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Exploring pathways to transformations in post-disaster-event communities

A case study on the Mad River Valley, Vermont, USA

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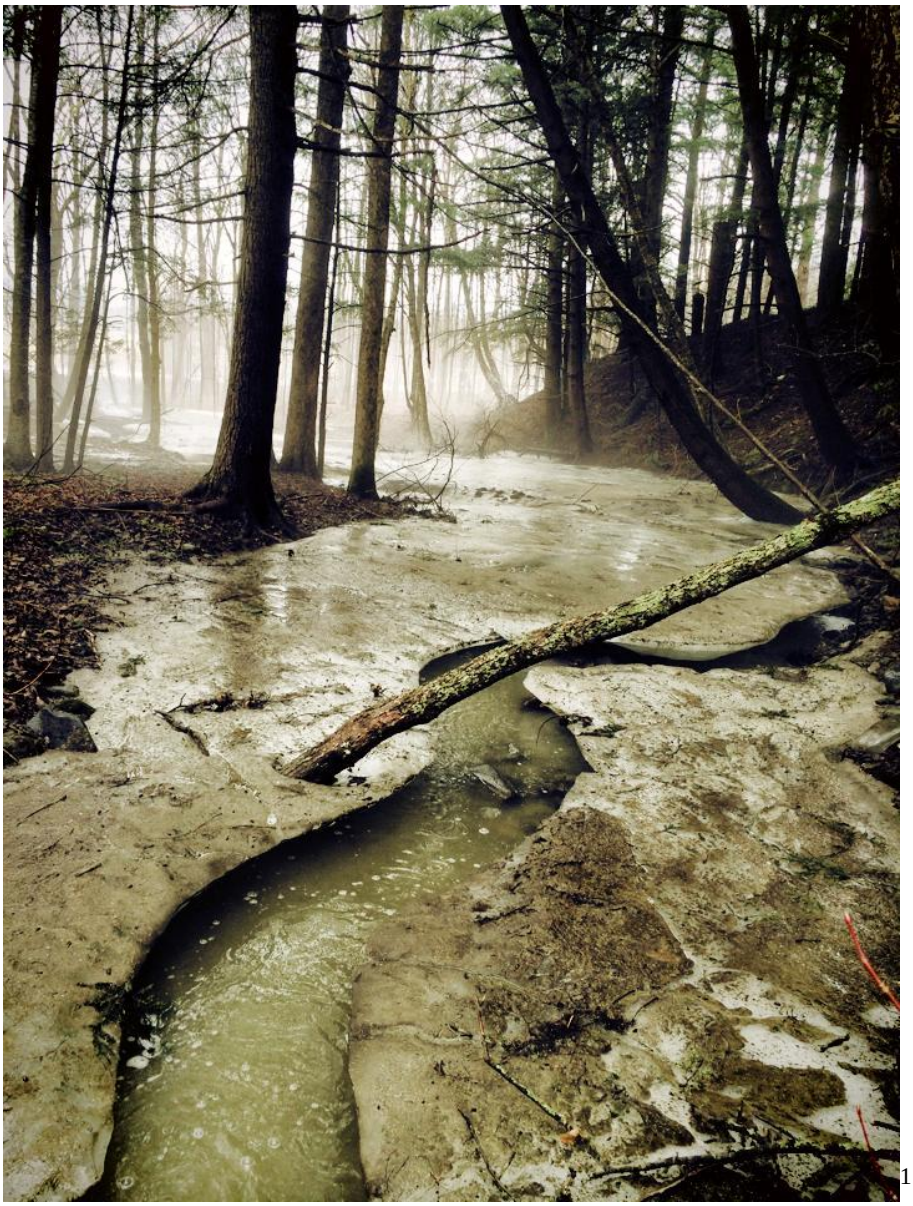 [1]

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[1] Photos used by permission from an interviewee in this study, to whom I am also deeply grateful.

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ABSTRACT

Climate change is already having a powerful effect on many areas through superstorms and flooding events. The flooding from tropical storm Irene in 2011 took Vermont by surprise, sparking momentum for change. While adaptive capacity as a response to climate change is vital, in many cases it may not be enough. This thesis developed an analytical framework for assessing transformative capacities from a linked social-ecological system perspective. By combining the literatures of transition management and resilience transformations, a cohesive framework emerged, with a scope incorporating multiple interacting scales and phases of transformation.

