



The
UNIVERSITY
of **VERMONT**



Winooski Watershed Flood Hazard Empaneled Focus Group #1: Technical Brief

March 22, 2023

On March 22, 2023, a group of professional emergency managers, regional planners, watershed and river managers, and town managers who work in the Winooski watershed of Vermont convened for the first of four empaneled focus groups. This first focus group centered on gaining better understanding of the most salient flood “hot moments” of most concern, the vulnerable “hot spots” where life, property and infrastructure is most vulnerable, and how risk communication, early warning and imminent threats are disseminated and received.

The specific purpose of the first empaneled focus group was to provide an opportunity to lay out the plan of action for the two-year period, identify key assets and issues facing the watershed, both physical and environmental, and discuss the relevant risk communication and coordination challenges and needs facing the region.

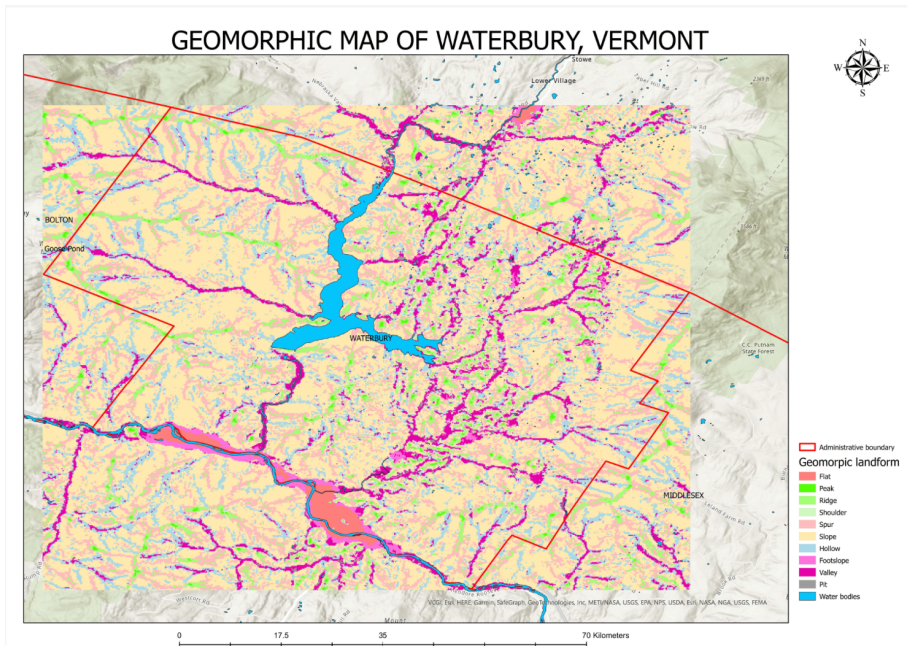
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Biggest flood hazard concerns in the region

The flood hazard concerns of the professionals convened focused on the unique characteristics of the region’s climatic, geomorphic, hydrologic, and development patterns. The region’s location in New England renders it subject to clipper lows, tropical storms/hurricane, nor’easters (weather systems following the coast), and the relevance of snow pack and changing freeze/thaw patterns in winter and early spring.

The mountainous topography provides for greater amplification of stream and river flows that cascade down from higher terrains, causing flash and erosive flood hazards. The development patterns in the region have cultivated settle patterns on valley floors, so locating residential and commercial properties with critical physical infrastructure (roads and bridges, energy, and commercial infrastructures).

Specifically, the types of weather systems and flood hazards identified by the focus group respondents include:

Given the region’s proximity to the Atlantic coast, **tropical storms** and **hurricanes** are a major threat to the region. Most participants were present for the 2011 late summer **tropical storm Irene**, that led to --- in property loss and cost 5 lives in the region. The damages caused by Irene were exacerbated by an extremely wet year, including widespread lake flooding caused by high snowpack and rapid melt off.

The prevalence of **clipper lows coming off the Great Lakes** can lead to substantial precipitation events.

