The Nelson A. Rockefeller Center at Dartmouth College
The Center for Public Policy and the Social Sciences

Policy Research Shop

Vermont River Management Strategies

A Preliminary Survey of Existing and Potential Policy Options

Presented to the Vermont House of Representatives
Committee on Fish, Wildlife & Water Resources

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EXECUTIVE SUMMARY

Effective Vermont river management is vital to preserving the economic value of floodplains and waterways while reducing the damage to human property and life. Waterways are an important feature in the Vermont environment, and play a great role in agriculture, nutrient transport, recreation, transportation, and providing drinking water. These rivers can also cause extensive damage in communities and to local infrastructure during flooding events. The balance between utilizing this great resource and reducing its harm is essential to proper management strategies. These rivers are mapped and zoned through different federal, state, and local policies and regulations. While some policies have had great success in saving money and lives, policy improvements can enhance cost effective and sustainable strategies in Vermont. In order to develop effective management policies, it is important to first understand the economic values contained within Vermont floodplains. This report provides information on the foundation of Vermont river management in how the economic value of floodplains is assessed, how risk is determined, which government policies affect Vermont rivers, and what available methods exist to calculate the economic value of floodplains to better inform effective policy and management.

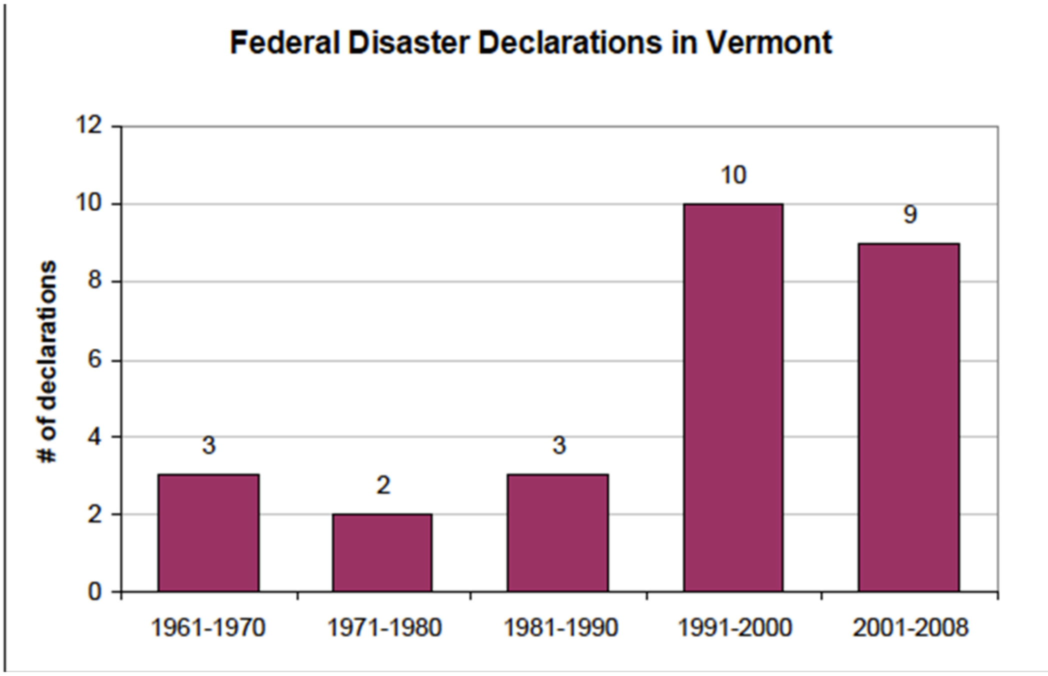
1. INTRODUCTION TO FLOODPLAINS

Vermont river floodplains protect necessary environmental and sustainable assets that benefit both local communities and ecosystems. Floodplains provide distinct services for healthy, thriving communities including "ground water recharge, floodwater retention and control, nutrient cycling, sedimentation control, recreation, and habitat for a diversity of species."[1] They also provide communities with easy and inexpensive access to water transportation. Because of these accessible, but exhaustible services, the National Flood Insurance Program (NFIP) and local and state governments are implementing policies to restore floodplains and the services they provide.