The findings suggest a multiplicity of capacities are activated in a post-disaster setting, with networks, bridging organizations, and leaders as primary for restorative, adaptive, and transformative capacity activation, while innovation and obstacle negotiating as primary foci for informal networks and experimentation. Broadly, the framework when applied spatially (multi-scale) and temporally (multi-phase) was effective in uncovering dynamics of change processes. Additionally, a foundation of social, economic, and cultural aspects was shown to be influential in the development and mobilization of capacities, including community resilience, place attachment, and the long-term viability of the economic sector. This study makes a theoretical contribution by linking transitions and transformations literatures in a single framework, which can be tested in further studies.

List of Acronyms

ACCD	Agency for Commerce and Community Development
ANR	Vermont's Agency of Natural Resources
CAS	Complex Adaptive System
CSA	Community supported agriculture
EPA	Environmental Protection Agency
FEH	Fluvial erosion hazard
FEMA	Federal Emergency Management Agency
FMR	Friends of the Mad River
FPF	Front Porch Forum
IE	Institutional Entrepreneur
ISC	Institute for Sustainable Communities
MRFH	Mad River Food Hub
MRLTRG	Mad River Long Term Recovery Group
MRV	Mad River Valley
MRVPD	Mad River Valley Planning District
MRWCP	Mad River Watershed Conservation Partnership
NGO	Non-governmental organization
SES	Social-ecological system
SGIA	Smart Growth Implementation Assistance
STT	Socio-technical transitions
TC	Transformative Capacity
TSI	Tropical Storm Irene
VFN	Valley Futures Network
VTRANS	Vermont Agency of Transportation

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1.0 – INTRODUCTION

1.1 – Problem Formulation

Climate change has been predicted to have serious implications to regional weather patterns including increasing the frequency and intensity of large storms (IPCC 2013). The world is already experiencing these phenomena with Typhoon Haiyan in 2013, possibly the most powerful cyclone ever recorded, as well as Hurricanes Sandy and Katrina among many others. These events have devastating effects on human settlements and ecosystems alike. Furthermore, the IPCC (2013) warn that extreme sea level rise, prolonged heat waves, extended droughts, and heavier and more precipitation are virtually certain for many parts of the globe. How this will affect planetary systems (Rockstrom et al. 2009) and more localized areas is uncertain. This uncertainty is fueling the push to discover how social and ecological systems can become more robust through adaptation measures (Adger, Arnell, and Tompkins 2005).

The call for society to adapt to climate change has come from many corners of the international community (Adger et al. 2008; Moser 2010). However, in a social-ecological system (SES) context, adaptation to climate change has limits (Adger et al. 2008) and may not always be sufficient to weather future surprise or disaster events, necessitating a transformation (O'Brien 2011). A SES is understood to be a complex adaptive system (CAS) on multiple temporal and spatial scales, which can exhibit non-linearities, emergent properties, feedbacks, can self-organize, has a historical dependency, and is difficult to predict (Olsson, Folke, and Berkes 2004; Cumming et al. 2012; Scheffer et al. 2001). Transformation can be defined broadly as fundamental change in the SES resulting in a different system (Folke et al. 2010; Chapin et al. 2010). A deliberate transformation, as a result of conscious decision-making and goal setting for the specific purpose of transforming the system (O'Brien 2011), may be the correct course of action as a response to climate change and uncertainty (Chapin et al. 2010; Olsson et al. 2006).

Successful transformations or transitions are complex processes and management frameworks are developed from both the Transitions Management (Geels and Schot 2007) literature and the resilience transformations literature (Olsson et al. 2006). These frameworks, however, do not deal well with the concept of capacities. There is

quite a large body of work surrounding adaptive capacity (Adger, Arnell, and Tompkins 2005; Brown and Westaway 2011) but that work cannot be assumed to transfer to transformations or transitions. Olsson et al. (2010) have called for a refining of the idea of transformative capacity in SESs: that they are broad regime shifts "points to a broader set of issues that need to be addressed as part of transformative capacity," (p 267). However, the literature is vague concerning specific social or ecological attributes that create transformative capacity. This study attempts to fill that gap by identifying specific attributes that can be said to be transformative, and providing structure for when and where these capacities may best be mobilized during the transformation process.

1.2 – Research Questions

This study is investigating transformative capacity on a community scale in a post disaster/flood event context. The following research questions are addressed:

What are the attributes of Transformative Capacity in social-ecological systems?

Sub-questions

1. How are transformative capacity attributes exhibited and activated in post disaster-event contexts?
2. When, and at what scale, are specific transformative capacity attributes mobilized during the transformation process?

