EMC Climate Adaptation Committee Flood Hazard and Risk Survey

5/30/2018

Abstract: We performed a case study of flood professionals actively engaged in flood risk mitigation within Tompkins County, NY US, a community dealing with moderate flooding, to gage how much variance exists among professional perceptions of local flooding risk. Results of this case study indicated disagreement among flooding professionals as to which socio-economic losses constitute a flood, disagreement on anticipated community needs, and some disagreement on community perceptions on climate adaptation. In aggregate, the knowledge base of the Tompkins County flood practitioners provided a well-defined picture of community vulnerability and perceptions. Encouraging interdisciplinary flood mitigation work could reduce risk, and potentially better support climate adaptation within flood risk mitigation.

We concluded with several recommendations that would move Tompkins County towards establishing a method of collecting and archiving hydrologically important information on flooding events, as well as encouraging interdisciplinary work between flooding professionals.

1. Introduction and Background

Tompkins County has documented cases of riverine flooding over the past 30 years from Fall Creek (M. Thorne, city engineer, personal communication, 2015). Anecdotal discussions and interviews by EMC members with community leaders suggests that flooding issues extend beyond our documented cases, with some locations within Tompkins County potentially affected by flooding every year. Hydrologic boundaries often cross socio-political boundaries. Negative flood risk is all too often translated to communities which do not directly benefit from urban development in upstream municipalities. Further, many low-lying areas of Tompkins County are facing elevated flooding risks with limited resources to study these problems directly. The overarching goal of the EMC Climate Adaptation Committee was to collect information necessary for beginning a riverine flood hazard and risk analysis at the County level.

The first goal of our Committee in 2017 was to create a central database of historical flooding events to develop a more complete picture of flooding across Tompkins County. Knowledge of flooding hazards and risks in Tompkins County is currently spread across working groups in government, advocacy, education, research, and private industry as well as long-term residents. Ongoing flood mitigation efforts within Tompkins County have been focused on several well-known flooding problems. Realizing opportunities to design for multiple flooding problems at once first requires that all problem locations are well documented prior to hazard mitigation design.

The second goal of our committee's work was to document the flooding perceptions of community leaders in order to understand the degree of disparity in expectations. Mitigation efforts aim to reduce the current frequency or magnitude of flooding to some level deemed acceptable. Through 2017 the Committee conducted informal discussions with community leaders and flooding experts within Tompkins County. The first informal conclusion was that there was no strong universal definition of flooding, which could translate into poorly defined design goals. These preliminary discussions also suggested that there is a broad range of perceptions as to whether or not flooding is a problem, and a broad range of expectations with respect to what is an acceptable levels of flooding. Some individuals expressed a need for flooding to be halted completely, whereas others saw flooding as a natural occurrence with no required mitigation measures.

Finally, the Northeast US is likely to experience some climate variability in the future, necessitating a discussion of how flood mitigation practices should incorporate climate adaptation practices. Recent research suggests that there is large uncertainty in future flooding due to intensifying rain, changes in snow-melt dynamics, and potentially increasing drought conditions during summer. Simplistic analysis and decisions can become difficult in the face of highly uncertain problems, sometimes leading to inaction. The third goal of our effort was to better understand the level of knowledge and prior beliefs of community leaders with respect to climate change and the need to incorporate climate adaptation into the design of flood mitigation practices.

2. Survey Design

Informal interviews were conducted by the EMC subcommittee on climate adaptation with ten flooding professionals from January 2017 through August 2017 to understand what beliefs were commonly held by flood risk mitigation practitioners and which issues were of most concern. Common themes included: understanding where flooding occurred frequently within the county, understanding what socio-economic losses constituted a flood, concern about shifting flooding risk under climate change, potential disagreement

around the design goals of a county-wide flood mitigation project, and community perceptions of climate-flood linkages.

A questionnaire was distributed to community members who engage directly with flooding through development of policy and legislation, science and engineering, education, community outreach, and advocacy. Candidate participants were identified by the Tompkins County Environmental Management Council (EMC), the citizen advisory board to Tompkins County. A review of the final survey was performed by the Cornell University Institutional Review Board and found to have no ethical implications related to human participation.