1.1 Economic Value of Floodplains

Floodplains contain many natural and human systems that make them valuable economies in each state. Their nutrient-rich soil allows agriculture to thrive and profit from marketable goods. On the other hand, without floodplains in these areas, the opportunity costs from flood damage, soil degradation, water pollution, and loss of biodiversity could be significant. Direct and indirect values are difficult to quantify. For example, flood control is measured "in terms of the avoided costs (prevented damages) of the flooding… dependent upon the ability to accurately measure the damages (e.g., loss of human life or property)."[2] Current estimates of flood damage to Vermont amount to more than $14 million a year, which include damages to transportation infrastructure and utilities. As seen in the table below, there has been a spike in the number of federal declarations in Vermont. With no recent changes in policy for floodplains and emergency responses to floods, the financial burden of future flooding will continue to increase in Vermont.

Table 1. Federal Disaster Declarations[3]



When analyzing a similar floodplain in Massachusetts, we can see a breakdown of basic costs. According to Paul Keddy, author of *Wetland Ecology*, the estimated economic value of flood protection for the Charles River basin amounted to approximately $33,700 per acre. The total economic value ranged from $153,535 to $190,009 per acre when pollution reduction, water supply, biodiversity, and recreation were added.[4] Though economically sound, restoring floodplains are beneficial to society, but there exists no financial incentive for farmers to preserve them.

1.2 Costs of Hurricane Irene

The severe impact of tropical storm Irene in Vermont caused extensive damage across the state. Vermont experienced its worst flooding of the century, with early-predicted costs of over $1 billion. That amount initially included $640 million for clean up costs and road repair, but costs were lowered to between $175 to $250 million due to roads being built with federal aid, therefore being eligible for more money. The aftermath of Irene included more than 500 miles of roads damaged or washed away and about 200 bridge that required repaired.[5]

2. ASSESSING RISK IN FLOODPLAINS

In order for any regional or state river management policy to exist, a level of risk of flooding must first be established. This section explores which parties are assessing flood risks and the methods by which they are doing so. It then discusses options for managing flood risk at a state level.

2.1 Flood Maps

Flood risk assessment is completed at various levels, including for local communities and for entire river basins. A range of experts and policy professionals complete risk assessments, including the federal government, local environmental agencies, and research institutions. The largest single group that compiles information about flood risks is the Federal Emergency Management Agency (FEMA), who compiles data into flood maps for the purposes of assessing insurance values for the National Flood Insurance Plan (NFIP). As such, these Flood Insurance Rate Maps ("FIRMs"), map out the entire United States for federal insurance purposes, while also helping regional planners prepare for disasters. FIRMs show the geographic and topographic location of rivers, the extent of the rivers during a 100-year flood, and the distance at which buildings can be placed away from the river in order to prevent damage in such an event.[6]

FEMA is currently in the process of switching all maps to a digital format, available to regional planners online or via CD. These maps are more detailed and interactive, allowing the user to zoom in or out of maps, and identify specific areas of risk more effectively than in printed maps. The methods that are used to garner the data for digital maps is the same as those for print maps, and have the same margins of error, though now they can be looked at on a smaller scale. This is a particular problem in Vermont because the maps are more precise in highly populated areas and less precise in less densely populated areas, including most of Vermont.[7]

FIRMs are the most comprehensive data that exist on statewide flood risk. Independent studies are sometimes done on river systems, particularly in rural areas such as Vermont. Occasionally, these are required by the Vermont River Management Program or by a regional planning commission. These organizations can petition to FEMA to update their maps by means of a Letter of Map Revision. These letters are usually to correct topographic discrepancies but may also petition a change in the 100-year flood mark or the distance buildings may be placed from the river.[8]

Approved by Congress in 2009, the process of creating new FIRMs will take FEMA five years, from 2010-2014. All results from the study should be available in digital and print, and are expected to be available in 2014. Should Vermont decide to adopt a new river management system, the state may consider using this timeline to coordinate its policy implementation accordingly.[9]

2.2 Methods for Assessing Risk

FEMA has outlined specific methods for assessing risk of a flood. Risk is expressed in a probability (from 0 to 1) that a flood will occur within a given calendar year. For example, the risk that a 10-year flood will occur in a given year is 0.1 while the risk that a 100-year flood will happen in a given year is 0.01. Floods of a given magnitude are measured on time intervals, called "recurrence intervals," or the average number of years between floods of a given magnitude or higher.[10] It should be noted, however, that floods of any magnitude are equally likely to happen on any given year.