1.3 – Aim of the study

The aim of this study is to deepen the understandings of pathways to transformations by identifying a framework through which overall transformative capacity may be assessed. This study is expected to provide evidence that:

- Communities can radically change current practices to create adaptive/restorative capacity in the face of climate uncertainty
- The above change requires the development of certain social and ecological characteristics coupled with certain strategies and skills, which this study refers to as transformative capacities whose time of use and application, as

well as the locality and/or subject of transformation are critically important in each characteristic's efficacy.

- Integrating ecological dynamics with social transitions is essential to avoid unintended consequences of transitions and embark upon sustainable pathways.
- Tension exists between community identity/culture (place attachment) and the ability to transform.

Furthermore, the study makes a methodological contribution by combining the transitions management and resilience theories in a community disaster response setting.

2.0 – CASE SITE DESCRIPTION

2.1 – The Mad River Valley (MRV)

The Mad River Valley is located in northern Vermont in the northeast region of the United States (see Maps 1,1a). It is a narrow valley hemmed by the Green Mountains to the west and the Northfield Mountains to the east. The Mad River is 42km long and runs north into the Winooski River, which then flows into Lake Champlain. The Mad River watershed covers an area of approximately 373km^2, and contains the towns of Warren, Waitsfield, Fayston and parts of Duxbury and Moretown (see Map 2). There are also 2 ski resorts in the MRV: Sugarbush and Mad River Glen. The geography and climate of the area makes the MRV a popular tourist destination in all four seasons for a large variety of recreation activities. For these reasons and others Waitsfield was voted the east's Best Ski Town in 2010 and one of 2013s Best Towns by Outside magazine[2]. The MRV has previously established the ability, through inter-town agreement, to regulate land use and development in a large majority of the watershed. Therefore, the MRV is a well-defined social-ecological system where social and eco-hydrological boundaries nearly match (see Map 3). This regulatory office is called the Mad River Valley Planning District (MRVPD) (see Appendix 9.1.1). For a discussion of the governance and demographics of the region see Appendix 9.1.

2.2 – Tropical Storm Irene

In late August of 2011 Tropical Storm Irene (TSI) moved inland over the northeastern United States bringing heavy rains and high winds. The Mad River of north central Vermont rose to 5.8 meters, 2 meters above major-flood stage for the valley. This was a devastating event for the small towns of the valley (population 5000) causing millions of USD in damage and loss. Floods are not unusual in the MRV; however, Irene was the first tropical storm (or hurricane) to hit Vermont since 1938. Current

[2] http://www.outsideonline.com/adventure-travel/Best-Towns-2010--Waitsfield--Vermont.html
http://www.outsideonline.com/adventure-travel/north-america/united-states/Best-Towns-2013-Waitsfield-Vermont.html

projections of climate change impacts for the region focus on warming and the increase in intensity and frequency of storms in the coming decades[3].

2.3 – Past Transformations in the Mad River Valley

The MRV has history that is best described as a punctuated equilibrium, "where long periods of stability and incremental change interact with abrupt, non-incremental, large-scale change," (Olsson et al. 2010 p 267). The importance of past transformations cannot be understated. These reveal clues to how both the social and ecological systems respond to different stimuli, while building a depth of understanding for the current state of the system. Indeed, "understanding the sequence of events that leads to such junctures is of crucial importance for understanding transformative capacity" (Olsson et al. 2010 p 267).

The MRV was settled in the late 18th century, and began as an agricultural and logging area. A series of transformations occurred to take it from the rural farmlands of its founding to the tourist/resort destination of today. These transformations are outlined in Table 1. The most significant for the ecology of the region is the vast deforestation that occurred between 1800 and 1900. The hillsides, which were heavily forested, became barren causing a significant loss of water retention capacity in the landscape. Even though the area today is over 70% forested, the size of the trees and the complexity of the forest are still diminished (16,18), as well as the depth of the topsoil, all of which (along with the network of roads and other impervious surfaces) contribute to a lower capacity to hold, slow, and spread water before entering the Mad River and its tributaries. This historical foundation highlighted the dynamics of this region as being in a regular process of stabilization, collapse, and reorganization, consistent with the adaptive cycle and panarchy literature (Gunderson and Holling 2002).

