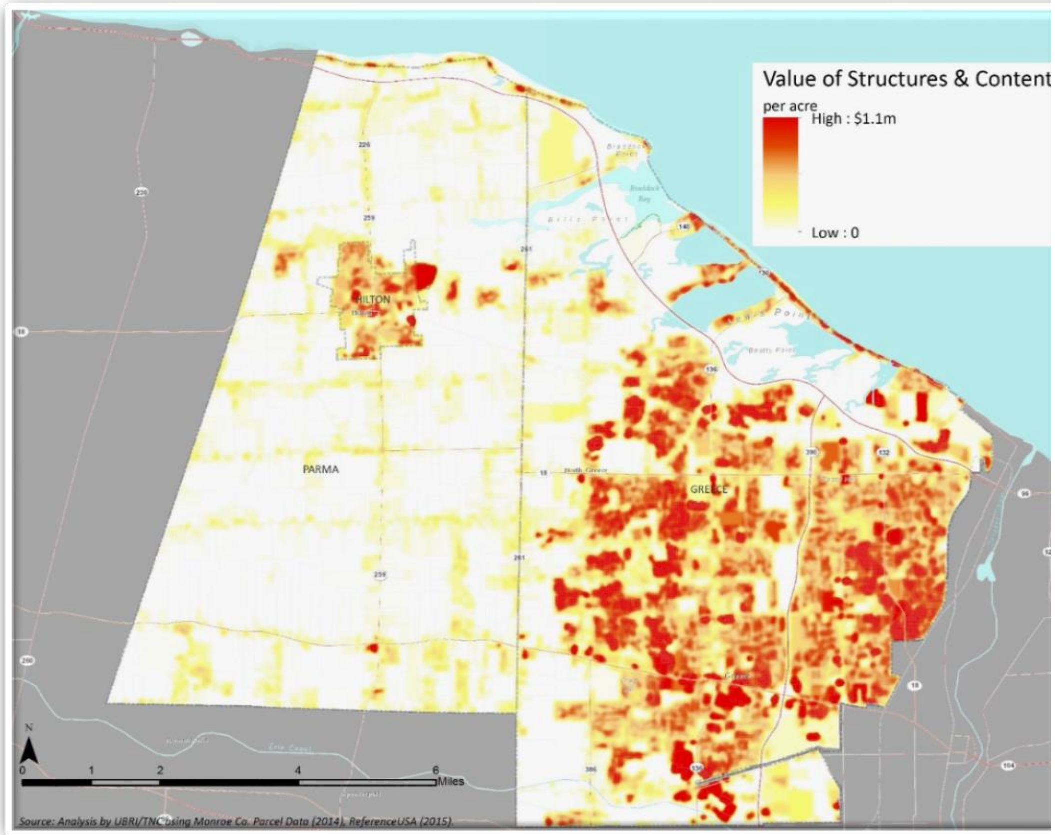

Figure 4. Economic susceptibility to flooding of Greece, Parma and Hilton (value of structures and contents)

The economic susceptibility of these communities reflected in Figure 5 is an aggregated score that includes not only the value of community structure and contents, as illustrated above, but also the economic productivity of these areas (e.g., productivity of local businesses and labor productivity). The central business district in the Village of Hilton, areas along NY 104/Ridge Road in the Town of Greece, and the intersection of New York State Route 259 (NY 259) and NY 104 in the Town of Parma are the most economically susceptible to flooding risk.

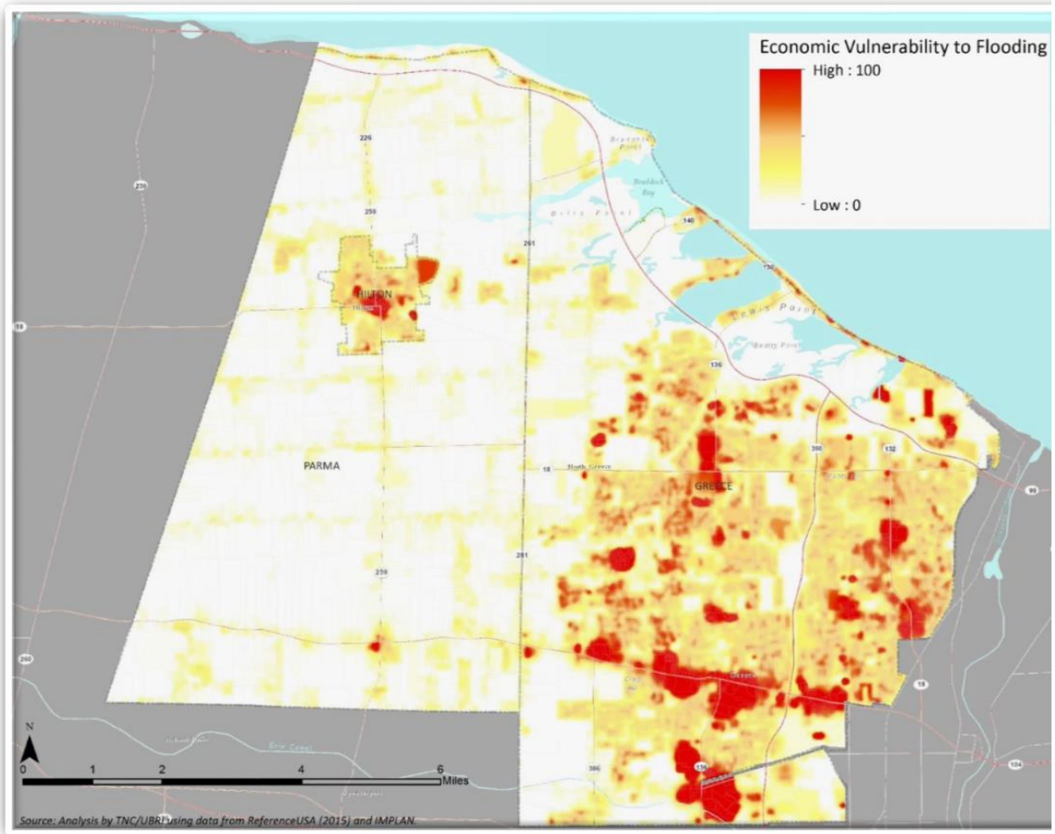

Figure 5. Economic susceptibility (aggregate score) to flooding in Greece, Parma and Hilton

Social Susceptibility to Flooding

Social susceptibility is a critical element in assessing the overall vulnerability of these three communities to flooding. A better understanding of the capacity of a person, neighborhood or community to anticipate, cope with, resist, or recover from flooding impacts can lead to better strategies for assisting these vulnerable populations. As illustrated in Figure 6, the Village of Hilton and the eastern-most areas in the Town of Greece neighboring the City of Rochester are highly susceptible to flooding from a social perspective. This susceptibility is derived from several factors, including the fact that these areas generally have lower income and educational attainment levels, coupled with higher rates of unemployment; households typically are headed by a single-parent persons of color who tend to rent, not own, their home; and/or comprise persons living in households who have “special needs” (e.g., a child, a senior citizen, a person with a disability, a person who does not own an automobile, or a person with other special needs), which makes them more susceptible to a flooding hazard.

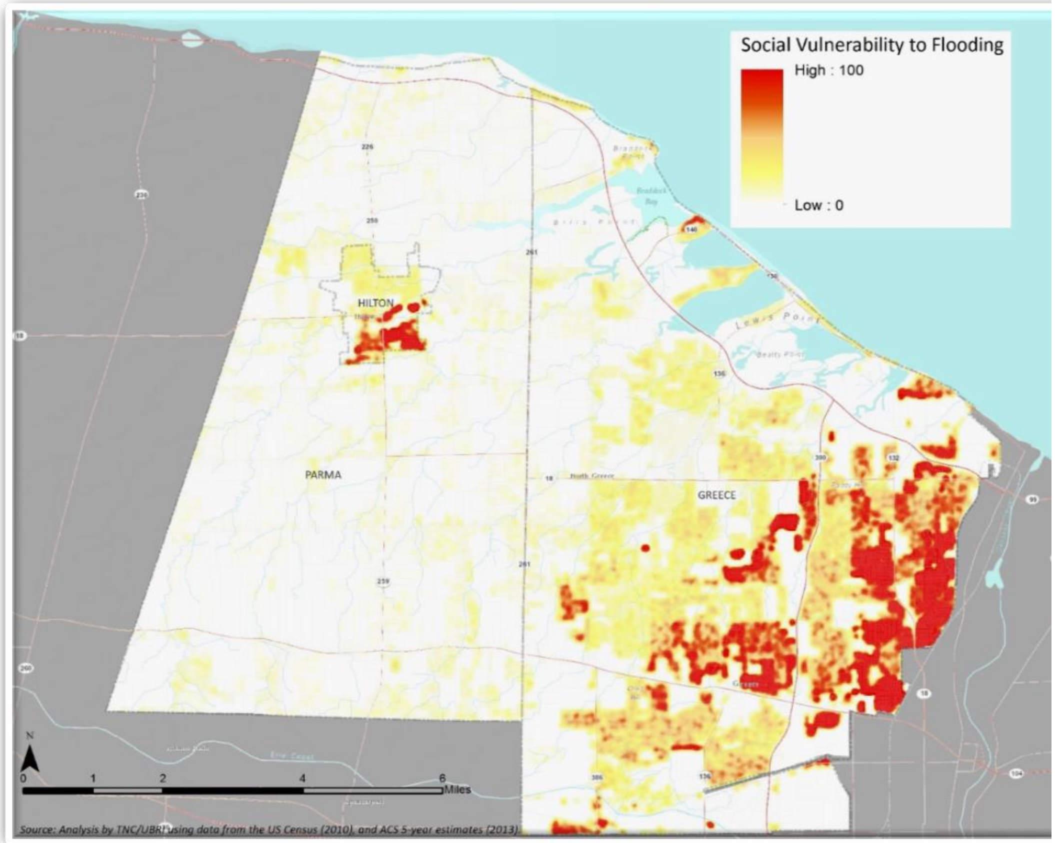

Figure 6. Social susceptibility to flooding in Greece, Parma and Hilton

Composite Flooding Vulnerability

Taking physical, structural, economic and social susceptibility together, Figure 7 illustrates that the Village of Hilton near Salmon Creek and neighborhoods located in the eastern end of the Town of Greece are most vulnerable to flooding risk. Also, several neighborhoods on the Lake Ontario shoreline (notably along Edgemere Drive) are also vulnerable to flooding risk.