3. Results

3.1 Survey Response Rate

The survey was distributed to 89 professionals, of which 48 responded (response rate of 54%). Individuals were asked to self-sort into one of six possible disciplines: community planning (n=8), education and outreach (n=7), local government leadership (n=8), policy (n=7), advocacy (n=9), and Engineering, Science and Research (ESR, n = 11). We first asked flooding professionals whether they believed they had a good understanding of flood risk mitigation, to which 53% indicated they had a strong grasp of the subject, 42% knew of a professional who could inform them, and 5% were not knowledgeable on the subject.

3.2 Community Leader Definition of Flooding

Exploratory interviews with community leaders suggested that there were 13 socioeconomic losses that individuals commonly used to define a past flooding event (Table 2). The survey presented these 13 possible flooding losses and asked flooding practitioners to define which types of loss constituted a flood. Professionals also had the option to write in their own preferred definition.

Table 1 – Results of which socioeconomic losses were considered a flooding event

Type	Description of Flood	Number of Responses
1	Loss of life	29
2	Damage to private structures	32
3	Displacement of people	34
4	Damage to vehicles	30
5	Damage to public property	34
6	Inundation of public roads	34
7	Flow over private property	21
8	Backed up culverts	25
9	Loss of streamside vegetation	29
10	Stream flow out of channel banks	31
11	Substantial erosion in the stream channel	24
12	Minor erosion in the stream channel	4
13	Any flow greater than baseflow	11
14	Write-in definition	4

No single type of reported flood was held common to all individuals surveyed (Table 1). The belief that negative flood consequences related to minor erosion in the stream channel and flow above baseflow constituted a flood was only held by a few respondents. Individuals in planning, government, and advocacy were more likely to hold a broad definition of flooding, whereas individuals in outreach, policy, and ESR tended to hold narrower definition of flooding (Figure 1). Approximately 50% of ESR responses opted to use a write in definition based on numeric description of flood frequency. For example "*any flow exceeding a 100yr or greater storm recurrence interval.*"

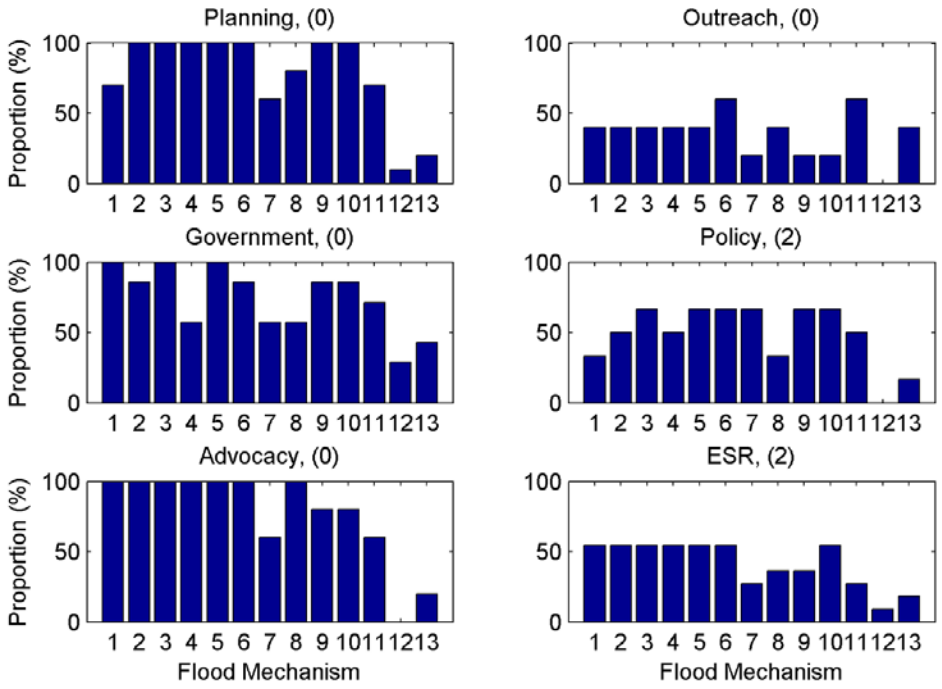

Figure 1 – Socio-economic losses that defined flooding events by discipline (Table 2 subset by discipline). Values in parenthesis indicate the number of respondents who did not offer an answer.