A number of factors are considered when assessing past floods. These include:

- Stream-gauging records
- Rainfall records
- Recorded historical information
- Newspaper and personal accounts
- Botanical evidence (presence of new growth vs. old growth, scarring on trees, etc)
- Physical markings (placement of boulders, debris on shores, etc)

These accounts of magnitude and frequency of past floods are used to assess real risks for how large and how soon an upcoming flood could be. According to a training handout distributed by FEMA, "Flood flow rates (hydrology) and channel or floodplain characteristics (open channel hydraulics) are needed for engineering mathematical models. The end products are calculated flood levels for floods of various magnitudes and the transfer to maps or photographs to outline areas are subject to the occurrence of those floods."[11]

Hydrologists use a myriad of techniques when modeling the risk that a river poses to flooding in the future. The most common measures used are:

- Statistical analysis of stream-flow records
- Regional methods
- Transfer methods
- Empirical equations
- Watershed modeling

The risk management process required by FEMA incorporates these computer models for each community within a watershed. Through these processes, outlined in the diagram below, FEMA aims to reduce the risk of floods on major rivers throughout the nation, including in Vermont.

Figure 1: FEMA Risk Map Process[12]

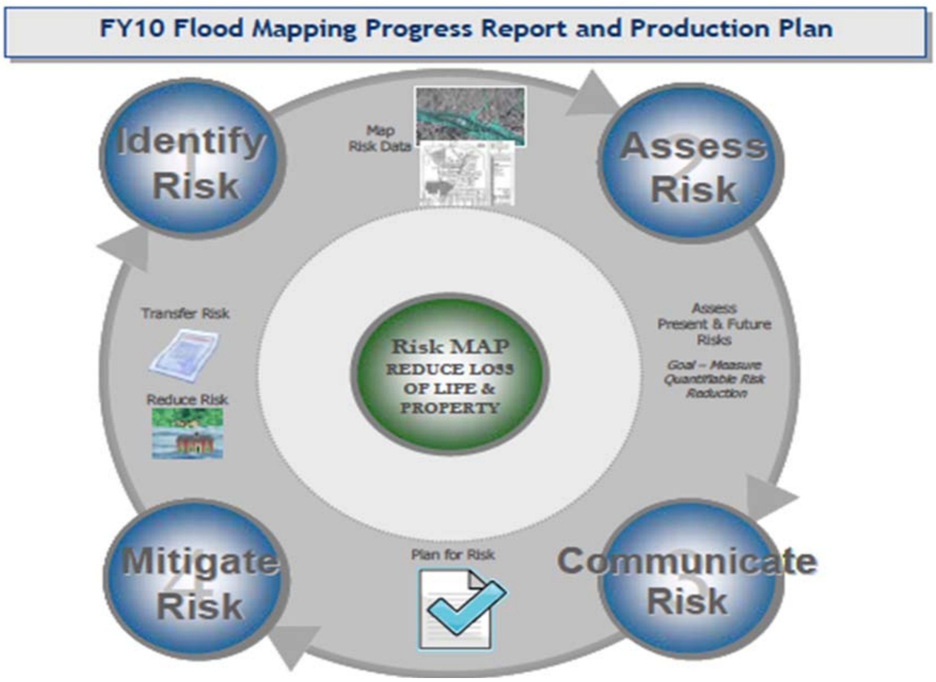


Figure 1. FEMA Flood Mapping Plan

3. POLICY AND MANAGEMENT OPTIONS

Floodplain management is a complex system of levels of government and agencies working together to ensure safe and sustainable use of river corridors and floodplains. Federal, state, and municipal powers coordinate through mapping principles, policy objectives, scientific research, and economic incentives to create and implement effective river management strategies.

3.1 Federal Level Management

The Federal Emergency Management Agency (FEMA) administers the National Flood Insurance Program (NFIP), with the mission of providing flood insurance protection to property owners in flood risk areas. NFIP produces detailed floodplain maps for waterways and provides a platform for communities to create river management guidelines. The NFIP is successful in preventing damage across the nation, with an estimated savings of $1 billion in flood losses every year. The U.S. Army Corps of Engineers also contributes to river management to prevent water pollution and flood damages. The Corps' main objective is to regulate dredging, filling, or obstructing waterways.[13]

The NFIP experiences success and failure in managing the development of buildings and construction projects in flood areas. In Vermont, only 200 buildings constructed in the last 20 years have not been constructed by NFIP standards, limiting the potential flood damage on thousands of construction projects. This is in sharp contrast to the number of communities that actually participate in the flood insurance program. Only 55 of 272 Vermont communities participate in the NFIP, causing flood-affected communities to lose millions of dollars in flood insurance premiums. The NFIP also does not prohibit the diversion of floodwaters or increases in erosive velocities, both of which can contribute to enhanced flood damages.[14] These policies are left to state and local governments.