Entraining thunderstorms in which precipitation rich thunderstorms stack up and follow one another in sequence, dumping large volumes of rain within a specific localized region, was seen as a major driver of flood events in this region, the most recent of which occurred in July 2017. This concern with entraining thunderstorms led one participant to mention that the National Weather Service can issue thunderstorm warnings, focusing on high winds and lightening, but miss the eminent flood threat. It was noted that the Green Mountains, particularly the western slopes, can exacerbate the volume of precipitation to fall within a localized region. These localized flooding threats impact smaller streams, some of which are adjacent to residents, and threaten lives and property. These scenarios are not well captured in flood inundation maps. The threats to travel on the region's back roads can be amplified by having "too much water, too fast on steeper roads and driveways."

The largest flood threat facing the region is **localized flash flooding**. These events or threats of these events may not reach federal emergency thresholds, and therefore not be folded into National Weather Service messaging.

Being situated in a northern climate, the region often faces significant snow fall, despite rising temperatures during the winter months. Still during some seasons, a significant snow pack is still possible. However, with increasing frequency, multiple winter season freeze-thaw- freeze cycles are increasing. These changing dynamics can lead to rapid snow melt off during **rain on snow events**. These events had been somewhat a routine happening during the early spring when temperature rises were more gradual. The most extensive rapid flood event accounted during the spring of 2011, leading to record lake levels in Lake Champlain. Climate change is altering these patterns, leading to abnormal warming, followed by the reformation of ice. In some cases, not necessarily in the Winooski Watershed, ice flows can lock in people in their home. Record setting temperatures during the winter month catches people off guard.

A major point of concern for specific segments of the Winooski Watershed, specifically the middle and upper reaches, face the threat of **ice jams** that are driven by freeze-thaw and rain on snow events. Ice builds up around bridges and other pinch points leading to localized and sometimes very rapid flooding, which can be very serious and localized.

The experts convened for this focus group stressed how they were less concerned about **inundation flooding**, which tend to be very rare occurrences. Tropical storm Irene in 2011 did have some inundation flooding, particularly around Waterbury and the Vermont State Complex. However, the bigger flood hazard, according to these experts, concerns **erosion** damage. Erosion along river and stream banks can have profound impacts on infrastructure, specifically roads, bridges, and dwellings. Stream bank erosion can also create **debris fields** from falling trees – especially in highly erosive stream valleys. These debris fields can move

and clog waterways generating localized flooding event. There are efforts underway to attempt to map and model the concentration of these debris fields.

When asked which flood hazard threat poses the biggest problem, **major dam failure** on Winooski River or its tributaries was cited by several as the most serious threat to life and property in the region. Discussion turned to tropical storm Irene and the potential for the breach of the Marshfield Dam. The need to have evacuation plans in place if any major dam breaks was cited. The Vermont Agency of Natural Resources has modeled catastrophic failure and done some planning in this regard. However, the scope of the event is large and holds extreme adverse consequences.

A secondary issue raised by a few participants concern the **social trauma** endured by those who have experienced catastrophic flooding and the anxieties future flooding threats can cause them. The positive impacts of this experience of trauma are that there is a shifted mindset, and an increased sensitivity to flood hazards, among some segments of the population. The challenge is that this heightened awareness is ephemeral as people forget or move on, replaced by newcomers who did not experience the extreme event.

A consistent message to be culled from this focus group concerns the fact that the **current hydrology and geomorphology of the region is changing**, in some cases, drastically. Criticism of existing flood hazard maps and products were said to not to be adaptive to these changing conditions. The challenge of these changes is that the watershed does not respond to flood hazards in predictable ways.

The participants stressed the everchanging nature of watersheds. And that these changes are exacerbated by the specific type of geomorphology and hydrology of the region. The everchanging hydrology of the region has been shaped by increases in major precipitation events seen in recent decades, the **consequences of climate change** which are leading to **changes in the intensities of streambank erosion**. The watershed scientists present stressed the emerging challenges of rising intensity of erosion leading to gullying and landslides, particularly in those regions where sand deposits side on beds of clay. *It was suggested that we need better data on where and why gullying and landslides are possible and the communicate those possibilities to the public.*

Hot Spot of Vulnerabilities in the Winooski Watershed

The Winooski Watershed may be understood as three distinct regions. The lower reaches of the river flows through the flatter Champlain Valley and into Lake Champlain. The reach includes a power generation dam and higher density development. Development adjacent to the river is limited, and it characterized by wetlands and adjacent farm fields.

