Stream Channel Migration of the Mad River

Lindsay Jordan, Department of Geography, University of Vermont
Elizabeth Olliver, Department of Geology, University of Vermont
Faculty Sponsor: Dr. Beverley Wemple, Department of Geography, University of Vermont

Abstract

Rivers are constantly changing their shape through everyday erosion, seasonal changes in flow, flood events and changes in the land use on their banks. Significant changes in a stream channel can cause damage to roads, homes and businesses located along the channel. The pattern of settlement and topography of Vermont puts Vermont's infrastructure at a high risk for potential damage from flooding and erosion. Like many Vermont Rivers, the Mad River has undergone great change in the last few decades. This study uses the combination of aerial photography, GIS and River Geomorphic Assessment (RGA) data to determine if there are specific locations along the Mad River that are more susceptible to change. We were able to identify a number of places that are more vulnerable to change, calculate the magnitude of that change and compare these locations to RGA data for each reach. This information could be used to help predict how the river will behave in the future, changes in soil mobility, and what locations might be more dangerous to build on.

Methods

Historical imagery for this project was selected based on availability and proximity to recent flood events, which were identified using hydrograph data (Figure 2). The imagery from 1995 is an orthophotograph acquired by the Vermont Mapping Program The 2003, 2008, and 2011 imagery are all NAIP collected by the USDA.

The imagery was used as a visual guide to digitize the river into separate polygons for the stream channel, point bars, and islands. Unions were then created between consecutive years to show the transitions between channel features in each pair of years. A Union was also created between 1995 and 2011 to show the total change over the time period studied. The Select By Attribute tool was used to isolate specific types of change within the union layers and tables were constructed to show the total area of each type of transition. Floodplain to floodplain was left blank in the tables since the extent of the floodplain was not digitized.

A 60m buffer was generated around the centerline of the Mad River, which contains the locations of the reaches of the Mad River (i.e., M01, M05). Unions were created between this new layer and each of the unions of the consecutive years, allowing us to calculate change by reach for each set of years.

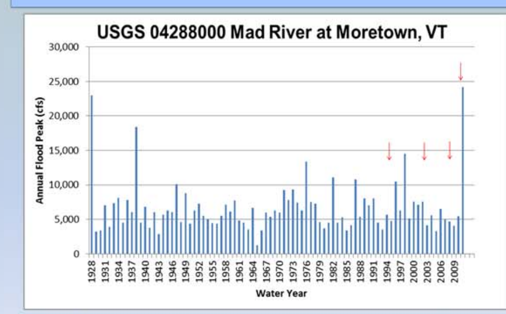

Figure 2 – This graph displays the hydrograph data used to identify recent flood events and select appropriate sets of photos to bracket them. Red arrows indicate photo years.

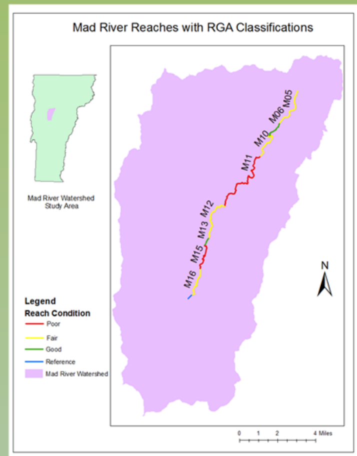

Figure 1 – This map displays the extent of the Mad River watershed, our study area, which is 144 square miles. The portion of the river studied for this project was 2616 meters in length and ranges in elevation from 535 to 860 feet above sea level.

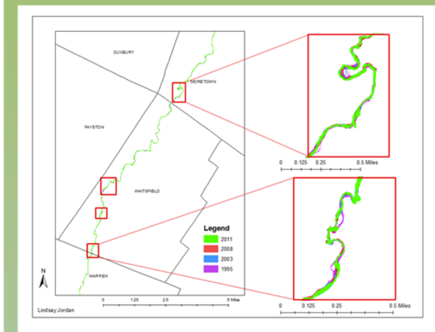

Figure 3- This map shows the sections of the Mad River study area that were selected based on visual examination of the channel overlay. Moving north to south, the boxes represent M09 and M10, M12, M13 and M15.

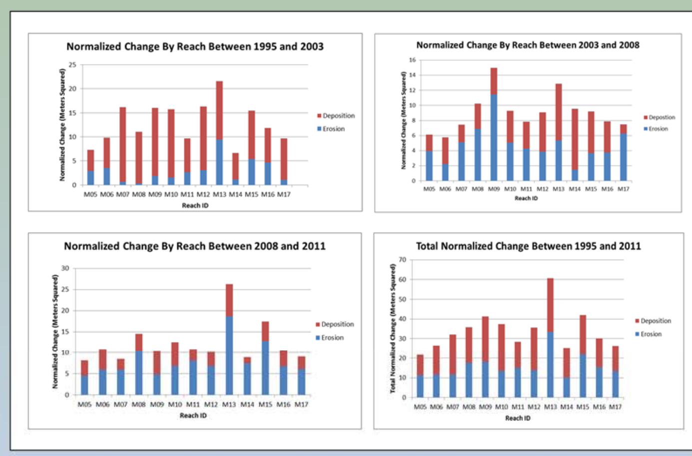

Figure 4 – Graph A displays the total normalized change by reach for the Mad River from 1995 to 2011. Graphs B,C, and D break the data from Graph A down to show the normalized change by reach for the year pairs of 1995-2003, 2003-2008, and 2008-2011.

Results

Through visual inspection of the stream channel overlays, four sections of this portion of the Mad River were identified as regions vulnerable to change (Figure 3). These sections were located where reach M09 meets M10 and within reaches M12, M13, and M15. The calculation of normalized change by reach (Figure 4) provided similar results. Reach M13 displayed the most change over the entire study period, followed by reaches M15, M09, M10 and M12. The reach M09 is short, but begins showing channel change right before it turns into reach M10. The majority of the change that occurred between 1995 and 2003 was depositional (77%). The change that occurred between 2003 and 2008 was 54% erosional and 46% depositional. Between 2008 and 2011, 67% of the change was erosional and 33% was depositional. Overall, the change during this study period (1995-2011) was 47% erosional and 53% depositional. With the exception of reach M09, the reaches identified as vulnerable to change through this study were classified as either "fair" or "poor" by the River Management Program. Reach M09 is confined by bedrock for the majority of the reach, but shows change right before the end of the reach. M10 is classified as "fair" and has gravel bed material. Reaches M12 and M13 are classified as "fair" and also have gravel bed material. M15, which showed the most change in this study, is classified as "poor" and also has gravel bed material.

Conclusions

From this research, it can be concluded that this method of identifying locations of change or vulnerability to change could be used as a preliminary method of analyzing stream dynamics without having to perform extensive field work. The locations identified in the results section are susceptible to change and should continue to be monitored. The 2008-2011 time period, which experienced record flooding during Tropical Storm Irene, displayed more change in the course of four years than the other two time periods experienced in the course of eight and five years respectively. Preliminary analysis of the data suggests that sections of the river that have gravel bed material and are not confined by bedrock are more susceptible to change. This data can be used to further examine what conditions are conducive to channel change and why change happens where it does.

Acknowledgements

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