3.2 State Level Management

The Vermont River Management System (RMS) manages flood hazards within the Department of Environmental Conservation (DEC). The RMS works with FEMA to ensure that the NFIP criteria are met within each participating community and that flood map and technical assistance is given when changes occur. Vermont Emergency Management (VEM) coordinates federal requirements for communities, but also helps to create and maintain emergency hazard mitigation plans. In addition, VEM provides emergency assistance and grant funding when disasters occur.[15]

In an attempt to improve the management practices of floodplains and waterways in Vermont, the DEC is in the process of establishing an integrated comprehensive flood protection and river restoration program under the River Management Program. The program has the following objectives:[16]

1. Reduction in the magnitude of property and infrastructure damage resulting from future flooding
2. Reduction in the cost of flood prevention, repair and recovery operations
3. Improved river system and watershed stability
4. Protection of both human investments and our state's natural resources

As a way to achieve these objectives, the DEC established the Fluvial Erosion Hazard Program (FEH) administered by the Vermont River Management Program to prevent and mitigate the erosion caused by the shifting of rivers and streams. FEH Zoning is not included in NFIP mapping zones, but causes most of flood damages in the state of Vermont due to its geography and development patterns. Because of this, FEH mapping is a central component to the Vermont River Management Program, which uses the Stream Geomorphic Assessment Tool (SGAT) to construct FEH zones from stream assessment data. FEH maps provide communities with a better sense of the danger areas for floods so they can adapt their management strategies accordingly.[17] Figure 2 shows the difference between the FEH Zone and the NFIP Minimum Requirement Zone. Once an FEH map zone is created (called the model FEH Area Overlay District), the community has the option to adopt the program. In order to ensure that communities take advantage of the River Management Program, the state is considering a number of incentive options that include: pass-through funds, educational support, grant money, and technical assistance to communities bearing the financial cost of these programs. By adopting the FEH program, communities will have increased protection from floods that could damage people, investments, and taxpayer public investments.[18]

Figure 2: The Different Areas Included in FEMA and FEH Floodplain Zones[19]