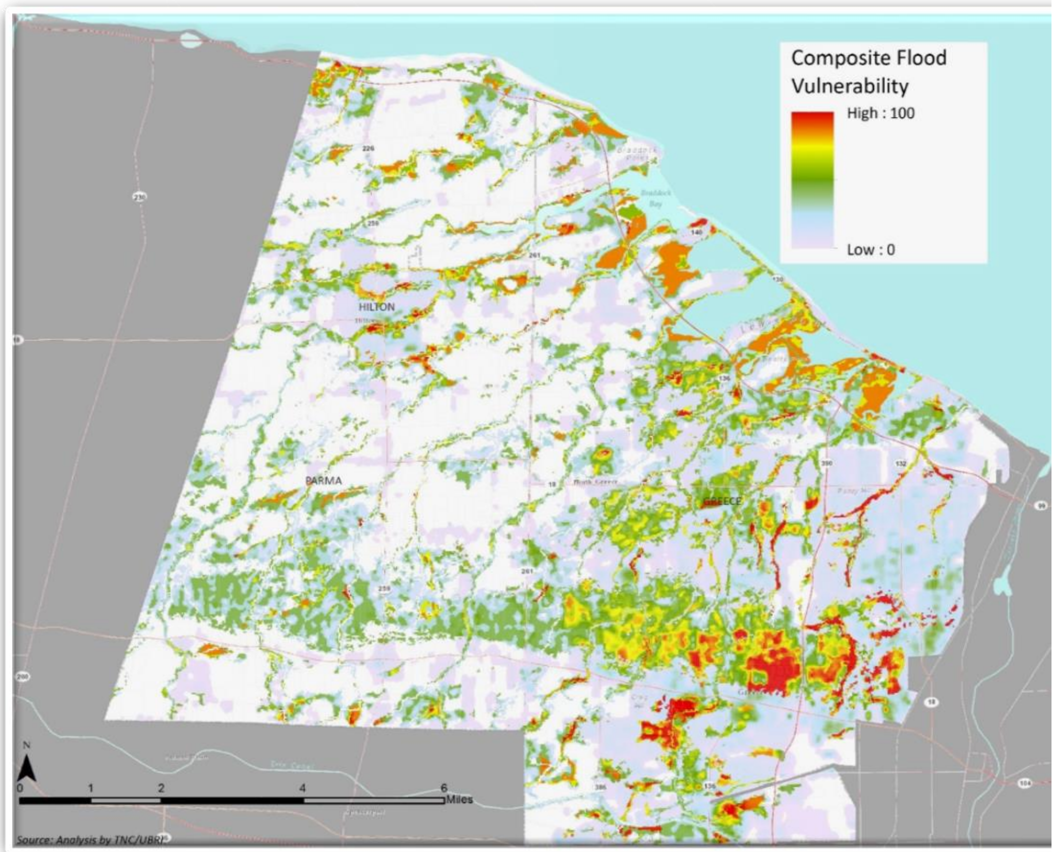

Figure 7. Composite vulnerability to flooding in Greece, Parma and Hilton

Drilling down a bit further, Figure 8 illustrates more specific areas in Hilton and Greece where all four component scores are relatively high ("hot spots"). This Figure suggests that residents in these areas are especially exposed to flooding events because they are exposed to risks stemming from the physical location, potentially live in old housing stock and are economic and socially at-risk.

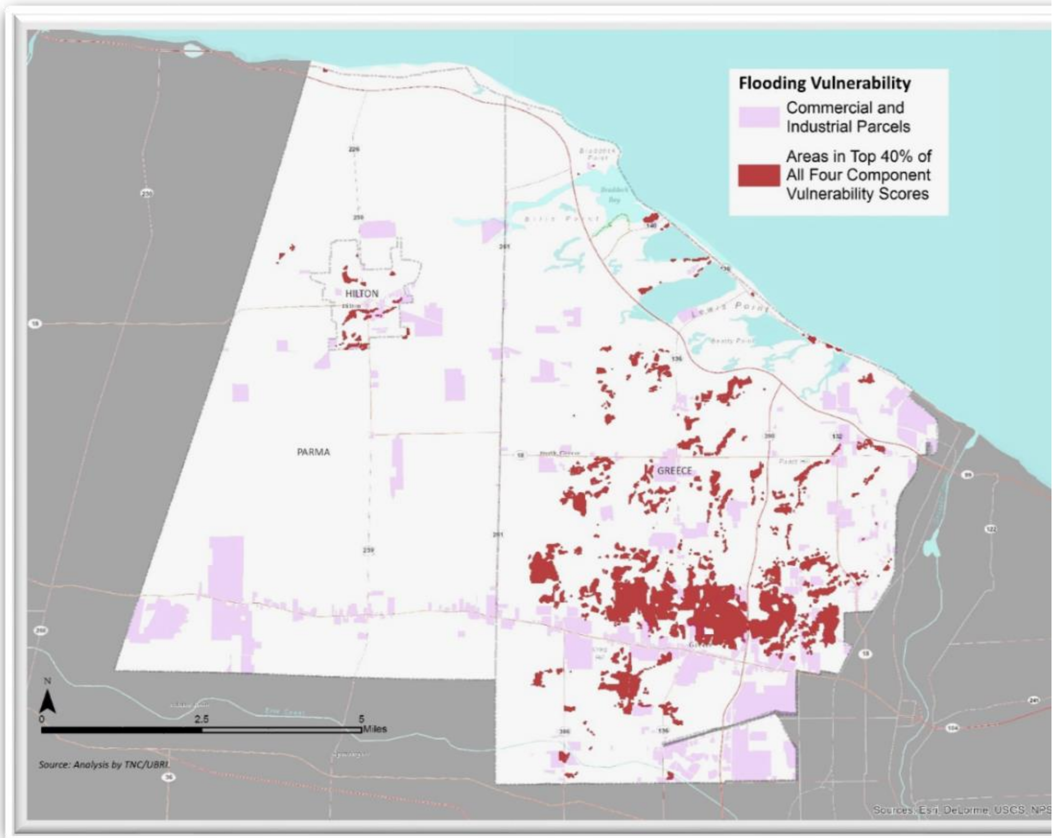

Figure 8. Composite flooding vulnerability hot spots in Greece, Parma and Hilton

Conclusions

By adopting a holistic vulnerability assessment that analyzes structural characteristics, economic factors and social susceptibilities separately and then together with physical susceptibility to flooding in these three communities, leaders in Greece, Parma and Hilton have a more informed understanding of flooding vulnerability that they can then use to target policy action. Broadly speaking, this analysis illustrates why a coordinated approach to floodplain management is desirable – that is, each community shares flooding vulnerabilities. Given limited resources, officials can use this analysis to identify common issues to work on collectively. It also assists them in their purpose of protecting life, health and property against flooding damage by providing a rich understanding of where they are most vulnerable. Armed with these detailed analyses, officials can be more strategic or targeted in their approaches. This analysis also helps officials meet their goal of minimizing damage to property owners and the concomitant objective of Increasing understanding of vulnerable areas and what's causing these vulnerabilities. Armed with data and information, these analyses also are helpful in assisting municipal officials in applying for funding related to flood mitigation, thus adding value to another stated goal of this effort – maximizing a sustainable funding stream for flooding issues. Finally, the mapped information allows local officials to target and prioritize different areas throughout the four phases of emergency management - in the mitigation, preparedness, response and recovery efforts. They can deter further development in areas physically susceptible(mitigation); target pre-event outreach, like information on evacuations, shelter locations, or guidance on homeowner precautionary measures, to socially susceptible areas (preparedness); and focus response and recovery efforts in areas with high economic and overall vulnerability.

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Appendix B: Assess the Problem

B.2. Application of the Benefit Cost Analysis Tool and IMPLAN Modeling in the Town of Greece, Town of Parma and Village of Hilton

Introduction

Appropriate flood mitigation or management strategies require an understanding of the benefits of flood mitigation measures when compared to the costs of installing or implementing these measures. An understanding of broader economic impacts is required as well. In collaboration with The Nature Conservancy Central-Western New York Chapter and the Genesee Finger Lakes Regional Planning Council, and officials from the Town of Greece, Town of Parma and Village of Hilton, the University of Buffalo used two tools – the Benefit Cost Analysis (BCA) Tool developed by the Federal Emergency Management Agency (FEMA) and IMPLAN – to 1) compare the costs of flooding damage to the benefits of mitigation measures; and 2) calculate the primary and secondary economic impacts of flooding, not only on the property owner and/or structure inhabitants but on the broader community as well.

A Summary of the Tools

FEMA provides technical and financial assistance to state and local governments to assist in implementing flood mitigation projects that are cost effective and designed to substantially reduce injuries, loss of life, hardship or the risk of future damage and destruction of property. To evaluate proposed flood mitigation projects, FEMA developed a BCA tool to validate cost effectiveness.

The BCA tool estimates the future benefits stemming from reduced flood damage due to a mitigation measure and compares these benefits to costs of installing a mitigation measure. The end result is a benefit-cost ratio (BCR), which is derived from the total net benefits of a flood mitigation project divided by the total project cost. The BCR is a numerical expression of the cost effectiveness of a project. A project is considered to be cost effective when the BCR is 1.0 or greater, indicating the benefits of a prospective hazard mitigation project are sufficient to justify the costs.

IMPLAN (IMpact analysis for PLANning) uses a classic input-output analysis in combination with regional specific inter- and intra-industrial data to create economic consequence scenarios of various direct and indirect activities or events on a regional economy. In the flooding event context, it is important to conduct an IMPLAN analysis in conjunction with a BCA analysis because the BCA tool only accounts for direct impacts caused by flood inundation of a property.

Direct damage caused by a flooding event encompasses the recovery cost of a property and contents, reduced productivity of workers and escalated mental stress of the people who live there. All these factors are transformed to monetary values by BCA using the standard formulas and parameters provided by FEMA. Due to inter- and intra-industrial relationships, however, secondary impacts must be accounted for as well. Secondary impacts include two elements:

1) Indirect impacts – these impacts reflect spending by a business that sells goods and services that respond, either directly or indirectly, to direct impacts relating to things like damage to buildings, loss of residential and commercial content, displacement of residents out of their home, and purchase and installation of mitigation measures. Examples include a contracting company purchasing lumber and siding; a retailers purchasing more furniture, electrics or vehicles; or a medical supplier purchasing more medical equipment.

2) Induced impacts – these impacts reflect spending by employees in those businesses associated with indirect impacts. Examples include spending by employees at a local hotel or restaurants where displaced residents will go; or spending by contractors, building subcontractors, or sales and leasing agents.