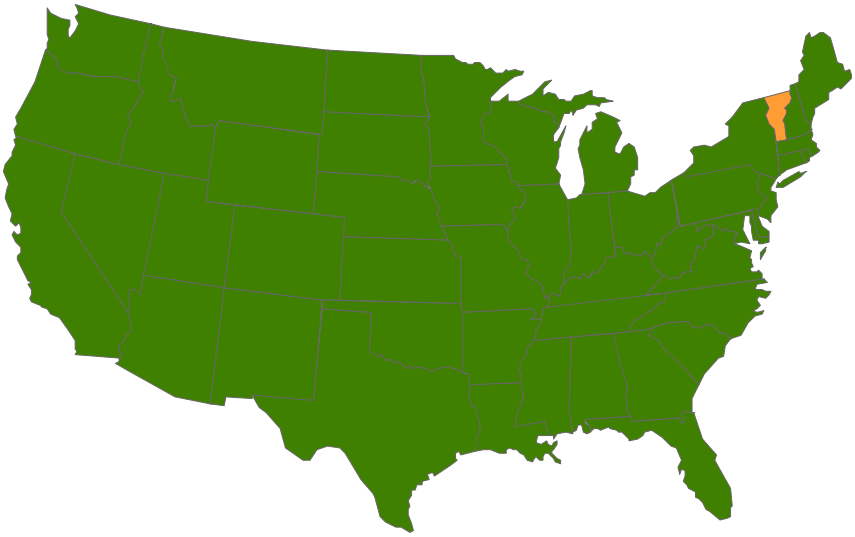
[3] Climate Change Vermont report 2011 from Vermont Agency of Natural Resources

Table 1: Historic transformations in the MRV (Town Plans, 16, 18, MRV Hill farm project.)

Pattern	Trigger	Resulting Change	System Impacts
First settlement on hillsides (1789)	Unpredictable river flooding	Slow deforestation of hill plateaus	Increased soil erosion dramatically. Without beaver dams or forest, storm water moved very quickly carrying large sediment loads into the Mad River.
Logging Industry (1800-??)	Watermills on Mad River tributaries	Increased deforestation of hill plateaus	
Sheep Agriculture (1800~1850s)	Economic demand for meat and wool; newly opened grassland	Extensive deforestation of entire valley. All old growth forests gone.	
Beaver Trapping (~1800~1850s)	High demand for pelts	Virtual extinction of beavers in area. Loss of all beaver dams and habitat	
Dairy Industry (1850s~1900): **Butter and cheese**[4]	Sheep industry regional collapse. High demand from surrounding region. River dams and water powered mills flourished.	Move towards river valleys. Dairy farms better suited to lowlands.	Pushed development into the floodplain. Farms needed easy access to transportation. Therefore main roads moved from hillside to valley bottom where they remain today. Idea that man could control the river took hold.
Dairy Industry (1900~1950): **Milk and cream**	Refrigeration; automobile, train, truck.	Fresh milk transported long distances. Creamery cooperatives formed.	
Tourism (1947-today)	Ski industry: Mad River Glen and Sugarbush resorts	Shift of primary economic driver. Development of tourism infrastructure: roads, resorts, restaurants, retail, etc.	Led to development of service-dedicated jobs (the dominant employment sector in area), the decline of agriculture, and the steep increase in property values and second homeowners. Hill farmland became ideal tourist housing.

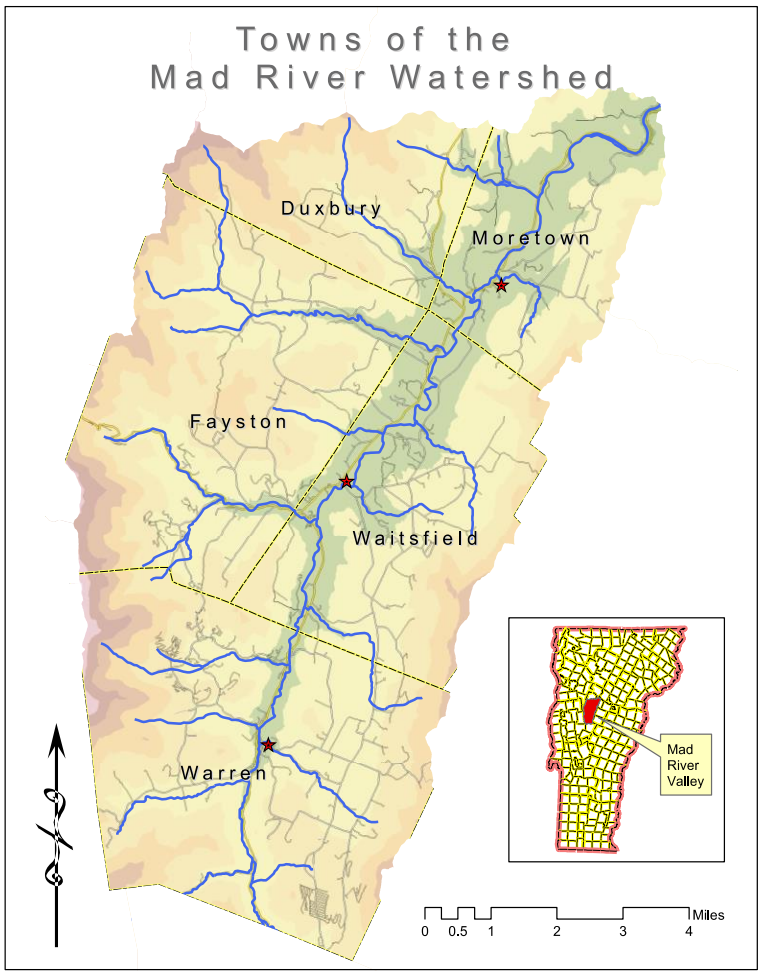
[4] Butter, artisanal cheeses, and other value added dairy products are having a resurgence in the MRV in the past decade, attempting to fill a niche in the local and small-batch markets.