The middle reach of the watershed is characterized by mountainous terrain with the river cutting through a narrow valley. Several major and minor roads run adjacent to the river. Networks of mountainous streams and brooks flow into the main stem. Several major towns,

including the state capital, Montpelier, and Waterbury lie adjacent to the river, with the majority of residential and commercial properties located in the watershed. Several dams and a major reservoir (Waterbury Reservoir) have been erected mostly for the purposes of flood control.

The upper reaches of the watershed are characterized by both mountainous and flatter valleys. It is sparsely populated, but subject to flash flooding and erosive dynamics.

We asked the focus group participants about the vulnerabilities for each reach.

Lower reach inundation or erosion issues?

- Elevated, sandy bluffs adjacent to rivers and streams
- Lake shore flooding
- Landslide areas
- Power dam is situated with heavy bedrock
- Stone cutting from Winooski dam had impacts on flood plain dynamics

New development taking into consideration flood potential dynamics

- Standards- some avoid no net new in-fill- but this varies by communities

There are significant building pressures facing the region.

Mid reach inundation or erosion issues?

- Roads adjacent to the river- impacted by erosion
- Many bridges subject to scouring
- Interstate running adjacent in pretty good shape- not vulnerable—railroad beds serve as a levee
- Most of the mid reach of the watershed is farmland—impacts what they grow
 - o Some vegetable and chicken farms had to close due to flooding events

There have been some property buy-outs in the region.

Town centers (Waterbury and Montpelier) situated in narrow bands of land situated on floodplains, adjacent to river coordinators and hemmed in by steeper slopes.

Upper reach inundation and erosion issues?

Biggest concerns in this reach are:

- Flash flooding threats
- Streambank erosion resulting in landslides, ice jams, and debris fields

Mapping and related flood hazard products

We sought to better understand how these content experts and end users of mapping and predictive tools generated by federal agencies and local researchers. The role of flood hazard maps, specifically from the Federal Emergency Management Agency (FEMA) took center stage.

We asked, what is the **efficacy of FEMA maps**? It was noted that these maps are inundation-centric (not erosion), which makes them less applicable to the types of flood hazards found in this region. It was also noted that FEMA maps can provide a sense of false security. “A lot of people are sitting outside of the FEMA flood lines but are still facing serious erosion challenges that can impact their properties,” commented one of the focus group participants. While another participant commented that, “FEMA’s concept of flooding is based on historical records and does help us understand what is here now, in order to avoid future losses and damage.”

It was recognized that new FEMA maps will be released shortly. However, these new versions are limited. For instance, the Mad River will be reconstituted with one-foot contours using a pre-Irene context. The new FEMA maps will provide for 2D Rain on grid modeling—which will reflect flooding in smaller streams. They will provide a portrait of where water deposits are and will model two different sized events. It was noted by one participant, that, “These new maps should be integrated into our new community conversations around flood hazards.”

Challenges with the 100 and 500 year flood message

The focus group participants were asked about their perceptions of the messaging around the “100” and “500” year flood used by FEMA and other flood risk managers. Several participants expressed concerns about the messaging, with one even commenting that the 100 and 500 year flood event framing, “is a terrible nomenclature.”

During Tropical storm Irene there were several examples of instances that exceeded 500 year flooding due to changes in geomorphic properties. It was noted that Irene was in the 50 year rain event range, but had 500 plus year flooding implications due to changes in stream bed or stream clogging factors.

Their was concern raised was that “Flood level and flood probability are not the same” and that there really needs to be a better characterization of high risk regions of the watershed. It was noted that we need maps that accommodate for the changing conditions of stream beds, etc. and that the current flood maps do not take these important nuances into consideration.

Regarding alternatives to the 100 v 500 year flooding messaging, it was suggested a 30 year mortgage standard be used, or move toward more grid flooding approaches.

Alternative ways of representing threshold?

When asked about the best alternative ways of representing flood thresholds there was a lot of interest in presenting risk warning as “binary,” e.g. “High risk” vs. “Low risk” and simply, “don’t go here,” type messaging.

The variability of some flood events was noted. One person noted, “In the smaller flood events you have situations where one house is covered in silt and people are not living in it and next door, someone is mowing their lawn.”