Whereas some people regard these secondary effects as positive because they interpret them as driving factors of regional economy, they are economic turmoil consuming regional resource that would not happen if there is no flooding. These secondary effects, therefore, are negative to regional economy, and they should not be ignored due to their significance. In a broader perspective, secondary impacts are valuable input information of benefit in generating BCR. However, the following paper denotes BCR as a parameter generated only by BCA tool.

Method and Analysis: Flood Smart Communities

The "Flood Smart Communities" initiative was intended, in part, to assist local government officials in the Town of Greece, Town of Parma and Village of Hilton and others to create effective flood mitigation or management strategies that are supported by the local community. To accomplish this goal, these communities required an understanding of the benefits of certain flood mitigation measures when compared to the costs of installing or implementing these measures. These communities also required an understanding of the secondary economic impacts of mitigation measures on a community.

The BCA Summary of Findings

The University at Buffalo, in consultation with The Nature Conservancy and representatives from the three communities, seven properties were selected to examine the benefits and costs of certain flood mitigation strategies: three residential properties, one commercial property, one large grocery store, one office building and one apartment complex. Three different mitigation measures appropriate to these communities and properties – utility elevation, basement fill and structure elevation – were run for each property; only one mitigation measure, installing a water shield, was run for the commercial properties as it was determined to be the most appropriate.

The assessment of each scenario was first limited to use of the BCA. The overall project BCR, which denotes an aggregated benefit-cost ratio of multiple properties and multiple mitigation measures (for housing properties) in a flood mitigation project, is 5.8376. This essentially means that implementing flood mitigation measures for properties in the area under study is cost-effective. Comparing three residential and four commercial properties, the residential properties show a relatively higher BCR than the commercial properties, except for the large grocery store on South Avenue in Hilton. This is due to the fact that grocery stores have relatively large content value (85% of a BRV)[1] than other building types.

An analysis of the utility elevation options illustrates the highest BCR among the three scenarios in all of the residential properties (15.2638 for the North Avenue residence, 51.9778 for the Country Village Lane residence and 51.5035 for the Lake Shore Drive residence). This is primarily due to the fact that this option is relatively low-cost, as opposed to a large mitigation benefit. Hence, despite its cost-effectiveness, residents in the properties at risk will continuously experience significant flood damages with this mitigation measure. Basement fill with utility elevation scenarios show intermediate BCR results with substantial mitigation benefits. They are even close to the mitigation benefits for elevation scenarios, which illustrate the largest mitigation benefits with the largest mitigation costs. Elevation is the least cost effective option according to the BCR analysis, but the best option for mitigation benefits. While this option is costly, it almost entirely eliminates flood damage.

For the commercial properties, only a water shield scenario was assessed as it was determined to be the only option for this class of properties. There are fair BCR results for the large grocery store (11.0866) and office building (4.5140), but very low scores for the Ridge Rd property (0.0071) and apartment complex (0.6033). There are different reasons for these results. Although historical data illustrates significant flood damage to the Ridge Rd property, the FEMA Flood Insurance Study (FIS)[2] identifies the property as rarely affected by floods (i.e., it historically has had very low flood depths). Hence, because the latter is used as an input into the BCA analysis, only a small amount of flood damage is captured, which leads to a lower mitigation benefit. To more adequately capture flood damage in the future, observational data from key stakeholders could be used to adjust the FIS data. For the apartment complex case, the low BCR is due to a lower property value compared to a larger mitigation cost. That is, the apartment complex has a relatively low property value when compared to single-family houses

[1] Content value is automatically determined by detailed building types based on Build Replacement Values (BRV) in the BCA tool. All content values are set by an algorithm in the BCA except for housing properties. Whereas the content value default ratio of housing properties in the BCA is 10%, we manually applied a value of 24% because of relatively low housing prices in the Rochester area vis-à-vis content value for the three housing properties.

[2] FIS identifies the levels of water depth in 10, 50, 100, and 500 years flood plains for each property based on the stream discharge information of the nearby stream and relative location of a property to the stream

and commercial buildings, however, it has a substantial foot print, which increases the mitigation cost. In this case, applying more inexpensive mitigation options (e.g., cheaper material[3], utility elevation) should be considered.

Table 1 summarizes the BCA results. For more detailed information, see the comprehensive table that includes details for each scenario at the end of the appendix. Table 2 and 3 categorizes flood damages before and after mitigation scenarios for residential and non-residential properties, respectively. "Other" denotes the "utility elevation" option. This option does not decrease any damage of building and contents because it neither prevents water nor changes the base floor elevation, but this option replaces utilities from the basement to the first floor level. The basement fill option decreases a substantial amount of building and content damage because basement damage contributes the most cost in most flooding situations. Structure elevation results illustrate the most significant reduction of building, contents and displacement costs.

Table 1. Summary of BCA Results for the Selected Properties

Properties	Mitigation Scenarios	EADBM_A	EADBM_P	EADAM_A	EADAM_P	Mitigation Benefit	Mitigation Cost	BCR
North Ave.	Utility Elevation	$40,804	$517,408	$31,982	$456,353	$61,055	$4,000	15.2638
	Basement Fill	$40,804	$517,408	$3,302	$47,112	$470,296	$46,200	10.1796
	Elevation	$40,804	$517,408	$376	$5,370	$512,038	$94,528	5.4168
Country Village Ln.	Utility Elevation	$61,268	$545,159	$23,635	$337,248	$207,911	$4,000	51.9778
	Basement Fill	$61,268	$545,157	$3,626	$51,738	$493,419	$31,375	15.7265
	Elevation	$61,268	$545,159	$3,655	$52,148	$493,011	$60,225	8.1862
Lake Shore Dr.	Utility Elevation	$59,107	$546,738	$23,878	$340,724	$206,014	$4,000	51.5035
	Basement Fill	$59,107	$546,738	$4,671	$66,648	$480,090	$31,000	15.4868
	Elevation	$59,107	$546,738	$343	$4,895	$541,843	$62,640	8.6501
Ridge Rd.	Water Shield	$107	$1,478	$97	$1,333	$145	$20,482	0.0071
Large Grocery	Water Shield	$882,696	$1,222,787	$15,972	$220,421	$1,002,366	$90,412	11.0866
Office Building	Water Shield	$37,322	$67,758	$1,324	$18,275	$49,483	$10,962	4.5140
Apartment Complex	Water Shield	$50,346	$694,815	$35,035	$483,504	$211,311	$350,273	0.6033
Project BCR						**$810,097**	**$4,728,982**	**5.8376**

Notes:
Basement Fill and Elevation includes Utility Elevation mitigation option. For detailed cost of mitigation scenarios, see the attached table.
EADBM_A: Expected annual damage before mitigation
EADBM_P: Present value of EADBM_A
EADMA_A: Expected annual damage after mitigation
EADMA_P: Present value of EADMA_P
BCR: Benefit-Cost ratio

[3] There is a wide range of unit-cost (per square feet) for the water-shield mitigation measure. Although the quality of protection is not guaranteed, cheaper material could be an option to increase the BCR.

Table 2. Categorized Damages Before and After Mitigation Scenarios for Residential Properties

Properties		North Ave			Country Village Ln			Lake Shore Dr		
Mitigation Scenarios		Utility Elevation	Basement Fill	Structure Elevation	Utility Elevation	Basement Fill	Structure Elevation	Utility Elevation	Basement Fill	Structure Elevation
Damage Before Mitigation	Building	$23,489	$23,489	$23,489	$17,326	$17,326	$17,326	$17,471	$17,471	$17,471
	Contents	$8,456	$8,456	$8,456	$6,237	$6,237	$6,237	$6,271	$6,271	$6,271
	Displacement	$37	$37	$37	$71	$71	$71	$135	$135	$135
	Loss of Function	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Other	$3,936	$3,936	$3,936	$12,832	$12,832	$12,832	$12,808	$12,808	$12,808
Damage After Mitigation	Building	$23,489	$2,401	$277	$17,326	$2,614	$2,687	$17,471	$4,630	$262
	Contents	$8,456	$863	$99	$6,237	$941	$967	$6,271	$37	$78
	Displacement	$37	$37	$0	$71	$71	$0	$135	$4	$4
	Loss of Function	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Other	$0	$0	$0	$0	$0	$0	$0	$0	$0

Table 3. Categorized Damages Before and After Mitigation Scenarios for Non-residential Properties

Properties		Ridge Rd	Large Grocery	Office	Apartment Complex
Mitigation Scenarios		Water Shield	Water Shield	Water Shield	Water Shield
Damage Before Mitigation	Building	$95	$14,887	$2,021	$25,025
	Contents	$13	$11,681	$357	$4,090
	Displacement	$0	$0	$0	$21,231
	Loss of Function	$0	$0	$0	$0
	Other	$0	$0	$0	$0
Damage After Mitigation	Building	$86	$9,465	$1,149	$17,150
	Contents	$10	$6,507	$175	$2,524
	Displacement	$0	$0	$0	$15,360
	Loss of Function	$0	$0	$0	$0
	Other	$0	$0	$0	$0

Table 4 summarizes flood damage caused by a road closure of Rte259. Based on historical records of average traffic volume and map measurement of the length of the fastest detouring route under a scenario of 24 hours of disruption[4], the BCA generated economic damage and expected annual damage using a Depth-Frequency-Function (DFF). When this event happens, $60,306 of economic loss would be expected. When allocating this damage into 100 years with 7% interest rate, $2,010 of expected annual damage was generated.

Table 4. Summary of Flood Damage for Route 259

Road	Route 259
One-way traffic trips per hour	375
One-way traffic trips per day	9,000
Additional miles	5 mile
Additional time per one-way trip	8 minutes
Economic loss per day of loss of function	$60,306
Expected annual damage	$2,010

[4] Mike McHenry stated that there was 24 hours of disruption in the South Avenue Rt. 259 bridge in 2004.

IMPLAN Analysis Summary of Findings

Economic impact analyses also were run for each of these scenarios**.** As noted below, these analyses offer further support and validation for the positive BCRs calculated with the BCA tool**.** Secondary impacts contribute anywhere from 25 percent to 50 percent of the total economic impact calculated. These impacts are largest for the grocery store scenario and smallest for the apartment scenario. The apartment scenario has very large displacement costs, unlike the others, and although the team assumed people would rent an alternative apartment in the study area, the actual supply of housing there may limit this and result in significant leakage of dollars outside the study area. Whereas the BCA analysis resulted in a score of less than 1 (0.6033), when secondary impacts are considered using IMPLAN, the BCR increases to 1.15 for the apartment complex. Nonetheless, given the very substantial costs of mitigation for this scenario (more than $350,000), interested parties should proceed cautiously when considering mitigation in this context.