Map 1: Location of Vermont in relation to the United States

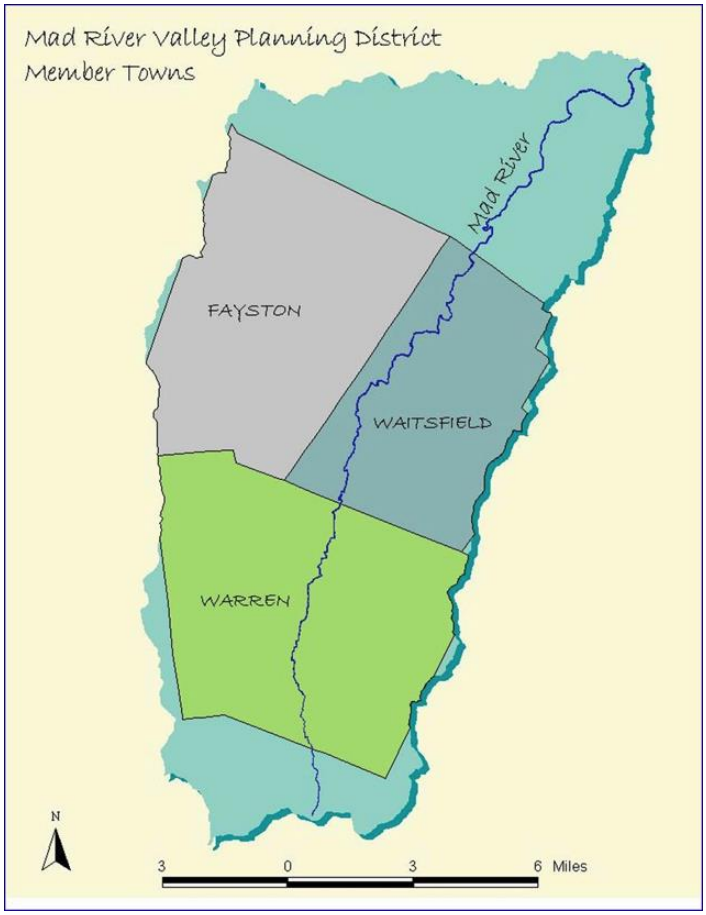


Map 1a: Location of MRV in relation to the state of Vermont

Map 2: The Mad River Valley watershed. Source: Friends of the Mad River's *Best River Ever* Report 1995



Map 3: The Mad River Valley Planning District jurisdiction compared to the Mad River Valley Watershed. Source: MRVPD



3.0 – THEORETICAL BACKGROUND

3.1 – Introduction

This study draws heavily on two major areas in literature focusing on change in CASs: resilience transformations and transition management. A significant dividing line between them is that resilience transformations tend to focus on SESs while the transition management literature focuses first on socio-technical systems (Olsson, Galaz, and Boonstra 2014). This case combines elements from both arenas and applies them in a community response to a disaster event context assuming a SES perspective, ultimately viewed through a resilience lens.

3.2 – Resilience Theory

3.2.1 – Undesirable States

General resilience or SES sustainability is often stated as the goal of SES transformations, especially in response to extreme events and unknowns such as climate change (Carpenter et al. 2012). Resilience theory states that there are multiple stable states or stability landscapes for any SES (Walker et al. 2004). Resilience is here defined as the ability of a SES to absorb shocks and perturbations while maintaining the same functions, structure, and feedbacks (Walker and Salt 2006; Folke et al. 2010). This is in contrast to engineering resilience, i.e. the time it takes a system to return to the same state after disturbance (Walker et al. 2004; Folke 2006), assuming only one stable system state. This study assumes the multiple stable system state hypothesis. System states can be either desirable or undesirable, and both can be highly resilient (Scheffer et al. 2001). In the undesirable state, a system may have to undergo a transformation to shift to a more desirable stability landscape (Olsson et al. 2006). For this to be accomplished, the resilience of the undesirable system must be eroded to affect systemic change (Walker and Salt 2006).