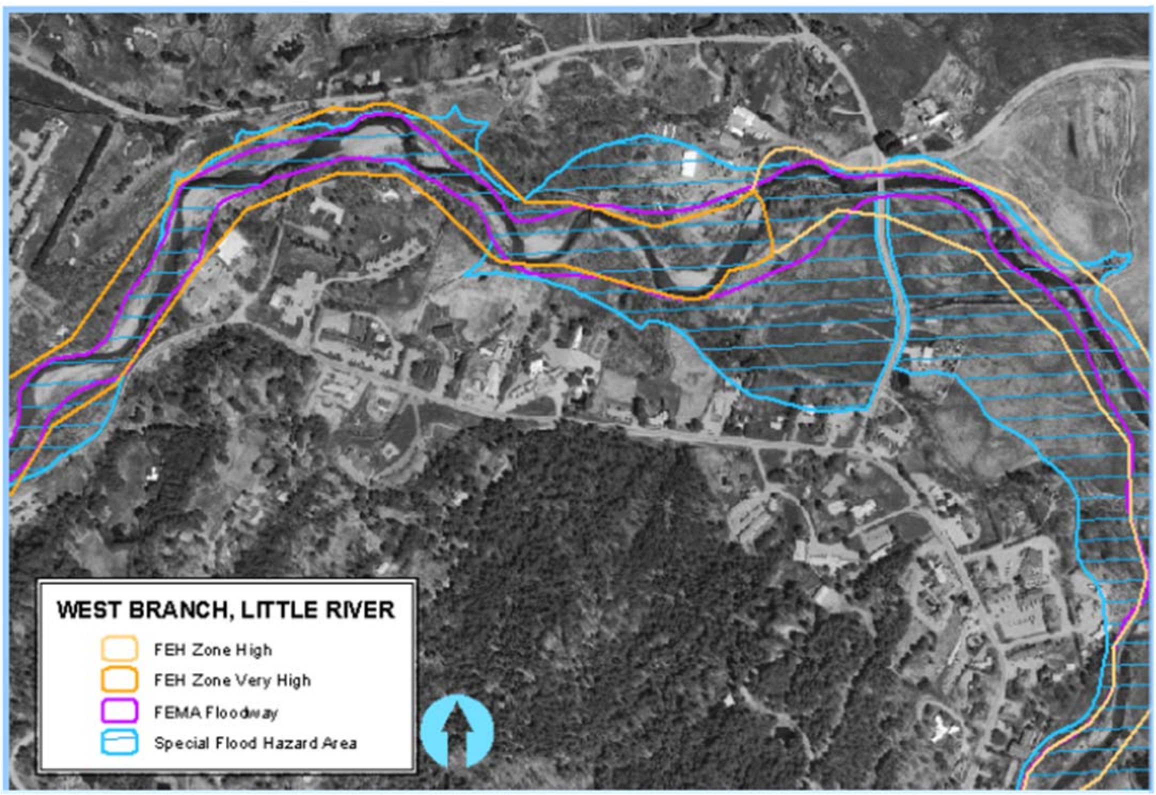


Figure 2. NFIP vs. FEH Map Zones

3.3 Community Level Management

In Vermont, municipalities are responsible for adopting all NFIP regulations and FEH standards. The Vermont Planning and Development Act encourages land development that promotes public safety against floods and other dangers. The Act also authorizes municipalities to regulate development along shorelines and in flood areas. This system has created a disjointed network of floodplain management strategies in Vermont.[20]

Because most municipalities in Vermont only adhere to the minimum criteria set forth by the NFIP, the Community Rating System (CRS) was established to provide incentives to communities to go above and beyond the minimum criteria for protection against floods. The CRS reduces flood insurance premiums depending on the certification level the community achieves. With the CRS, a community can evaluate its flood program compared to benchmarks set by FEMA, receive free technical assistance, and continue to receive program benefits as it maintains its flood program over the years. Currently, only a few communities in Vermont participate in the CRS program, leaving room for improvement and expansion of the program throughout the state.[21]

3.4 Community Policy Comparison

This sub-section compares policy management strategies in Vermont to those in King County, Washington, where flooding is a frequent occurrence and floodplains have high economic value. Some of the methods to determine economic value of floodplains in Section 4 of this report are adopted from methods used by King County.

Selection Criterion: The King County government offers a voluntary buy-out to flood-prone properties and structures as determined by the FEMA flood zone mapping. In general, any structure located in a flood-prone area of unincorporated King County is eligible for these programs, where properties with repetitive histories of flood damage and those properties identified as part of a project in the Flood Hazard Management Plan are given priority.[22]

Buy-Out Process: First, an independent appraisal is performed at the county's expense to establish a basis for the property's fair market value. At this point, the County and the property owner agree on a fair purchasing price. During the sale of the property, King County pays for all closing costs, with the exception of the Real Estate Excise Tax. At this point, the landowner leaves the property, the County removes the house, and native vegetation is planted. The house is then moved above the established 100-year elevation, which reduces the threat of any future flood damage. The new resident is able to remain on the property and preserves the County's existing housing stock.[23]

Funding: The buy-out process can be extremely expensive, considering the added closing costs and the fluctuating price of real estate. The elevation process typically costs King County approximately $90,000 per structure. King County has traditionally relied on both state and federal grants from FEMA and other agencies, which provide the opportunity to fund the program. A small amount of funding was also provided across the State of Washington from the Washington Emergency Management Division on a competitive basis. Additional funds are also made available after the presidential declaration of a disaster, which occurred in King County as a result of the December 2007 flood and the January 2009 floods.[24]

4. METHODS OF ECONOMIC VALUE ASSESSMENT

In order to manage floodplains effectively through policy initiatives and community planning, accurate assessments of the economic value of floodplains must be determined. Waterways and their associated floodplains are complex systems that can affect human development and ecosystem services in a variety of ways. Based on a review of best practices found in the environmental economics literature, this section presents four methods for assessing the economic value of floodplains. This section also describes how these models of determining economic value can be applied to a sampling of Vermont communities.

4.1 Employment and Payroll Model[25]

Employment and payroll are two of the greatest values in flood zone. To estimate employment levels and annual payroll for the floodplain regions of Vermont, an analysis of the major industries and businesses located within the floodplains must be done. After establishing what businesses are within the floodplain, a preliminary analysis of employment and payroll can be done for cities within the flood zone areas. This assessment includes citizens who are not able to travel to work from a flood zone or work in a flood zone area during a potential flood, expressing the total amount of productivity and payroll loss.

The method of assessing the value of employment and payroll in floodplains uses geographical information system (GIS) analysis. The geographical boundary map of the floodplains would overlay the employment and payroll data for each county, allowing for an analysis of employment within each floodplain compared to areas outside the floodplain. Information for this analysis can be obtained from FEMA flood maps, United States Geological Survey maps, US Census data, and from municipal governments.