[insert Sharon's summary and tables here or perhaps at the end of the appendix if it is easier]

Conclusions

The BCA and IMPLAN analyses offer insight into the benefits of flood mitigation measures when compared to the costs of installing or implementing these measures. These analyses, therefore, are helpful to homeowners and officials when strategizing about the best approach to flood mitigation efforts in these three communities. These tools help officials in achieving several objectives of this initiative. For example, these analyses allow officials to move toward their goal of minimizing damage to property owners and the related objectives of reducing flood damage to residential structures and contents by providing insight into the costs and benefits of various mitigation measures and the most cost-effective ways to mitigate against flooding susceptibility. Officials could discuss mitigation options with property owners in similar situations to those properties selected for the scenarios. Additionally, the BCA and IMPLAN analyses combined could assist officials and residents in selecting the most cost-effective flood attenuation solutions – an objective that stems from their broader goal of minimizing economic impacts of flooding. For example, although the BCA tool demonstrates that it would be difficult to justify certain mitigation measures for lower valued properties, secondary effects generated by IMPLAN add to the rationale for mitigating lower valued properties, given the indirect and induced effects generated in the regional economy. In these situations, officials could perhaps offer financial incentives or assistance to property owners wishing to install mitigation measures, notwithstanding the cost-benefit ratio. One strategy in this regard is incorporating floodproofing structures into "eligible repairs" for one-time grants and low interest loans, such as the Monroe County Home Improvement Program.

Appendix B: Assess the Problem

B.3. Residential Property Owner Survey

Contents

University at Buffalo
The State University of New York
School of Architecture and Planning

UB Regional Institute

Findings from a survey of residents in Greece, Parma and Hilton on flood vulnerability

A report by the UB Regional Institute to The Nature Conservancy

October 26, 2015

This report summarizes findings from a survey of flood vulnerability conducted by the UB Regional Institute for The Nature Conservancy. The survey is part of a larger research project being completed by the UB Regional Institute to assess vulnerability to flooding in the neighboring Towns of Greece and Parma and the Village of Hilton ("the study area"). These three communities are located in the northwestern portion of Monroe County, New York, just south of the Lake Ontario shoreline.

The survey was designed to evaluate the community's perceptions and impacts of flooding and support the design of better flooding protection programs and policies for this area, which is in or in proximity to a flood plain where the risk of flooding over future years is elevated. The survey was developed by researchers at Syracuse University and refined by the UB Regional Institute and The Nature Conservancy.

An invitation to complete the 15-minute online survey was mailed to 1,013 property owners in the study area during the last week of July 2015. A second round of postcards was mailed approximately three weeks later in mid-August to those who had not yet responded. All potential respondents were offered the option of completing the survey over the telephone, if they so preferred. As an incentive, respondents were told they would be entered into a drawing for one of four $50 VISA gift cards.

The postcard mailing generated 57 survey responses as of September 14, 2015. This reflects a response rate of 6%, short of expectations but consistent with similarly low survey response rates realized by the towns of Greece and Parma as part of different initiatives in which community residents were surveyed. Also weighing on the response rate to this survey is the absence of a recent major flooding incidence in the community. Despite its elevated risk, the last major flood occurred in 2004, at the heels of Hurricane Francis. Area creeks overflowed and a state of emergency was called, as water buried surfaces in Hilton and surrounding municipalities.[1]

[1] See Flood clean-up, recovery continues in Westside News Inc., September 19, 2004.

To improve survey participation, partial page ads with information about the survey, a photo and a link to a shortened version of the online survey were placed in the Greece Post and Westside News during the last week of September. However, these ads resulted in no additional survey responses as of October 26, 2015.[2]

As **Chart 1** shows, those who responded to the survey are longer-term residents of the study area. Close to nine out of ten have been at their current residence for over 5 years. The large majority are also long-term residents of the town they are currently in, as well as Monroe County and New York State. An analysis of respondent addresses reveals that two out of three (67%) are on the 100-year floodplain, perhaps explaining the interest and willingness of these residents to complete the survey.

Half of survey respondents were age 59 or older. All reported their race and ethnicity as "white." Nearly all (98%) said that English is the language they primarily speak at home.

Respondents were almost three times more likely to report a person age 70 or older living with them than a child age 9 or younger. Households in the community are relatively small with half of respondents with only one or two persons in their household.

Those who responded tended to be college educated, with nearly three out of four saying they have at least a two year degree. More than not are employed, although a significant proportion (40%) told us they are retired.

The large majority – 70% - described their political affiliation as either "very conservative," "conservative," or "basically independent but leaning towards conservative."

[2] Three survey respondents indicated they would like to be entered into the drawing for the $50 VISA card but did not provide their email; nor did they provide answers to any survey questions, beyond agreeing to participate. A couple other survey takers began the survey but did not answer any questions beyond the initial agreement to participate. These surveys were omitted in the compilation of the survey findings presented here.

Flood experience and concern

Nearly one out of three survey respondents[3] said they have experienced flooding at some point over the past 10 years at their current residence. (See **Chart 2**.) For purposes of this study, flooding was defined to mean “when a waterbody overflows its ‘normal’ banks, potentially resulting in erosion, unusual or rapid accumulation, or water inundation that causes damage to your home, infrastructure and/or property.” The definition excluded nuisance flooding, or the presence of water that is troublesome but not threatening or damaging. Floods affecting exterior property were most commonly reported by 28% of respondents, followed by floods affected their routine (16%) and basement (10%).

Nearly a fifth of respondents (17%) say that parts of their property are still affected by flooding that has occurred in the past 10 years. Structural damage and/or a permanent loss of function to lawn and landscaping were most commonly reported (15%), followed by damage to respondents’ garage and driveway (4%).

In describing the feelings that come to mind in thinking about the community being affected by flooding, “sadness,” “very devastating,” “cost of rebuilding,” “frustration,” “helplessness,” “a very scary proposition,” and “personal losses” are some of the thoughts respondents shared. Exacerbating their concern may be changing weather patterns. Over half of respondents say they have observed periods of heavy rainfall and/or cold winters becoming at least somewhat more frequent.

About two out of three respondents (68%) say they are at least somewhat concerned about the effects of flooding. (See **Chart 3.**) Weighing on this concern are the negative consequences of flooding. Over half (54%) say the consequences would be serious to them, as flooding threatens the supply of food, water and power. Over half of respondents said losing power, drinking water, access to supermarkets and/or communication services are extremely or very disruptive to them.

Yet the majority of respondents (57%) indicated that they do not feel vulnerable about the possibility of flooding affecting them or their family. (See **Chart 4**.) This gap between those who say they are concerned and those who feel vulnerable may reflect the level of preparedness of property owners in the study area. As Stephen King once said, “there’s no harm in hoping for the best as long as you’re prepared for the worse.” The level of preparedness of property owners in the survey area was another topic this study explored.

[3] Unless otherwise noted, proportions and percentages reflect the answers of survey respondents who answered the question. Not all survey respondents answered every question on the survey and were allowed to skip over those they chose not to answer.

Flood Preparedness

The majority of survey respondents agree that personally preparing for floods will improve the value of their house and property; improve their quality of life; and improve their ability to deal with disruptions to everyday routines. Yet the majority (63%) have not taken even one mitigation and prevention measure. Only one about out of four property owners responding to the survey (27%) say they keep ditches and drains around their property clean, and even smaller numbers (21%) say that they have purchased flood insurance. Lesser percentages have prepared an emergency kit (18%); sought out information about flooding (16%); or prepared sandbags and/or plywood (10%) for redirecting water away from their home.

The level of difficulty associated with some of these measures plays a role, with those perceived as most difficult (such as installing a floor vent and elevating floors and utilities) implemented by the lowest percentages of property owners responding to the survey. (See **Chart 5**.) Survey takers reported needing help to implement various preparations. Residents, for instance, say they need financial help to install a flood vent and elevate floors and utilities. Forty-two percent of residents said they also need financial help to purchase flood insurance or to increase existing coverage.

With the majority of survey respondents being of retirement age or close to it, physical help is also commonly needed. Close to four out of ten residents say they need physical help maintaining drains and ditches around their property and preparing sandbags and plywood. Meanwhile, greater informational help would support residents in seeking out information about flooding and preparing an emergency kit with supplies for safety, survival and well-being.

Environmental values and perceptions

In considering the risk of flooding and potential mitigation strategies, it is important to assess the value residents have for the environment and their general opinions on the state of the environment. Nearly two out of three respondents (65%) strongly agree that they strongly value Monroe County's natural environment for at least one of eight reasons offered to them. Among those feeling less strongly, 100% still agreed that they do value their county's natural environment. What matters most to the greatest numbers of respondents is the integral role the environment plays in agricultural production, plant life, fish and wildlife, scenery, tourism, outdoor activities and sustainability for future generations. (See **Chart 6.**)

As a group, survey respondents disagree that human existence, modern life and economic growth necessarily degrade the natural environment. (See **Chart 7.**) However, 62% of respondents also disagree that we worry too much about human progress harming the environment, suggesting that economic and population growth could better consider environmental impacts and consequences, from the perspective of survey respondents.

Water quality

Nearly nine out of ten respondents (87%) report that poor water quality has already very much impacted at least one water-supported resource or activity. The largest proportion of respondents (79%) has observed impacts on the drinking water supply. (See **Chart 8.**) Nearly three-quarters of survey takers also report that aquatic life, fish consumption, and swimming are very impacted. Fewer than 5% of respondents report no impacts at all on resources and activities such as recreation, swimming, fish consumption, drinking water, aesthetics, habitat and aquatic life.

For the large majority of respondents (69%), these changes in water quality of streams and ponds have been observed over the past 10 years. Seventy six percent of respondents describe the changes they observe as resulting in water that is "lower" or "much lower."

Leadership, roles and responsibility

The majority of respondents (62%) trust scientists and engineers to give them a fair idea of their actual risk. (See **Chart 9.**) At the same time, respondents are less agreeable in thinking about whether they can trust others who play an important role in flood awareness, prevention and the reduction of damages. Only four out of ten or fewer agree or strongly agree that they trust community leaders or government to meet the needs of its residents or do what is right for the people. Yet local government and community leaders garner more trust from property owners than the media. Less than a third of respondents say they trust traditional media – newspapers, TV and radio – to report fairly.