3.2.2 – Adaptability vs. Transformability

Transformation research has grown out of adaptation research and represents a new and contested field with a large and growing variety of definitions and frameworks (Brown & Westaway 2011, O'Brien 2012). It is significant to understand the distinction between transformation and adaptation as it bears directly on the way this study considers capacities. Adaptability of a SES is seen as the capacity "to be robust

to disturbance and capable of responding to change (Armitage and Plummer 2010 p1)," and uncertainty through "short and long-term responses and strategies,"(Armitage and Plummer 2010 p288). Adaptability and adaptive capacity reflect the ability of the current SES to maintain its function, structure, and feedbacks, i.e. its identity, in the face of internal and external perturbations. Said another way, adaptive capacity is a measure of the resilience of the current SES system (Walker and Salt 2006). Transformative capacity mirrors the definition of transformability and is generally the ability of societies, cultures, economic and governance systems, institutions, and SESs to dramatically change in the face of external shocks, challenges and trends (Kates, Travis, and Wilbanks 2012; Walker and Salt 2006; Folke et al. 2005). Transformability is the capacity to ultimately change the identity of the current SES system through shifts in the function, structure and/or feedbacks. Transformability, in this sense, represents the ability to erode and reduce the resilience of the current SES to enable and then support systemic change (Folke et al. 2005). Therefore, this study assumes that capacities that may be suitable for transformation may be separate from those for adaptation (Wilson et al. 2013).

3.3 – Transition Management (TM) and Socio-Technical Transitions (STT) Definitions

The TM and STT literature focus on the dynamics of a socio-technological systems by examining the processes of structural change, technological diffusion, and innovation (Rotmans, Kemp, and Van Asselt 2001; Geels 2002; Van der Brugge and Van Raak 2007). Socio-technical systems are defined as the "linkages between elements necessary to fulfill societal functions," encompassing production, diffusion, and technology (Geels 2004 p900). There is a proliferation of transition frameworks in this literature reflecting multiple transition pathways (Geels and Schot 2007). As such there are a variety of definitions for a transition. Rotmans (2001) defines a transition as "a gradual, continuous process of structural change within a society or culture…described as a set of connected changes, which reinforce each other but take place in several different areas, such as technology, the economy, institutions, behavior, culture, ecology, and belief systems (p2)." Geels and Schot (2007) defines a transition as a "shift from one socio-technical regime to another (p399)," recognizing the potential for multiple stable system states or regimes. Also, a transition is a "fundamental change in the structures, cultures and practices of a societal system,

profoundly altering the way it functions," (de Haan and Rotmans 2011). Combining these we find a transition to be a fundamental change resulting in a shift from one stable regime to another, occurring as a process of reinforcing changes in multiple areas. Comparing the definitions of transition and transformation, this study will henceforth consider them identical.

3.4 – Synergies between TM and Resilience Transformations

Though there has been much critique between proponents of these theories (see Voß and Bornemann 2011; Shove and Walker 2007 among others), recent research explores potential synergies (see Frantzeskaki et al. 2010; Ferguson, Brown, and Deletic 2013; Olsson, Galaz, and Boonstra 2014). Three key aspects of transformative change both theories address: Scales; Phases of transition/transformation; and Crisis response.

3.4.1 An Explanation of Scales

Transformations occur on multiple interacting levels and scales, which are especially significant in response to climate change contexts (Adger, Arnell, and Tompkins 2005). The multi-level perspective distinguishes three levels: the micro, meso, and macro, (Geels and Schot 2007), corresponding to those in STTs: the niche, regime, and landscape (see Figure 1). The particular make-up of these levels is elaborated in Table 2. This allows analysis of cross-scale connections, interactions, and the dynamics of the diffusion of innovation/s in the system (Geels 2002).