<u>Brattleboro</u>

Brattleboro, VT is a town of 12,046 (population density, 373 people/square mile) in southern Vermont. Brattleboro is drained by the West River, but lies in the Connecticut River basin. Brattleboro has a large population and experienced severe damage caused by Hurricane Irene. Flooding especially affects Brattleboro because the downtown center of the city is developed next to streams feeding into the river and the river itself. Many commercial and residential properties are located inside flood zones established by FEMA. The economic value of Brattleboro's employees and their payroll within the floodplain could be calculated with this model. By combining the FEMA Flood zone maps and the business data from Brattleboro, a GIS map could be created to show the exact payroll and employee data from each flood zone area.

4.2 One-Day Flooding Scenario Model[26]

The One-Day Flooding Scenario model is a method for evaluating the potential short-run impact to a county-wide economy of a one-day work stoppage in the floodplain areas. This model would require Vermont to develop input-output economic models for the Vermont floodplains using IMPLAN software. Using these sub-county models and a corresponding economic model for all of Vermont, this model can estimate the impact of an economic shock—negative or positive—occurring within the floodplains. Assessment without software could include calculation of total loss of salary, business transactions, and transportation stoppages. The scenario being analyzed by using the IMPLAN software is a one-day shutdown of all business activity within a county or designated region. In reality, a flood event would not close all business, but this assumption shows the relative economic costs of a flood in each floodplain.[27] The analysis does not consider damage to homes, businesses, or public infrastructure, but rather the value of foregone economic activity.

The IMPLAN software incorporates environmental and economic data to model the effects of a one-day flood in a community or greater regional area. In order to do this accurately, a city would need to properly identify all of the commercial and residential properties in a given floodplain. Values must be assigned to these properties and accurate outputs (in dollars) of the commercial properties must also be made available.[28] This would have to come from the county clerk and through tax information provided on an annual basis. Each city or county would also need to provide environmental data about the floodplains and the history and severity of past floods. This information should be available through the Vermont Department of Forests and Parks.

4.3 Property Value of Residential and Commercial Real Estate

Property values of residential and commercial real estate represent one of the most significant values within floodplains. To estimate the price of commercial and residential real estate within different floodplain zones, FEMA flood maps available (on their website) show each flood zone and the likelihood of flooding in each zone. A comprehensive summary of all real estate prices can be identified through real estate agencies, insurance companies, and local governments. Municipalities can also provide information on value of properties within city limits and provide information on the zoning of building within different flood zones. Additionally, property value inside the flood zones could include roads, agricultural fields, train tracks, airports, and other elements of infrastructure.

GIS mapping analysis can also be used to show the value of residential, commercial, and public infrastructure values within different flood zone areas. Data can be found from the US Census, FEMA, and local governments and inputted into GIS Maps overlaid on each other. The different levels of the GIS maps make it easier to analyze the value contained within the floodplain.

White River Junction

White River Junction, VT is located in eastern central Vermont, along the Connecticut River. It has a population of 2,569 and population density of 1,558 people/square mile. White River Junction provides a unique look at where two rivers join: the Connecticut and White Rivers. Because the town is in a low-lying area between two rivers, the area has a higher chance of causing significant flood damage than other towns. Determining the economic value of the floodplains in White River Junction is more complex than other Vermont communities because of the interactions between the two rivers. The property value of real estate economic evaluation model would work well with this community because it is straightforward and offers concrete values. Using the FEMA and FEH Flood-zone maps with property values from the US Census data and real estate companies, a GIS mapping analysis would show the exact value of properties within each floodplain.

4.4 Consumer Costs[29]

Floodplains can be valued by consumers for a variety of reasons. Today, floodplains are valued for three reasons: non-use, indirect-use, and direct-use values. To determine consumer costs in the case of a flood today, it is necessary to determine how these three types of values affect consumers.

4.4.1 Existence Value, Option Value, and Bequest Value

One type of non-use value is existence value. Existence value can be defined as "the value of the continued existence of a non-marketable place or resource, independent of its value for human use."[30] An example of an existence value is the knowledge that an area of land is available to be enjoyed. Indirect values, such as existence values, cannot be measured directly and require valuation techniques such as contingent valuation. Contingent valuation is a technique used to place economic value on items without market value.[31] This method involves directly surveying how much a person would be willing to pay for specific environmental services. In some cases, people are asked for the amount of compensation they would be willing to accept to give up specific environmental services. For example, some people may value the existence of a floodplain for the ecological functions they provide rather than the economic benefit that can be derived by people. Another type of non-use value is option value. Option value is the value that people place on having the option to enjoy something in the future, although they may not currently use it (Food and Agricultural Organization of the United Nations). Similarly, bequest value is the value that people place on knowing that future generations will have the option to enjoy something. These values can also be measured using contingent valuation.[32]