In considering who is most responsible for preventing and responding to flooding in Monroe County, the majority of survey respondents identified all levels of government – federal, NYS, county and town – as "very responsible." (See **Chart 10.**) Highest proportions marked Monroe County as very responsible, with a larger 87% feeling that Monroe County is at least somewhat responsible, if not very much so. Only one out of three indicated that they themselves, as a property owners living in an area of high flood risk, are very responsible. An even smaller 19% said businesses in affected towns are very responsible. Larger percentages indicated, however, that actions by property owners and businesses are very important to reducing flooding, even if they are not perceived as ultimately responsible.

While survey respondents position government as very responsible for in dealing with flooding, very small percentages have ever communicated with government officials about how to reduce flood risk in their community. (See **Chart 11**.) Just 17% of respondents have reached out to their elected leaders on this topic.

An even smaller 15% have ever been involved with a local community group related to flooding. Respondents in the study area are, in fact, over two times more likely to regularly contribute money, food, or clothing to local causes (43% report often doing this), as compared to working with others on something to improve community life, which only 19% say they often do. A not much higher 15% say that they are often involved in volunteer activities that benefit the community such as fundraising, cleanup days, local groups or Scouts and Brownies. In thinking about how property owners in the study area might organize to prevent flooding or reduce flood damages, these findings suggest that residents here are more apt to financially support initiatives they believe in with hands on assistance from others.

Preparation and Mitigation

Greater flood preparedness should leverage existing assets and resources, involving those who are most prepared, to ensure the entire community ultimately becomes highly prepared to deal with flood related emergencies when they happen. For this reason, we asked property owners in the study area about their perceptions about who is prepared and who is not, for future floods affecting the community. Not surprisingly, emergency responders earned the highest number of marks from survey respondents, 89% of which reported these professionals are at least somewhat prepared. (See **Chart 12.**) Nearly a quarter believe emergency responders are very prepared.

Somewhat surprisingly, the next highest percentage of survey respondents – 77% altogether - believe their own household is at least somewhat prepared, if not very prepared. This is true even though the majority of respondents report they have not taken one of several selected measures to mitigate damages or prepare to deal with the effects of flooding.

While lower percentages of respondents believe their neighbors, service providers, insurance companies and county and federal government agencies (such as the EPA or FEMA) are less prepared than themselves and emergency responders to deal with flooding, the majority of survey takers report that these people and entities are at least somewhat prepared.

Least prepared, according to survey takers, is local government. A slight majority (52%) reported said municipalities are "not very prepared" or "not at all prepared" for future floods affecting the community.

Among the various ways flooding can be addressed, respondents specifically favor some more than others. Resource sharing agreements among local governments; limitations land use in high risk areas; and the use of different permitting processes to protect development in high risk areas are strategies that just under a majority of respondents say they "strongly support." (See **Chart 13**.)

A third or more of residents say they strongly support programs that help property owners reduce risk of flooding and/or allow local governments to buy flood-prone land for preservation purposes. An additional tax or fee that would pay for projects to reduce the risk of flooding garnered the lowest number of "strongly supporting" respondents and the highest number who said they would strongly oppose an extra tax or fee.

The large majority of property owners responding to the survey said they would at least somewhat support, if not strongly support, their tax dollars going towards projects outside their town but within

Monroe County if all county residents saw particular outcomes. (See **Chart 14**.) Water quality improvements for all residents in Monroe County is the outcome the largest (98%) of respondents are supportive of, with 36% saying they strongly support a project that achieves improved water quality with their tax dollars. Flooding prevention measures are also supported, at least somewhat or more, by a notable 87% of residents. Close to three-quarter or more of residents say they would somewhat support or very much support spending tax generated money to increase safety for all county residents and/or improve recreational opportunities. Less than 7% of respondents would strongly oppose using tax dollars to achieve these ends.

Charts and Graphics

Chart 1

Demographics of Survey Respondents	
Age, Race &Language	
Median Age	59
White	100%
English (Primary Language)	98%
Household Composition	
Persons in household (median)	2
Children under age 9 in household	11%
Person age 70 or older in household	30%
Education & Employment	
College degree	72%
Employed full or part time	55%
Retired	40%
Politics	
Conservative or leaning towards Conservative	70%
Residence	
at current house over 5 years	89%
in current town over 5 years	94%
in Monroe County over 5 years	98%
in NYS over 5 years	100%
Source: UB Regional Institute, Flood Smart Communities Property Owner Survey, 2015	

Chart 2

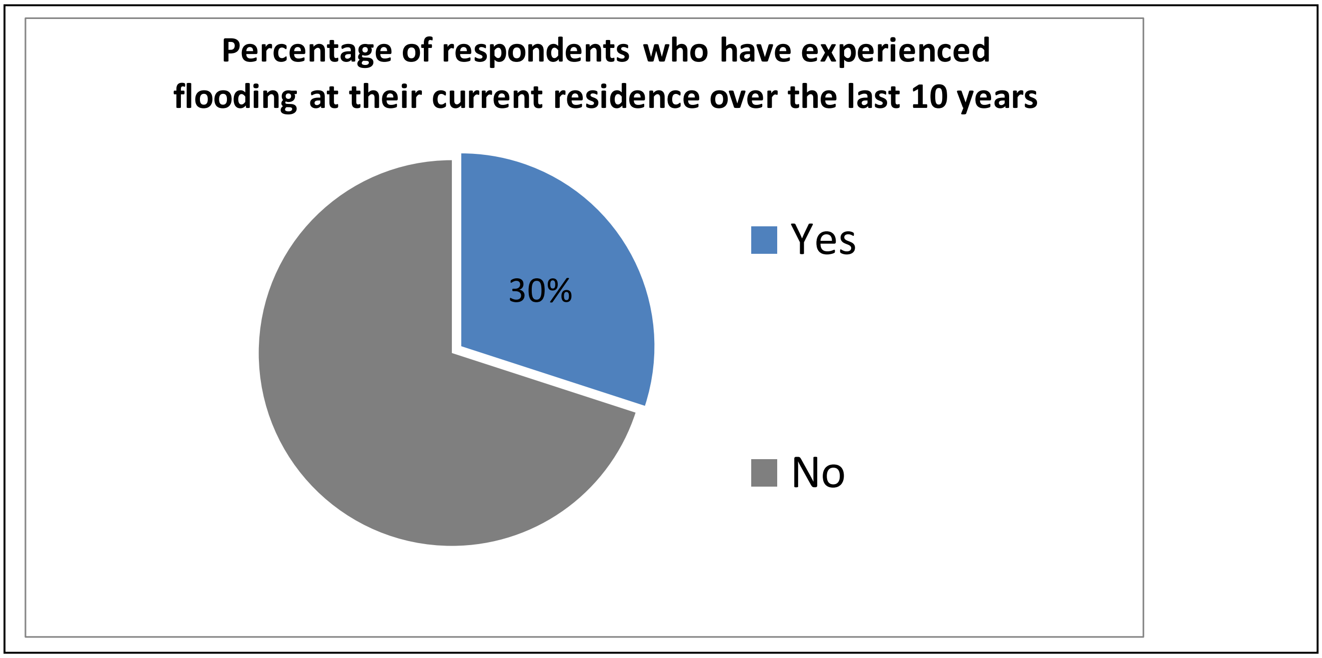


Chart 3

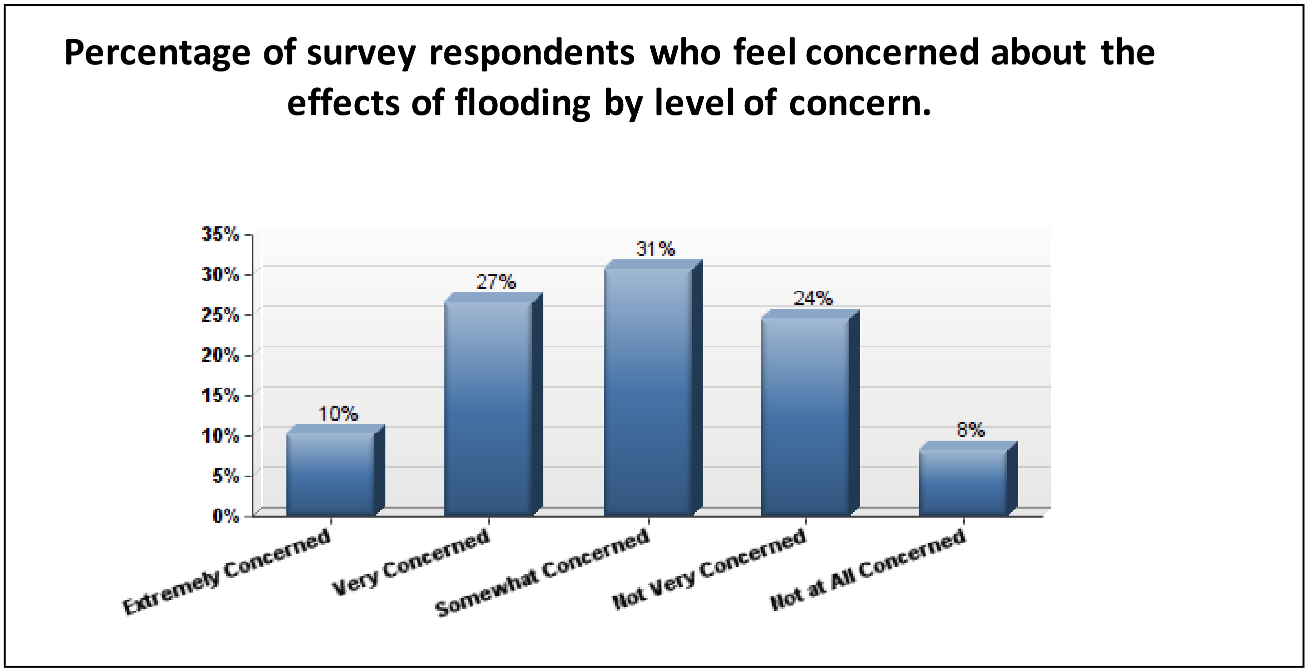


Chart 4

Percentage of respondents who feel vulnerable about the possibility affecting them or their family, by level of vulnerability.