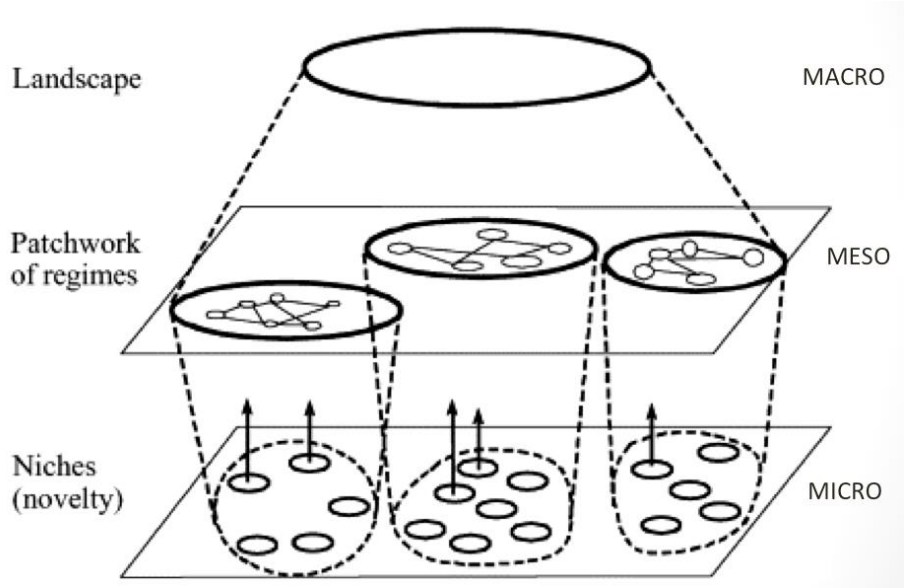
The levels are a nested hierarchy with the niche or micro level embedded within the regime, which is embedded within the landscape (Geels 2002). Change processes tend to move slowly in the landscape while comparatively quickly in the niche level (Geels and Schot 2007), while the change process can be triggered by pressures externally from the landscape or internally from niche innovations, a transition comes about from the alignment of processes on all scales (Geels 2002).

Resilience theory uses panarchy and the adaptive cycle to address the dynamics of multi-scale interactions in CASs. The similarities are many: scales are nested; smaller scales have faster processes; transformations on one scale can be triggered on others; and scalar interactions can hinder or support transformations (Gunderson and Holling 2002; Folke 2006). A significant difference is that panarchy focuses more on tipping points and thresholds in SES interactions (Olsson, Galaz, and Boonstra 2014).

Table 2: Levels in social and socio-technical systems (Rotmans et al. 2001)

Levels: Societal/Socio-technical systems	Societal Components	Socio-technical System Components
Micro/Niche	Individuals; individual actors (companies)	Individual actors; technologies; local practices
Meso/Regime	Networks; communities; organizations	Dominant practices; rules; shared assumptions; political interests, rules, and beliefs
Macro/Landscape	Conglomerates of organizations and institutions (nations)	Material infrastructure; political culture and coalitions; social values; worldviews and paradigms; the macro economy; demography; the natural environment

Figure 1: The multi-level perspective adapted from Rotmans (2001) and Geels and Schot (2007)



3.4.2 – Phases of Transition/Transformation

Transitions and transformations are processes that can evolve over long periods of time. Transition management has divided the process into four phases: predevelopment, take-off, acceleration, and stabilization (Rotmans, Kemp, and Van Asselt 2001). Resilience transformations have three phases: preparing, navigating, and building resilience (Olsson et al. 2006). These two perspectives are very similar, and each phase has its corresponding equivalent in the other, with the take-off phase serving as the transitional period between the preparation and the navigation phases (Van der Brugge and Van Raak 2007). The preparing/ predevelopment phase takes place in the protected niche setting and involves innovation development and building knowledge through e.g. experimentation and strategy potentials (Van der Brugge and Van Raak 2007, Olsson et al. 2006). The take-off phase is the period where the innovation breaks out of the niche by taking advantage of a window of opportunity (Rotmans, Kemp, and Van Asselt 2001). In the navigation/acceleration phase, the innovation spreads throughout the regime, and may involve multiple transitions in multiple sectors of society including individual paradigm shifts (Cumming et al. 2012; Frantzeskaki et al. 2010). The final building resilience/ stabilization phase is virtually identical and involves embedding the new regime in place, protecting it from back sliding (Rotmans, Kemp, and Van Asselt 2001, Olsson et al. 2004).

3.4.3 – Community Response to Climate Crisis Events

The ability of communities to engage in change processes while restoring/recovering from the disaster is a focus of this study. Resilience theory perceives climate induced disaster event as a window of opportunity for change (Keeler 1993; Carpenter et al. 2012; McSweeney and Coomes 2011 among many others). This window can open wide enough to allow a fleet of adaptations to lessen vulnerability or can open wider and allow for or lead to a transformation. Walker and Salt (2006) associate a crisis with the release of resources and the change and creation of policies. Olsson et al. (2010) state that a crisis can be used to "to stimulate experimentation, innovation, novelty, and learning within society," (p266). However, there is uncertainty surrounding whether individual changes represent an adaptation/mitigation measure, or a transformational one (Kates et al. 2012).