4.4.2 Indirect Use Values

Indirect-use values can be defined as utilization of the positive externalities an ecosystem provides. Examples of indirect-use values of floodplains include groundwater recharge, nutrient cycling, sedimentation control, and floodwater retention and control. To measure indirect-use value, the "hedonic pricing" method can be used.[33] This method is typically used to estimate economic values for ecosystem or environmental services that directly affect market prices. The basic premise of the hedonic pricing method is that the price of a marketed good is related to its characteristics, or the services it provides. The value of the good can be determined by noting how the price people are willing to pay for it changes when the characteristics of the good change.[34] The hedonic pricing method is most often used to value environmental amenities that affect the price of residential properties. Contingent valuation can also play a role on measuring the indirect-use value of an ecosystem.[35] When measuring indirect-use values it is important to consider trade-offs. Trade-offs are a measure of an opportunity cost which is the net benefit foregone because the resources providing the service can no longer be used in their next most beneficial use.[36] Trade-offs are important in this model because a floodplain must be assessed in its value developing the land and its value in conserving it.

4.4.3 Direct Use Values

Direct-use values stem from the immediate utilization of the ecosystem. Examples of direct-use values include recreation and tourism, fishing area, agricultural and grazing area, property for homes and businesses, and organic material use. Direct-use values are tied to market price. In other words, market price indicates the value put on the direct use of the ecosystem.[37] This applies to commodities like food, timber, and water, as well as entrance fees to a protected area for education purposes and fishing licenses for recreation. To capture true direct-use values, the costs of externalities must be accounted for. Externalities are any cost or benefit not included in the price of the good. The problem with negative externalities is that the ecosystems they are imposed upon are generally not compensated for the damages they suffer and thus true cost is not reflected in economic price.[38]

Fairlee

Fairlee, VT is a town of just less than 1,000 in eastern Vermont, on the Connecticut River. Fairlee was chosen because although it is near three different bodies of water – the Connecticut River, Lake Morey, and Big Brook – it was relatively unscathed after Irene. This will serve as a case study for towns in which multiple water sources of multiple types (moving and non-moving) affect floodplains. Fairlee also is a popular destination for many tourists throughout the year that visit the area for the lakes, rivers, and recreation the town offers. This would is an ideal case study town for these methods because a survey could be given to not only residents of the community, but also to tourists to determine what the existence, option, bequests, direct and indirect use values of the floodplains in the area. This survey would reveal the value that visitors and residents place on the floodplains in their travel and daily lives. Many Vermont communities rely on tourism from visitors enjoying the natural environment, so the values of how much people are willing to spend to conserve the floodplains as a part of river and lake systems is important to determining economic values.

5. OPTIONS FOR VERMONT

This section offers an analysis of the costs and benefits of each economic evaluation model presented in Section 4 as it applies to Vermont communities. A brief description of the feasibility of each economic evaluation model is also discussed.

5.1 Employment and Payroll Model

The employment and payroll model can be used very effectively with GIS Mapping software to determine accurate and up-to-date economic values within floodplains. This model would require collaboration between FEMA, County governments, and the US Census to collect and combine the data into useable GIS Maps. This data may be difficult to collect in some counties as flood maps may not be available in sparsely populated regions within Vermont. GIS experts are also needed to create these maps and interpret the results of the economic values in different regions. The benefits of using this model is that much of the data can be easily collected from government resources (online or through their offices) and can be interpreted by someone with experience using GIS Maps. This should be a relatively simple and straightforward way to determine a primary part of the economic value within floodplain regions in Vermont. This method would be ideal for cities with higher populations that contain downtown centers within floodplains or other industries located along waterways. The Vermont Department of Environmental Conservation has the capability to evaluate the economic value of riverways using this model with their current mapping systems and access to business data from local communities.

5.2 One-Day Flooding Scenario

The One-Day Flooding Scenario model is heavily dependent upon the successful implementation of IMPLAN software. According to the company's website, the appropriate software would cost approximately $150 per county. However, the real cost to the software is the data that must be collected in order to run accurate models. This data collection would involve collaboration between the Vermont Department of Forests and Parks and county clerks across the state. Thus, the modeling is feasible, but may be time consuming given the size and scope of the data collection required.