The challenges with representing the likelihood of flood events as percentages was noted. Presenting flood risk as a 1% chance per year is still problematic.

While those who have experienced recent flooding will likely have a heightened sense of risk. People move out resulting in turnover and new residents won’t perceive the risk the same way. Those experiencing recent flooding will be more sensitive to the recurrence intervals of flood frequency.

Use of NOAA FIMs and other NWS products?

We asked the participants about their awareness of NOAA Flood Inundation Maps (FIMs). Some were aware of them but indicated that NOAA has yet to fully roll them out. The Montpelier region is one of those areas not yet released, which is due to the availability of data, prior analysis and gauges available. NOAA will show predictive levels of a certain rain event. Yet, it is unclear how much these are being used. And it should be noted that the emergency management professionals involved in the focus group were not aware of FIMs.

Use of USGS gauge data?

At least one river manager mentioned the value of NOAA’s Snow cap maps. It was also noted out the United States Geological Service (USGS) river and stream gauges are of tremendous value. It was noted that the flood cresting graphs of NOAA, “are a nice tool but it’s a little general and it only captures where you are gauging... and it will not capture smaller flood events.” These products will give flood stage from where the gauge exists— but won’t capture cresting and flood stages at other points.

It was noted that you can get daily updates as a subscribed service, and that most emergency management officials locally are tapped into this and receive alerts.

Role of Regional Planning Commission’s and other’s products?

Several participants noted that they use the Vermont Center for Geographic Information (VCGI) to provide more accurate, updated maps. VCGI and the regional planning commissions’ GIS professionals can provide maps as needed with different data layers. It was noted that some

towns have map viewers. In addition, the Vermont Agency of Natural Resources “Atlas” was viewed as an excellent mapping tool to draw on. It was also noted that towns and residents have also started using Google maps quite extensively.

Communication structures / patterns prior to and during flood events

It was noted that the **National Weather Service** has the power to **push messages** to cell phones and that these are generally timely and useful. The watch officers at the Vermont Emergency Management (EM) office get more specific alerts from the NWS. The **Vermont Alert system**- a subscription-based communication system- is used to push out messages to the public.

Both NWS and VT Emergency Management (VT Alert) can push messages beyond subscribers to send notices to the general public- for flash floods. This feature is driven through reverse 911 to get to land lines.

Some complained that these alerts occur too often and are less relevant (such as a major crash on the interstate highway).

Listserv group messages that go out to professionals was noted as a useful communication device among the emergency management, natural resources, and town manager communities.

There is also the annual **spring flood watch event**- which provides NOAA forecasts for the season; information sharing; and demonstrates what can and can't be done.... These events are usually pretty well attended, particularly since they have been conducted online.

Periodic **conference calls** are used to anticipate potential flood events, which are usually also widely attended, particularly by town officials. Vermont Emergency Management usually organizes Zoom calls when a big storm is coming—blasted out to the towns, where NWS officials field questions. This engagement is viewed as very helpful by the town planners, police chiefs, fire chiefs attending.

Lastly, **Outages.com** is a tool support by utility industry and pretty popular.

Risk Communication

Door-to-door warnings and messaging?

These push notices were described as “invasive” in that a message to cell phones in very specific locations to warn of hazards. These types of messages need VT EM director’s approval (VT EM), while the NWS doesn’t have this approval process. Push notices can be very specific, for instance, Emergency management system can tell us to not drive across a specific flooded road.

In times of evacuation the Emergency Management Director holds the responsibility to issue evacuations. This often entails going door-to-door. This evacuation capacity varies with town capacity—some have full time EM people, others do not. Physical outreach to the general public and/or specific persons will vary drastically. One factor depends on whether towns have gotten hit recently with events or not. Those with recent experiences have paid more attention to building local capacity. The door-to-door warnings are coordinated through Select Boards or Fire Chief.

It was noted that when a storm approaches and these officials get briefings from two districts can lead to fatigue.

How does direct communication (door-to-door) messaging work and for whom?

Some communities know who their vulnerable people are- elderly, shut-ins, etc. and others do not. There are some nonprofits that are helpful in this regard- Community Resilience Groups that have taken it upon themselves to coordinate these activities, a form of citizen co-production.