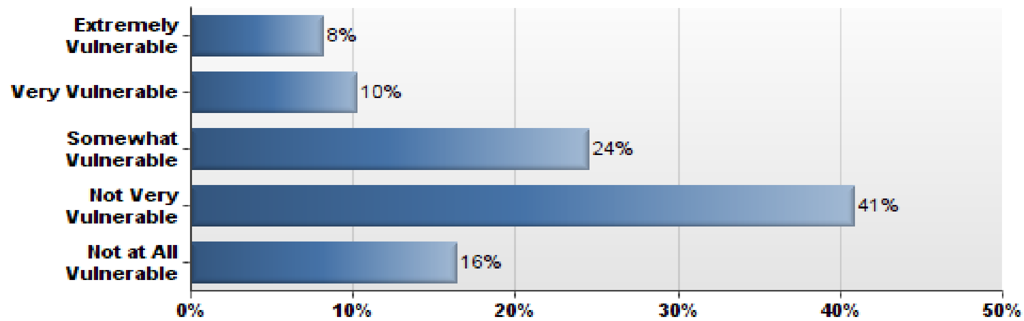


Chart 5

Flood preparation measures by level of difficulty and type of help needed

Preparation Measure	% describing as very or somewhat difficult	% who have done this or say they are very likely to do so	Most common type of help needed to implement
Install flood vent	94%	12%	Financial help (55%)
Elevate floor level	88%	12%	Financial help (59%)
Elevate utilities	87%	12%	Financial help (55%)
Prepare sandbags/plywood	39%	30%	Physical (44%)
Purchase flood insurance/raise coverage amount	36%	25%	Financial (42%)
Seek information about flooding	12%	32%	Informational (51%)
Keep ditches and drains clean	8%	70%	Physical (37%)
Secure outdoor possessions	6%	47%	Physical (24%)
Prepare emergency kit	0%	49%	Informational (8%)

Source: UB Regional Institute, Flood Smart Communities Property Owner Survey, 2015

Chart 6

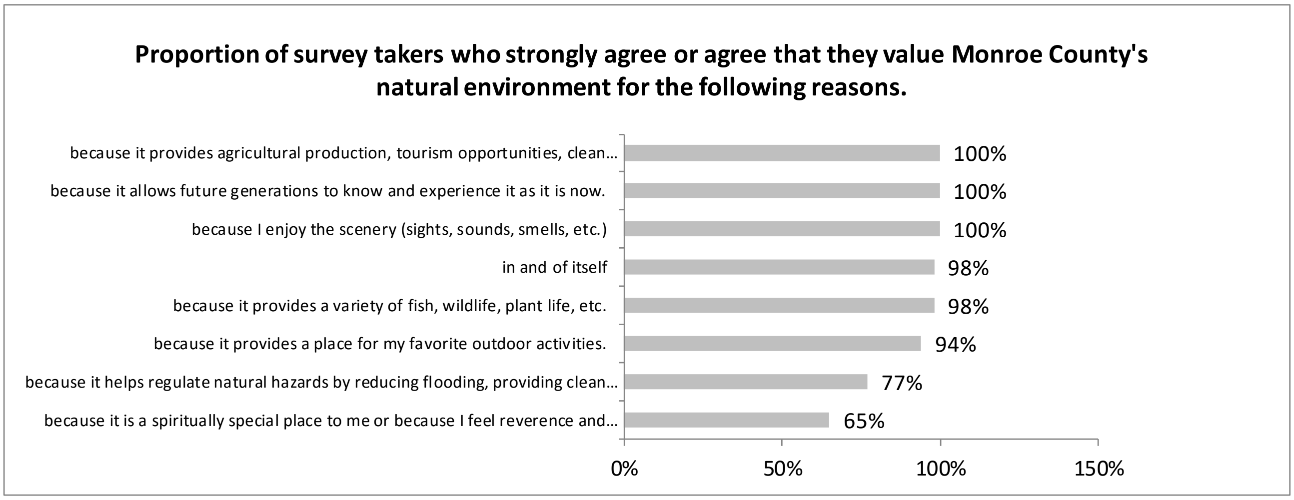


Chart 7

Proportion of respondents who disagree with the following statements

Statement	% Survey takers agreeing or strongly agreeing with
Any change humans cause in nature – no matter how scientific – is likely to make things worse.	84%
You can't have economic growth without harming the environment.	81%
We worry too much about the future of the environment, and not enough about prices and jobs today	71%
People worry too much about human progress harming the environment.	62%
Nature would be better off if only human beings would leave it alone.	60%
Almost everything we do in modern life harms the environment.	59%

Source: UB Regional Institute, Flood Smart Communities Property Owner Survey, 2015

Chart 8

Water resources and related activities that respondents say have been "very impacted" by poor water quality

Water Resource or Activity	% reporting this has been "very impacted" by poor water quality
Drinking water supply	79%
Aquatic life	72%
Fish consumption	70%
Swimming	70%
Habitat	68%
Recreation	60%
Aesthetics	53%

Source: UB Regional Institute, Flood Smart Communities Property Owner Survey, 2015

Chart 9

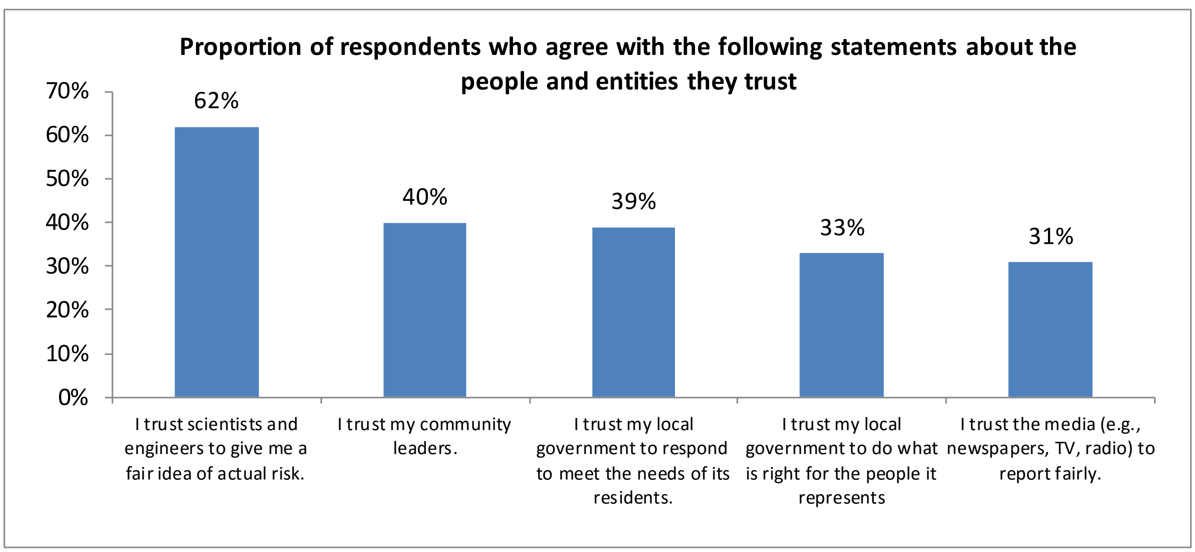


Chart 10

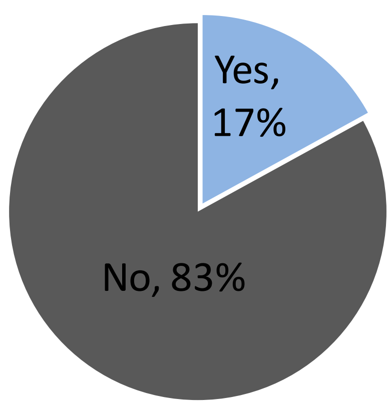
Who is responsible for preventing or responding to flooding?

	% survey takers indicating this party is "Very Responsible"
Monroe County Government	67%
My town government	65%
New York State government	60%
Federal government	54%
Property owner actions within areas of high flood risk	33%
Businesses in affected town	19%

Source: UB Regional Institute, Flood Smart Communities Property Owner Survey, 2015

Chart 11

Percentage of survey respondents who have communicated with government officials about how to reduce flooding.



Source: UB Regional Institute, Flood Smart Communities Property Owner Survey, 2015

Chart 12

Percentage of respondents saying these entities are at least somewhat prepared for future floods	
Entity	**% believing they are "somewhat prepared" or "very prepared"**
Emergency Responders	89%
Your household	77%
Commercial insurance companies	63%
Your neighbors	61%
Federal government agencies	61%
Service providers (such as telephone companies, water suppliers	61%
Monroe County government	57%
Municipal (local) government	48%

Source: UB Regional Institute, Flood Smart Communities Property Owner Survey, 2015

Chart 13

Flood mitigation programs that respondents strongly support and strongly oppose

Potential Strategy	% reporting they "strongly support"	% reporting they "strongly oppose"
Different permitting process to protect development in high flood risk areas	49%	4%
Limiting uses of open lands in high risk areas	49%	7%
Formal agreements between local governments to share resources for reducing the risk of flooding	49%	2%
Programs that would help property owners reduce their flood risk	41%	0%
Local government buying flood-prone open lands to preserve them	32%	9%
An additional tax or fee to pay for projects that would reduce at risk of flooding	19%	19%

Source: UB Regional Institute, Flood Smart Communities Property Owner Survey, 2015

Chart 14

Percentage of respondents saying they would support or strongly support their tax dollars being used on projects that achieve the following outcomes.	
Outcomes	**% reporting they would support or strongly support**
Water quality improvements for all Monroe County residents	98%
Flooding prevention for all Monroe County residents	87%
Increased safety for all Monroe County residents	85%
Improved outdoor recreation opportunities for all Monroe County residents	72%

Source: UB Regional Institute, Flood Smart Communities Property Owner Survey, 2015

Appendix B: Assess the Problem

B.4. Agriculture: Economics, susceptibility and best management practices

Contents

Introduction

Agricultural lands occupy approximately 40% of the nine HUC12 watersheds included in the project area. Because of this large proportion, the *Flood Smart Communities* Study Team[1] wanted to better understand how agriculture contributes to the local economy, how susceptible farmlands might be to flooding, and what the options are for reducing on-farm flooding as well as improving water filtration and reducing downstream flooding impacts. To answer these questions, The Nature Conservancy (TNC) and University of Buffalo, Regional Institute (UBRI) completed analyses using currently available data. TNC also completed a literature review of studies of agricultural best management practices that looked at nutrient, erosion and surface water benefits as well as elements of applicability and farmer support. Finally, both the analyses and literature review were used to draw conclusions to inform recommendations developed by local governments.