3.3 Spatial Distribution of Socio-Economic Flood Losses

Anecdotal reports of flooding were compiled to provide a spatial estimate of commonly flooded locations within Tompkins County (Figure 2). Anecdotal flood reports by community members demonstrate that flooding is a county-wide issue with the greatest flooding centered on the most densely populated areas. The reported locations of flooding cover substantially more locations in addition to the flooded areas established by the FEMA 100-yr floodplain map (FEMA 2018), particularly along smaller tributaries.

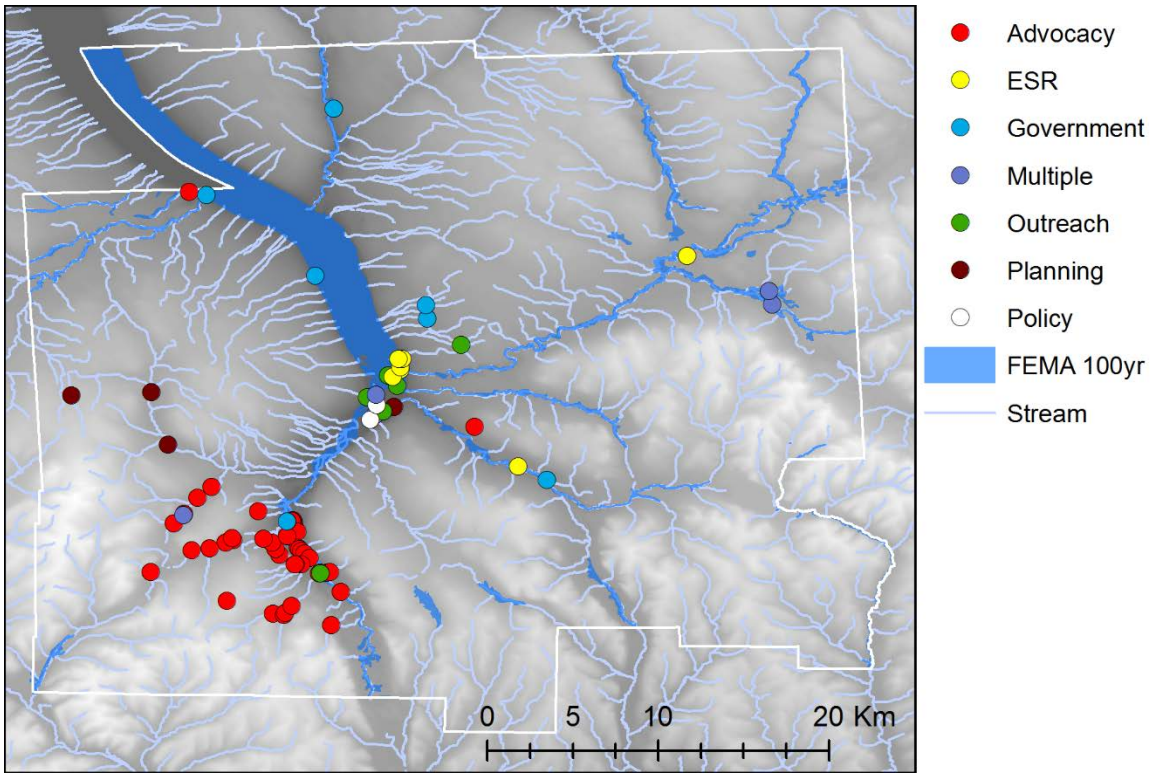

Figure 2 – Spatial distribution of survey reported flooding within Tompkins County (filled circles) and FEMA 100-yr flood plain (dark blue)

NWS flood stage on Fall Creek in Ithaca is estimated to be exceeded with a 9-year recurrence interval. Reported dates of flooding events (Table 2) suggest that for much of Tompkins County, professionals have collected information on negative socio-economic consequences from events that are hydrologically more frequently than the 9-year Fall Creek baseline.

Table 2 – Reported historical flooding events. Rainfall totals are the maximum daily precipitation (NCDC, 2018). Return periods are determined from NOAA Atlas 14 (NOAA, 2018).