In Vermont it was noted that often, “we do not have forewarning of flash flooding- dynamics can become very fast. And it was also noted that some messages don’t stick...”. Reflecting on the challenges with flood messaging, especially evacuation measures, one participant observed that during the 2011 Irene flooding, “In Waterbury, we had the fire department out a good hour before the flooding hit and people still ignored us, saying, well the river is all the way over there... and then they came back when the water was emanate and said, hey, if you stay, go to the second floor, but we are not coming back...”

It was noted that, “The warnings need to be ominous enough to get people’s attention.” In addition, considering **recurrence intervals of messages** and other communication efforts may be needed.

Flood watch vs. flood warnings?

When asked about the NWS watch/warning messages, there was recognition that these labels, watches vs warnings, was not intuitively obvious. An expert in this space admitted, with a chuckle, “I spend five minutes thinking which is which...”, while another added, “I still have to go to search the scale to determine which one is emanant.”

It was noted how “watches” may be sending the wrong messages, as one participant observed how, “Every time you are putting out messages that are not emanant, you are undermining the response” by undercutting the apparent severity of the hazard.

The use of color-coding during watch and warning situations was deemed as helpful, particularly in regard to providing a geographic and color coding scheme, which were deemed more effective than lists.

Uses of hydrographs- real time water tables?

Recognizing that there was a number of websites available to experts and the general public providing hydrological data (including USGS and NOAA products) a question arose, who uses these products from general public? Generally, it was noted that fishermen, kayakers, and people who have experienced flooding in the past tend to use them. As one person noted, “Unless there are watersheds that you look at frequently, you don’t understand the context.” Technically it was noted that providing some signaling in these graphs could be useful such as recurrence intervals pre-flow level. “By the time that those lines appear, it is too late,” one participant noted.

Recommendation for messaging to the general public and vulnerable populations?

It was suggested that the first question to be asked should be: “Is the content clear enough for the general public to make decisions?” One emergency manager commented, that was agreed with by many, that, “Your messaging should always have something about the consequences.... There needs to be a ‘so what.’”

Several participants again noted the importance of keeping messages simple and binary [high and low risk].

[*Need a matrix that lays out the types of events and the sources of information and messaging you need.]

It was noted that “Emanant” messages are pretty effective—radio alerts- “the tone” comes on, but also cell phone alerts - especially when others are getting pings in the same room. It was noted that email inbox messages are *not* effective. And that push messages should only be used when they are needed.

It was noted how these messages be parsed in order “to not cry wolf.” Subscription alerts should have differentiated settings for different types of hazards. As one participant noted, “Getting freeze warnings coming over the cell phone at 2 am in the morning...” is annoying.

It was suggested that “watch” signals are sending the wrong messages. “Every time you are putting out messages that are not emanant, you are undermining the response.”

Following prompts of two types of possible flood risk messaging several additional observations were offered. Messages must be “actionable.” There needs to be a suggested course of action.

It was felt that the more precision provided in the message, the more helpful. While contradictory messages should also be avoided such as “Move but don’t travel” type warnings.

It was also recognized that the sender of risk communication messages needs to take into consideration the prior knowledge and familiarity of the audience.

There was also some suspicion over the value of the message: “move to higher ground” and related messages that assume some level of familiarity with local topography. It was suggested that links to useful information sources should be provided in these text messages.

The matter of travel and flood hazards was noted. One of the biggest causes of flood death are due to people driving across flooded roads. Better refinement of messages relative to “You could be moving into a flooded area” type messages were needed. [Check to see if this level of targeted messaging is already being done?]

We asked about the potential value of using a consistent flood risk numerical and/or color coded scale, much like the Saffir-Simpson scale (category 1-5). There was interest in this idea. While the challenges with the current Cat 1-5 for hurricanes is that it only measures wind speed and not rain fall. A tropical storm dumping 15 inches of rain can be as bad or worse than a hurricane.

Do we need to advance the science and technology to be more precise or not?

One idea surfaced when our attention turned to the use of technology and science to better predict flood hazards pertained to the value of cell phone data. One could map using cell phones to find where disruptions are occurring, and where specific vulnerable populations are residing.

It was noted that the accuracy of some precision signals may not be there, but that it is better to warn and be wrong, than to not warn and be wrong.

There was a rich discussion of the trade-offs between the precision of technologically driven messaging versus generalized messages.