Contributions to the Local Economy

A University of Buffalo Regional Institute (UBRI) analysis of food production and food industries in the towns of Greece, Parma and Hilton was conducted using data derived from IMPLAN[2]. The analysis

[1] Stevie Adams, Freshwater Specialist (TNC), Jayme Thomann, Senior Planner (G/FLRPC), Dr. Kathryn Bryk Friedman, Research Associate Professor of Law and Policy & Director of Cross-Border and International Research (UB), Sharon Entress, Associate Director of Research (UBRI), Brian Conley, GIS Research Analyst (UBRI), Ha Hwang, PhD Candidate (UB)

[2] IMPLAN (IMpact analysis for PLANning) software uses classic input-output analysis in combination with regional specific data to create economic consequence scenarios of various direct and indirect activities or events on a regional economy. For this analysis Greece, Parma and Hilton were defined as the eight zip codes that are fully or partially in these municipalities: 14420, 14468, 14559, 14606, 14612, 14615, 14616, 14626.

estimates that within this three town region, farming contributes $7.7 million in income to workers (includes wages, salaries and benefits paid to employees and proprietors), with the largest share ($5.3 million) derived from fruit and vegetable production. Agricultural production generates 238 jobs and over $21 million in annual economic output. Output reflects the value of what is being produced by the industry and is estimated using producer prices. The region also supports a large food production sector (e.g. beverage & cereal production, meat, dairy and fruit processing) with approximately $89 million of income and an annual output of $1.3 billion. Of the 967 jobs supported by food production in this sector, beverage and beverage product production accounts for 602 of them. Assuming these industries are interconnected, agricultural production is a critical component of the supply chain for the food production industry.

Susceptibility to Flooding

Based on this assessment, it is clear that agriculture and food production are important contributors to the economic and social well-being of the Greece, Parma and Hilton communities. **Mitigating the risk of flooding, which has the potential to destroy crops and cropland, will protect a multimillion dollar industry that supports hundreds of local jobs and the supply chain for other important industries in the area.**

Recent (2015) Cropland data from the USDA –National Agricultural Statistics Service[3] were overlaid with flood prone areas from the Vulnerability Assessment (Appendix B) within the three communities. The flood prone areas score was used to divide these lands into two zones: flood prone lands with a score at or above the mean of 0.17 were zoned as high susceptibility, and flood prone lands below the mean as moderate susceptibility. This flood prone areas layer of the Vulnerability Assessment was created using flood frequency and ponding frequency SSURGO data and a wetness index. It was used rather than FEMA mapped floodplains because it covers all streams. Approximately 1,459 acres of 8,144 total acres of agricultural land are within a high susceptibility area, while 696 acres are within a moderate susceptibility area (Table 1). Nearly all crop types have one-fifth to one-quarter of their acreage in susceptible areas while row crops (corn silage/soybeans) have the highest number of susceptible acres of all crop types.

[3] http://nassgeodata.gmu.edu/CropScape/

Table 1. Acres of farmland susceptible to flooding.

Crop Type	High Exposure (ac)	Moderate Exposure (ac)	Total (ac)
Barren	53 (26%)	21 (10%)	202
Cover Crop	272 (15%)	120 (6%)	1869
Fallow	174 (18%)	89 (9%)	978
Fruit	24 (11%)	24 (11%)	224
Row (silage)	860 (17%)	399 (8%)	4931
Tree Farm	1 (7%)	1 (7%)	15
Vegetable	88 (16%)	42 (8%)	537
Grand Total	**1,459 (18%)**	**696 (9%)**	**8144**

The timing, intensity and duration of flooding events or saturated soils determine crop survival, primarily due to lack of oxygen for root respiration. Generally, the longer an area remains waterlogged, the greater the risk of crop mortality and yield reductions. Research on early germination of soybeans, indicates that seedlings are susceptible to flooding durations as short as 1 hour and short-term flooding can cause yield reductions up to 50%[4]. Corn is also most susceptible to flooding and waterlogged soils during early germination and growth phases, but can survive up to four days when germinating. Following germination, and prior to the 6th leaf stage, low nitrogen levels and higher air temperatures decrease chances of survival. Even where surface water subsides quickly, significant nitrogen losses may occur, and a surface crust may form impacting additional seedling emergence[5].

Agricultural Best Management Practices

Like other land uses, agriculture is both at risk from flooding and is one of many contributors to downstream flooding and water quality impacts. Use of best management practices (BMPs) on agricultural lands can reduce flooding and water quality impacts both on the farm and downstream while promoting soil conservation. They can be a single practice or a combination of practices that are effective and practicable (including technological, economic, and institutional considerations). When BMPs are strategically implemented, prioritized and employed properly, over time they can minimize farming impacts and even provide additional benefits.

[4] Elmore, R. and J. Specht. 2014. Early-season flooding and soybean survival. University of Nebraska-Lincoln, Institute of Agriculture and Natural Resources, Cropwatch (http://cropwatch.unl.edu/early-season-flooding-and-soybean-survival). Date accessed 5/17/16.

[5] Elmore, R. 2014. Flooding and Corn Survival. University of Nebraska-Lincoln, Institute of Agriculture and Natural Resources, Cropwatch. (http://cropwatch.unl.edu/flooding-and-corn-survival). Date accessed 5/17/16.

The literature is clear that there is a proper time and place for any particular BMP based on a number of factors, which may include the combination of other farming practices and BMPs, location of the site within a particular watershed or landscape, the length of time the practice will be employed, geophysical characteristics (e.g. slope and soil type) and crop rotations. BMPs need to be tailored to site-specific conditions, work with farm-specific activities and practices, and be designed in consultation with local experts like Soil and Water Conservation Districts (SWCD). SWCD can also help with implementation costs by connecting farmers with cost-share programs.

While no single improvement project or adoption of a best management practice will improve all downstream issues, a combination of approaches and strategies throughout a watershed can make significant improvements. A watershed-based approach uses soil data, topography, drainage patterns and land use practices (e.g. tiled) to identify key areas for the adoption of best management practices. A watershed assessment and framework which focuses improvements at critical and high risk locations can assist in directing funding and key strategies within farm fields, off or below the field and along riparian corridors[6].

Local governments can play a critical role in building long-term commitment and support for the adoption of best management practices. This includes helping to find and secure cost-share options, which will build program interest and participation. Local governments also play an important role in helping to build support and information sharing networks amongst farmers and with other agencies.

A number of Natural Resource Conservation Service (NRCS) BMPs were evaluated for their ability to first attenuate flooding and second improve water quality.

Flood Attenuation

Use of best management practices that reduce surface runoff can increase landscape resilience during droughts and decrease peak streamflows during floods. While these benefits can be critical to farmers experiencing increasing climate variability they can also benefit downstream communities.

BMPs can be strategically employed to attenuate storm runoff at different stages within a rain event. As streamflow begins to rise, BMPs such as riparian buffers, well-placed ponds and wetlands, and conservation tillage practices can slow runoff from fields thereby reducing the peak in storm-produced streamflow. Floodplain reconnection can be very effective at reducing peaks as well, but only works during the highest flows of the storm. Several BMPs work well at any time because they increase surface roughness and good soil structure which increases infiltration rates and soil moisture content. These BMPs include reintegration of perennial vegetation on the landscape, such as CRP, extended rotations and cover crops, and conservation practices that help build soil quality, like no-till, cover crops, and perennial-based rotations[7].

Wetlands whether natural, restored or constructed may increase flood storage potential and allow for moderated release of water over time, playing a role in reducing downstream flooding. A literature

[6] Tomer, M.D., S.A. Porter, D.E. James, K.M.B. Boomer, J.A. Kostel, and E. McLellan. 2013. Combining precision conservation technologies into a flexible framework to facilitate agricultural watershed planning. 68(5)113A-120A.
[7] Schilling, K. 2012. Thinking like a “water farmer”: Part two. The Practical Farmer 27(4):25-27.

review by De Laney (1995) indicated that even a low ratio (10%) of wetlands to land area within a watershed may help to moderate a watershed's annual hydroperiod[8]. Uppershed wetlands while working in combination with wetlands lower in the watershed, may help to reduce flood episodes. To reduce surface water runoff from agricultural lands, communities could work with farmers to explore wetland restoration and other temporary flood storage options in upper portions of watersheds. Communities should also target lands at risk of conversion from agriculture to impervious development for these types of BMPs.

An analysis was conducted by Manale (2000)[9] to model anticipated economic benefits of paying farmers for temporary upstream flood storage, employing old wetlands and already soggy lowland depressions. It was concluded that upper basin storage made economic sense for 7 of the 8 modeled watersheds in Iowa. A similar analysis was conducted for North Dakota's Red River Valley, an area of about 1,600 square miles. That analysis found that of all the evaluated wetland restoration options, none were economically feasible at reducing flood damage[10]. However, they did recommend that localized flood damage may be addressed through simple wetland restoration of specific targeted sites. More recently, an analysis was conducted in the same Red River Valley watershed, evaluating the use of "micro-basins" created along roads, and other existing structures to temporarily contain flood waters on adjacent lands[11]. Flood water would be managed through modified culverts that would store and release water. This study concluded that it was cost effective at mitigating economic damage to flood events within the watershed, with \$125 million to \$707 million of net present benefits over a 50 year timeframe.

Other benefits may be realized through modifying current field tilling operations. Improved tilling practices help to keep water on fields longer, by retaining macropore spaces overtime. Rain and water is more likely to infiltrate these spaces within the soils, as opposed to rapidly leaving the field as sheet runoff, especially if the top two to three inches of soils are continually stirred[12].

While the research on flood attenuation best management practices is difficult to accurately quantify or put into economic terms, many of the approaches are prudent and provide additional benefits such as water quality improvements, which will be discussed below. A myriad of approaches can and should be implemented where feasible and practical. For example, addressing roof design, may have potential water runoff benefits. A study by Getter (2007)[13] demonstrated a significant difference in the amount of water runoff between vegetation types; with grasses being the most effective for reducing water runoff on a simulated greenroof. Plant species with taller height, larger diameter, and larger shoot and root

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[8] De Laney, T.A., 1995. Benefits to downstream flood attenuation and water quality as a result of constructed wetlands in agricultural landscapes.

[9] Manale, A. 2000. Flood and water quality management through targeted, temporary restoration of landscape functions: paying upland farmers to control runoff. Journal of Soil and Water Conservation 55(3)285-295.

[10] Shultz, S.D. Leitch, J.A. 2003. The feasibility of restoring previously drained wetlands to reduce flood damage. Journal of Soil and Water Conservation, 58(1)21-29.

[11] DeVuyst, E.A., D.A. Bansund, and F.L Leistritz. 2009. An economic analysis of the waffle. Journal of Soil and Water Conservation. 64(1)7-16.

[12] Reicosky, D.C., 2015. Conservation tillage is not conservation agriculture. Journal of Soil and Water Conservation. 70(5)103a-108a.