Date	Rainfall (cm/day)	Return Period (yrs)	Weather Type
4/18/1905	1.2	< 1	-
6/3/1905	4.3	< 1	-
6/17/1905	4.6	< 1	-
7/3/1905	4.8	< 1	-
7/8/1935	20.0	> 1000	Local convective rain
11/3/1954	4.0	< 1	Hurricane Hazel
6/23/1972	9.0	10	Hurricane Agnes
10/28/1981	12.9	25	Local convective rain
1/19/1996	4.7	< 1	Rain on snow
9/8/2011	11.3	25	Tropical Storm Lee
4/3/2005	5.7	2	Rain on snow
1/11/2014	0.0	< 1	Ice jam release
6/14/2015	10.4	10	Local convective rain
7/1/2017	0.9	< 1	Local convective rain
1/12/2018	2.4	< 1	Ice jam release

Weather types assigned to each reported historical flooding event indicate that flooding has been induced by local extreme convective precipitation, tropical moisture derived precipitation, extratropical rain-on-snow / snowmelt, and release of ice-jams. Weather types for events prior to 1930 were not identified due to inconsistency among available sources.

3.4 Perceptions of Current and Desired Flood Frequency

Estimates of current flood frequency for Tompkins County varied slightly by discipline, however, most estimates were below the baseline flood frequency established for Fall Creek of the 9-yr event. The desired reduction in flood frequency varied considerably by discipline. The median ESR, community planning, and outreach response suggests that the expected flood frequency after mitigation efforts should be slightly higher than current flooding hazard (Figure 3). The median responses from governmental employees working on legislation and policy desired flood frequency to be reduced to the 100-yr event, suggesting a high level of disagreement between disciplines on anticipated outcomes of flood hazard mitigation.

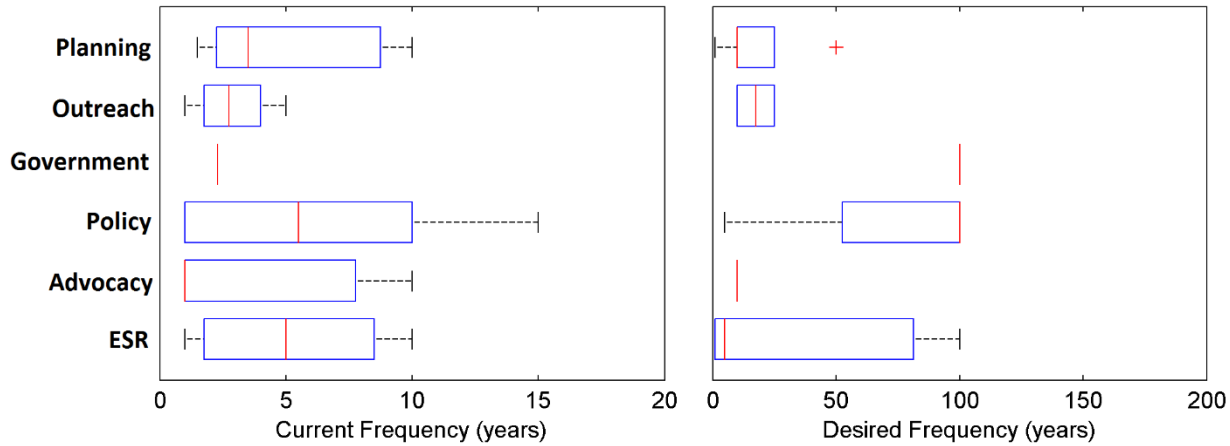

Figure 3 – Estimated a) current flood loss frequency and b) expected flood frequency resulting from flood hazard mitigation efforts

There was strong consistency in the perception of current flooding risks (Figure 1), though the spatial distribution of affected locations was highly individual (Figure 2). This result suggests that individuals within Tompkins County have a consistent understanding of the frequency of these socio-economic losses; however, there may not be a strong social network for communication of risks as knowledge was spatially constrained by discipline.

3.5 Perceptions of Climate-Flood Relationship

Anticipation of the need to incorporate climate adaptation into flood risk planning, as well as anxiety around "community perceptions" and "public opposition to planning for climate change" were common themes that emerged during the 2017 informal interviews. Flooding practitioners were asked which direction they anticipated future flooding risk within Tompkins County would move. The majority of individuals, 30, believed that flooding risk would increase, and 13 responded that they were not sure.