Generalized messages should include where to go, what to do. One emergency manager chided, “Don’t make someone have to rescue you...”

But then the need to craft messages for specific audiences was also needed. One participant commented, “You need to balance quick digestible message and they need to be multiple and tailored.”

The distribution of messaging across multiple media channels was raised as a consideration.

While, geolocated phone messaging needs to be specific, however, that “people not in that area (yet) need to know—whether loved ones or you are moving to that location...”

It was reiterated the need that messages lacking geographic specificity be avoided.

One participant noted that, “Too big of error bars with predicting flood events need to be taken into consideration both spatial and temporal uncertainty.”

It was also noted that there is a need to better understand channels of information and understand how people get their information. Different demographic considerations, such as those who are sedentary and traveling should be considered. It was recommended to send message to cars in roads adjacent to rivers.

Do we need improve the science of predictive capacities?

The availability of information regarding flood hazards for professional planners and watershed managers is good. As one participant noted, “technical information for technical needs—the information is great.”

However, it was noted by at least two participants that if we are looking at, “Systemic changes around managing watersheds.. more precision is not needed as much...”. There are fundamental principles of flood hazard mitigation that can be followed. Increased resolution and precision may give the impression that threats are avoidable or more readily managed, when in fact they are inevitable unless more fundamental actions are taken. This group was particularly amendable to “Vermont’s way” of managing rivers and streams—as naturally as possible.

On the need to calculate the true cost of flooding?

There was one area where more precision can be really helpful. There are known flood prone areas, and some of them are not readily apparent on available maps and hydrograph data. The discussion then turned to the issue of home flood insurance. It was noted that home in floodplains are generally cheaper, but added expenses could be catastrophically higher.

An issue pertinent to Vermont is the matter of identifying vulnerable places for fluvial erosion.

Mobile home communities are being approached, and conversations are being had about relocation without alternatives.

It was suggested to Include cost of housing premium on maps. However, flood disclosure is not required in Vermont.

The matter of long term homeowners who have paid off their mortgage and then decide not to pay a flood insurance premium was raised.

Major policy recommendations

“We want floods to show up in a lot of small places, so the floods don’t show up in Waterbury...”

It was noted by one participant that, “If we are trying to avoid systemic damage we need to bring people to a wider understanding of river systems. When things get reduced you fail to see the whole.”

It was also noted that, “We’ve been living with engineering standards of the last 50 years. Changes to geomorphology are radically changing those norms. We need to adapt.” One participant commented on how paving, culvert installations, and bridge maintenance practices still tend to follow 1950’s standards. These practices have evolved, but there is a strong need to **upgrade engineering standards** to meet evolving conditions. “Simply paving ditches” is not practiced anymore, but the standards haven’t caught up to practice. It was argued that federal agencies like FEMA need to help communities do what is right in terms of a changing climate. Historically, FEMA has given enough money to replace what is there, not make it better. That said, those FEMA standards have evolved and provide more allowance for rebuilding to more robust standards. It was noted that Vermont pushed for new standards that acknowledge updated river and bridge standards.

There was a strong perspective expressed by few of the river and watershed managers in the group of the importance to not let “spot fixes” or project-based interventions lead us to lose sight of more systemic needs. They expressed the need for a **stronger focus on river corridor management**. It was also noted that there needs to be **more clearly aligned flood hazard mitigation and clean water standards**. But, it was noted, that historical preservation standards are getting in the way of flood proofing (elevating) structures

In places like Waterbury, to mitigate flood hazard for the town, three areas have been identified to **reconnect floodplains to rivers for storage of the water**. Some of these areas are state owned but located in another town (Duxbury). State lands are available for these types of mitigations, but there is no champion to line up the money. It was noted that there was about “5 minutes of conversation about whether it could be taken by emanate domain, but the politics of it was too much. No one wanted to advance this.” If done, it would lower flood change by 1 foot during major flooding events. One participant with knowledge of the situation raised the question of “when and where is compelling state interest? This would require a huge amount of moving of earth. While a former Mobile home park in Waterbury was torn down and rebuilt new shotgun housing, elevated, but ideally this land should have been bought out and a park should have been developed in its place had federal funds lined up. There was nothing there to “buy-out” because all of the mobile homes were condemned.