[13] Getter, K.L. Rowe, D.B., Andresen, J.A. 2007. Quantifying the effect of slope on extensive green roof stormwater retention. Ecological Engineering 31(4) 225-231.

biomass were more effective in reducing water runoff from simulated green roofs than plant species with shorter height, smaller diameter, and smaller shoot and root biomass. The amount of water runoff from *Sedum* spp. was higher than that from bare ground.

Water Quality Improvement

Because flowing water carries pollutants like nutrients and sediment to streams, pollutant export is closely tied to the rise and fall of surface runoff and streamflow. Therefore, many best management practices that reduce surface runoff, also provide water quality improvement benefits. While the benefits of BMPs for flood attenuation are nuanced and not as well quantified, management practices addressing water quality are much more developed and substantiated. A number of practices have been demonstrated to reduce soil erosion and nutrient inputs to waterways, including conservation tillage practices, various filter strips, and cover cropping. Some filter strips have shown reductions in sediment and nutrients up to 93%, while cover crops used in combination with improved tillage practices reduced sediment 41%.

Practices targeted at reducing nutrients to waterways are varied and range from tilling practices to cover crops and filter strips. The following review of peer-reviewed literature is not meant to be exhaustive but to demonstrate general degrees of effectiveness of different practices.

Tilling is the preparation of soil for planting and cultivation and there is a range of tilling practices. Conventional tillage uses moldboard plows, disc plows, and deep rippers. Ridge till, vertical till, reduced till, and stubble mulch lie in the middle of the tillage spectrum. Conservation tillage practices include no-till, which is the least disruptive to soils and has the greatest level of crop residue covering the soil, reduced-till, which increases the amount of crop residue on the soil surface reducing soil disturbance and compaction, and strip-till. Conservation tillage practices allow for increased water infiltration and reduced soil loss from wind erosion and surface runoff, which in effect keeps nutrients and sediment on the field. A study of tillage practices in Ohio and Mississippi demonstrated that infiltration rates increased due to increasing soil organic matter in no-till treatments. Runoff decreased due to the development of greater porosity in the near-surface zone attributable to enhanced aggregate stability (Fig. at the soil surface. Thus, surface sealing tendencies were diminished[14]. No-till was also found to increase mean soil water storage while fallow, in a wheat dryland production[15].

[14] Rhoton, F.E., M.J. Shipitalo, and D.L. Lindbo. 2002. Runoff and soil loss from midwestern and southeastern US silt loam soils as affected by tillage practice and soil organic matter content. Soil and Tillage Research 66(1):1-11.
[15] Baumhardt, R.L. Jones, O.R., 2002. Residue management and tillage effects on soil-water storage and grain yield of dryland wheat and sorghum for a clay loam in Texas. Soil and Tillage Research. 68(2002)71-82.

Figure 1. Individual soil particles are shown on the left and aggregated on the right. Individual soil particles are more readily sealed by rainfall which leads to less water infiltration, more ponding, and more erosion. Aggregated soils reduce surface runoff by storing water within interstitial spaces.

Cover crops as defined by the USDA is the practice of growing grass, small grain or legumes primarily for seasonal protection and soil improvement. They are used to control erosion, add fertility, build organic matter, increase soil infiltration, and have been shown to decrease nitrate leaching[16]. A study conducted in the Mississippi River Basin, looked at the impacts of complimentary BMPs (cover crops, filter strips, inlet pipes) combined with a range of tillage practices; conventional, reduced or no-till[17]. They found that cover crops and winter weeds reduced soil loss the most in reduced tillage, while impoundments were most effective when in combination with conventional tillage. In addition, due to its effectiveness when employing a no-till practice, only marginal benefits were observed for complimentary BMPs like filter strips. For example, cover crops performed the best at removing sediment (41% reduction) when used in combination with reduced tillage. In comparison, sediment was reduced by 34% in no-till, and 32% in conventional till.

A survey of Iowa farmers on cover crops indicated that while the majority (70%) of surveyed farmers agreed that the practice can reduce N and P losses, there was uncertainty on the risks to production and profit margins[13]. Another survey of cover crop practices demonstrated that implementing cover crop practices was most likely to occur on larger farms, for those who were able to pay someone else to oversee cover crops, where land was not rented, or where there was a supportive landowner. Discontinuance of cover cropping was found to be significantly higher when practices were self-funded (e.g. no cost share)[18].

[16] Arbuckle Jr., J.G., Roesch-Mcnally, G. 2015. Cover crop adoption in Iowa: The role of perceived practice characteristics.

[17] Yuan, Y. Dabney, S.M. Binger, R.L. 2002. Cost effectiveness of agricultural BMPs for sediment reduction in the Mississippi Delta. Journal of Soil and Water Conservation. 57(5)259-267.

[18] Dunn, M., Ulrich-Schad, J.D., Prokopy, L.S., Myers, R.L. Watts, C.R., Scanlon, K. 2016. Perceptions and use of cover crops among early adopters: findings from a national survey. Journal of Soil and Water Conservation. 71(1)29-40.

Filter strips and vegetative barriers are strips of vegetation that work to reduce sheet and rill erosion, trap sediment and serve as buffer between streams, lakes and wetlands. Vegetative barriers tend to be more permanent strips of stiff dense vegetation running along slope contours of 10 percent or less.

Fiener and Auerswald (2006)[19] evaluated grassed waterways over an eight-year period and found a 39% reduction of runoff and an 82% reduction of sediment. They also found that the economic returns were favorable. Robinson et al. (1995)[20] evaluated the width of filter strips and various slopes. They found a 3.0 m wide vegetative filter strip removed 70% sediment from runoff, while a 9.1 m width provided an additional 15% reduction. Reductions in sediment and soil associated contaminants of 76-93% were observed for filter strips, but were less effective at reducing dissolved contaminants (nitrate 24-48%; dissolved P 19-43%)[21]. While doubling the width of the strip improved water infiltration, it did not improve sediment settling, nor did the addition of young trees and shrubs within the strip.

A review of filter strips in Illinois found that both forested and grass filter strips reduced nitrate-N concentrations in shallow groundwater by up to 90%. Forested filter strips were more effective at reducing nitrate-N, but less effective at retaining total and dissolved P. While both forested and grass filter strips performed as a sink during the growing season, both released dissolved and total P to the groundwater during the dormant season; thus removal plant biomass may further reduce P during the dormant season. The review also documented that the filter strips were not as effective on fields with tile drainage. In those situations, constructed wetlands may be more effective. An evaluation of filter strips in combination with tilling practices did not find 33-foot wide strips to be cost effective for any tillage system and suggest using a 3.3-foot vegetative barrier in place of a filter strip[14].

Conclusions

As seen through out this appendix, agricultural lands are significant in size across our geography. They are often along water courses and thus are affected by and can affect water flows and quality. Local governments can kill many birds with one stone by enabling landowners to not only manage their land more efficiently and effectively but also reduce risks to downstream landowners by adopting BMPs that serve to slow down and retain water and sediment

Successful application and implementation of BMPs is dependent on a variety of conditions, which include crop rotations, length of time the practice will be applied, site conditions (e.g. soil types) and the combination of other BMPs. A best management practice or combination of BMPs should consider those conditions.

Documentation of observed benefits and responses often take many years to be fully realized. Gassman et al. (2010) suggest that it could even take a decade or two to observe detectable water quality effects

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[19] Fiener, P., Auerswald, K., 2006. Concept and effects of a multi-purpose grassed waterway. Soil Use and Management. 19(1) 65-72.
[20] Robinson, C.A., Ghaffarzadeh, M., Cruse, R.M. 1995. Vegetative filter strip effects on sediment concentration in cropland runoff. Journal of Soil and Water Conservation. 51(3) 227-230.
[21] Schmitt, T.J. Dosskey, M.G., Hoagland, K.D. 1999. Filter strip performance and processes for different vegetation, widths and contaminants. Journal of Environmental Quality. 28:1479-1489.

due to lag times[22]. This is especially the case with streams with high baseflow, excessive bank and channel erosion and existing significant sediment deposits. They suggest that results may be more observable in smaller watersheds, and that multi-year baseline data is ideal.

In order to remain functional and effective, many BMPs require periodic assessment and maintenance. The actual frequency depends on the practice in question, yet it is important to plan for and ensure that assessment and proper maintenance is taking place; financial support can improve the maintenance and regular operational evaluations. For example, in order for filter strips to work most effectively, laminar water flow, or sheet flow, is best[23]. However, this can be difficult to achieve in practice and does require maintenance. In addition, washed out herbicides may reduce the function of the filter strip requiring additional planting, while sediment may build-up and need to be addressed over time.

To increase the adoption of BMPs, policy makers and agencies, must have a better understanding of why current practices are not implemented in greater numbers. Lack of adoption of BMPs may come down to financial reasons, time constraints, product yields, or not having a complete picture of all the risks. Larger farms were found to more often, and more quickly adopt and continue best management practices as a way to reduce long-term costs or increase yields than smaller farms[15]. In addition, it often takes a number of years of experimentation to determine how best to apply a practice to realize its full benefits. For example, knowing the optimal time to terminate a cover crop may take a few seasons to figure out.

Farmers may be more willing to explore BMP options on lands that have water or erosion issues. Barren or fallow acres, fields on highly erodible soils (HELs), acres of short-season crops and fields that flood regularly should be explored.

Local governments could convene agriculture interests to build relationships with farmers and learn more about needs and concerns. Local examples of practices being successfully applied should be showcased. This could help to address the risks, concerns and uncertainties that may surround a particular practice. A number of literature resources point out that benefits are often well articulated for a practice, but further work is needed to address potential risks and uncertainties. This is where peer-to-peer learning can be very beneficial as well as well-messaged outreach materials.

Local governments should explore a role in facilitating long-term, cooperative and consistent efforts with farmers and other partners and agencies like Soil and Water Conservation Districts. Commitment will help to overcome instability in funding as well as other issues with implementation. Cost-sharing is critical in generating interest and participation.

[22] Gassman, P.W., Tisl, J.A., Palas, E.A., Fields, C.L., Isenhart, T.M., Schiling, K.E., Wolter, C.F., Seigley, L.S., Helmers, M.J., 2010. Conservation practice establishment in two northeast Iowa watersheds: Strategies, water quality implications, and lessons learned. Journal of Soil and Water Conservation. 65(6) 381-392.

[23] Kim, Y.J., Geohring, L.D., Jeon, J.H., Collick, A.S., Giri,S.K., Steennhuis, T.S. 2006. Evaluation of the effectiveness of vegetative filter strips for phosphorus removal with the use of a tracer. Journal of Soil and Water Conservation. 61(5)293-302.