This model would involve a high level of cooperation between the departments specified above and a significant amount of data that may not be readily available. Collection of such data would involve significant time and financial resources, including costs of staff in collecting and interpreting data. As King's County has reported, the IMPLAN software is effective and does a sufficient job of modeling the effects of a one-day flood. It is also unique in its incorporation of the economic and environmental effects of a flood. This model would also best be implemented in areas with higher populations and high economic productivity, so the cost of using the software gives the benefit of providing accurate and usable data for a larger region. Smaller communities would not benefit from using IMPLAN because the economic data is small and sparse, which makes the model ineffective. The Vermont River Management Section within the Vermont Department of Environmental Conservation would be able to acquire this software and have the experts necessary to input and interpret the data.

5.3 Property Value of Residential and Commercial Real Estate

Assessing property value within floodplains is similar to the employment and payroll model, and can be incorporated into the same GIS Mapping system. The additional layer needed when assessing property values in a GIS Map is the real estate prices and costs of the destruction or repair of those properties. Again, collaboration is necessary between FEMA, the US Census, and local governments to collaborate on assembling the data on both commercial and residential property values. For Vermont, this data may be difficult to acquire and interpret, where GIS Maps and property value data may not be present. Once inputted into the GIS Map, it is possible to conduct an analysis of the exact values of different properties within the flood zones. This model can be used as a base for determining the total economic value of floodplains. This model suits every community equally and is the best used for a majority of Vermont towns. The highest values in most communities within floodplains will be property values, and these can be calculated relatively easily through the GIS maps. It is also not as complex as other models, so towns themselves can compile this data and submit it to Vermont state agencies or even use volunteers to collect the data. The Vermont Department of Environmental

Conservation could act as the leader in collecting this data and compiling total economic value of properties within the different floodplains. This agency also has the capability of evaluating properties within different riparian zones because of their recent work determining the affects of different riparian zones with waterways.

5.4 Consumer Cost Models

Non-use values are measured by contingent valuation and willingness-to-pay. Some costs of this model are that these methods rely on surveying people and thus fall vulnerable to the weaknesses of survey methods, including information bias, embedded effect, ordering problem, lack of participation and low response rates, lack of context, and inability of respondents to always tell the truth. More specifically, the contingent valuation model assumes that people understand the good that is in question and will reveal their preferences in the contingent market just as they would in a real market. Information bias may arise whenever respondents are forced to value attributes with which they have little or no experience. Also, some researchers argue that there is a fundamental difference in the way that people make hypothetical decisions relative to the way they make actual decisions. Respondents may also make associations among environmental goods that the researcher had not intended. For example, if asked for willingness-to-pay for improved visibility through reduced pollution, the respondent may actually answer based on the health risks that he or she associates with dirty air.

Some benefits of measuring non-use values is that this method accounts for all external values not included in the market price. Additionally, the model is flexible in that it can be used to estimate the economic value of virtually anything. Finally, the nature of contingent valuation studies and the results of these studies are not difficult to analyze and describe. Dollar values can be presented in terms of a mean or median value per capita or per household, or as an aggregate value for the affected population. This model is more difficult to implement and represents more costs because it would require staff to conduct surveys over the phone or on the ground to residents and visitors within each community. This model also does not provide as concrete of economic values because of the bias associated with these models and each person's opinion of values.

As noted previously, indirect use values are measured through hedonic pricing. Some limitations to the hedonic pricing model are that the scope of environmental benefits that can be measured is limited to things that are related to housing prices. Additionally, the method only captures people's willingness to pay for perceived differences in environmental attributes, and their direct consequences. Thus, if people are not aware of the linkages between the environmental attribute and benefits to them or their property, the value will not be reflected in home prices. Some advantages to this model are that it can be used to estimate values based on actual choices. Additionally, property markets are relatively efficient in responding to information, so can be good indications of value.

Property records are typically reliable. Data on property sales and characteristics are readily available through many sources, and can be related to other secondary data sources to obtain descriptive variables for the analysis. Finally, this method is versatile, and can be adapted to consider several possible interactions between market goods and environmental quality. There are challenges to implementing this model effectively: it is relatively complex to implement and interpret, requiring a high degree of statistical expertise. The results depend heavily on model specification and large amounts of data must be gathered and manipulated. Finally, the time and expense to carry out an application depends on the availability and accessibility of data.[39]

Direct-use values are directly tied to market price making this value very feasible to measure. Some of the costs of this model are that it does not consider external costs, any costs or benefits not included in the market price. Such costs include loss of ecosystem function, or pollution. This model allows for data to be collected easily and efficiently because the direct use values are often readily available. The Vermont Agency of Natural Resources would have the capability of using this model to determine economic values because it employs qualified experts on natural resources, pollution, and ecosystem functions, and already possessing information and publications on the values of different river systems and floodplain areas.

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