Table 3 – Perceptions of future riverine flooding risk within Tompkins County by flooding practitioners

	Not Sure	**Less Risk**	**Same Risk**	**More Risk**
Community planning	0	0	0	8
Education and outreach	1	0	1	5
Local government leadership	2	0	1	5
Policy development	3	0	0	2
Public advocacy	3	0	0	6
ESR	4	0	3	4
Total	13	0	5	30

Surveyed professionals were asked if they perceived a community desire to implement climate adaptation practices in flood mitigation planning. The result here was less clear, with 16 responding they were not sure, 7 probably not, 15 probably yes, and 6 definitely yes. There was some disagreement among disciplines on public preference for climate adaptation with ESR and public advocacy perceiving less interest, and outreach and government perceiving more interest (Table 4).

Table 4 – Perceptions of community desire to implement climate adaptation planning in flood risk mitigation

	Note Sure	Definitely Not	Probably Not	Probably Yes	Definitely Yes
Community planning	2	0	1	5	2
Education and outreach	1	0	0	4	0
Local government leadership	1	0	1	4	1
Policy development	5	0	0	0	1
Public advocacy	2	0	2	1	0
ESR	5	0	3	1	2
Total	16	0	7	15	6

We next asked practitioners to report their perceptions of the level of climate science knowledge of residents of Tompkins County. Results were divided with 14 responding that they were not sure, 16 believing that residents had basic knowledge, and 10 believe strong knowledge. Results were not substantially different among the disciplines (Table 5).

Table 5 – Perceptions of general community knowledge level of climate science and adaptation

	Not Sure	Little Knowledge	Basic Knowledge	Strong Understanding
Community planning	1	0	3	5
Education and outreach	1	0	3	1
Local government leadership	1	2	2	2
Policy development	5	0	1	0
Public advocacy	1	1	2	1
ESR	5	0	5	1
Total	14	3	16	10

3.6 Optional Write-In Responses

At the conclusion of the survey professionals were given the option to provide any additional information or thoughts on the topic beyond the survey responses provided. We summarize here the results of these submissions. Though we do not aim to interpret these results, they can offer important insights beyond what was captured in the survey questions.

Five professionals supplied optional comments in which they said that they had little knowledge of community perceptions and expressed difficulty in answering these particular questions, with one professional suggesting that community perception was perhaps too broad to accurately define by one single answer. Three responses suggested that they had a good understanding of community perceptions through involvement with county government and expressed that there was a willingness among the Tompkins County public to involve climate adaptation practices in flood risk mitigation. Four responses attributed recent flooding events to improper control of existing flood mitigation infrastructure by local, state, and federal government. One response listed the ecological benefits of flooding, and suggested that rather than seek mitigation opportunities to control floods, we seek to adapt human behavior.

4. Recommendations

4.1 Develop a Central Repository for Flooding Records: This survey demonstrates that there is no central database of flooding records for Tompkins County. Rather records, and important data, are divided across many organizations and individuals. Tompkins County EMC can potentially serve as this central database.

4.2 Develop Collection System for Reports of Recent Floods: Tompkins County should develop a call-in program where local flooding may be reported via phone or web. Collection of data nearest to the even in question will help to reduce loss of information through memory, and to help demonstrate the broader impact of flooding within the county.

4.3 Update the Tompkins County Hazard Mitigation Plan: The current plan contains few records of historical floods. This survey collected additional pertinent information that should be considered in future hazard mitigation planning efforts.

4.4 Develop an Outreach Program: There is no universal definition of flooding, flooding hazards do vary by location, and individuals have different preferences for flood hazard mitigation. Prior to flood hazard and risk reduction plans, there should be a discussion of these inherent differences among stakeholders who are working on this problem. Often these differences go undiscussed or unnoticed in the planning process, leading to difficulties and unexpected outcomes throughout the planning and design process. This survey presents results that should be understood and discussed at the outset of flood hazard mitigation projects within Tompkins County.

4.5 Host a Conference on Local Flooding Perceptions: The results of this survey indicate that professionals working on flooding with Tompkins County believe that they have a strong grasp of the subject, yet the survey responses indicated high levels of disagreement with respect to how we define a flooding event, where flooding is occurring, how often it is occurring, and what minimum level of protection should be provided. A discourse among decision makers of Tompkins County would help flooding practitioners recognize these differences, and hopefully provide a path towards more interdisciplinary work moving forward.

4.6 Inter-governmental / Agency Work: The EMC encourages the county to take up work that engages the towns and villages directly with respect to flooding hazard and risk mitigation.