Transition theory allows that a crisis can be a destabilization of the regime, which creates potential traction for niche innovations (Geels and Schot 2007). Crises and

potential disasters can also be prepared for and the momentum created by such a disturbance seized to activate sustainability pathways (Frantzeskaki and Loorbach 2010a).

3.5 – Building an analytical framework for Transformative Capacity

From the combined foundations of the above, an analytical framework has been assembled for assessing TC (Table 3 below), elaborated on in the following sections, beginning with a SES perspective. The attributes are presented in three clusters according to interrelations derived from the literature. The clusters represent three areas vital to the transformative process: novelty creation, agency, and scalar alignment. The first deals with innovation and niche development; the second with the actors that carry innovations from the niche to the regime; and the third with the manifestations of TC through cross-scale integration.

3.5.1 – Integrating the Ecological

Olsson et al (2010) summarize the need for integrating ecological dynamics in SES transformations: "Addressing only the social dimension…will not be sufficient to guide society toward sustainable outcomes. Societies may go through major regime shifts without improving the capacity to learn from, respond to, and manage environmental feedback from dynamic ecosystems, which in turn can lead to further ecological degradation, SES regime shifts, and deep traps," (p268). Neglecting the ecological system in change processes, especially in a community context, is dangerous and can deflect the desired transformation trajectory through the unintended consequences of practices, policies, or other decision-making (Chapin et al. 2010).

Chapin et al. (2010) propose the ecosystem stewardship framework as a "strategy to respond to and shape SESs under conditions of uncertainty and change to sustain the supply and opportunities for use of ecosystem services to support human well-being" (p241). Its focus is to reduce SES vulnerabilities while enabling system transformations to avoid unsustainable trajectories (Ferguson, Brown, and Deletic 2013). Ecosystem stewardship provided a foundation for integrating the social and ecological systems. In the TC assessment framework, therefore, integrating the ecological means infusing a SES perspective into the TC framework (Table 3) creating a co-evolving co-dependent paradigm.

3.5.2 – Cluster 1 – Novelty Creation: Innovation niches, Shadow/Informal networks, Technical and Governance experimentation

This group of TCs represents the spaces from which transformative actions emerge. Innovation niches are the safe or protected spaces in which novel innovations can develop (Smith and Raven 2012). A protected space is generally free from competition or restriction from the dominant/regime forces so the innovation may become more robust and expand relatively unimpeded through networks (Smith and Raven 2012). Innovations are understood to be more than just technological; they include concepts, strategies, initiatives, organizations, processes and products. Transformations are iterative processes, continuously cycling as new problems or obstacles arise requiring innovators and informal networks working in the protective shade of innovation niches (Olsson et al. 2006).

Frantzeskaki et al. (2009) define a niche as "a group of actors who adopt a new practice, a new routine, a new service or technology" (p9). That group of actors is the shadow or informal network in which these new ideas or strategies flourish. Shadow networks serve as incubators of innovation, and can exist both inside and outside the dominant regime (Westley et al. 2011). They can be testing grounds for new policies or methods of social learning, and can devise alternative or out of the box problem solving strategies (Olsson et al. 2006).

Experimentation is often cited as an aspect crucial to effective management of change processes and SES transformations (Folke et al. 2005, Olsson et al 2006). Experimentation is usually local-scale and critical for knowledge building and learning processes (Farrelly and Brown 2011; Van der Brugge and Van Raak 2007; Olsson et al. 2006; Folke et al. 2005; Geels 2002). Experimentation takes place within the innovation niche by the informal network actors (Olsson et al. 2006, Farrelly and Brown 2011). Technological experimentation (Geels 2002) is often used to test out and develop new ideas, foster the creation of rules, and to align with other innovations (Schot and Geels 2008). Experimentation in governance involves testing policies, indeed seeing policies as experiments, requiring flexibility in the management and governance bodies (Bos and Brown 2012).

These three capacities are nested in a who, what, and where scenario in which informal networks (who), are experimenting with innovations (what) operating in

protected innovation niches (where). These together form the foundation from which TC is cultivated and develops. A primary factor that fosters the development of innovation is diversity. For transitions, "diversity of social actors translates into innovation of practices and ideas hence innovative capital." (Frantzeskaki, Loorbach, and Kooiman 2009 p10).

3.5.3 – Cluster 2 – Agency: Leadership/Frontrunners, Social/Formal networks, Bridging organizations

The dynamics of transformative agency are only recently a focus in transformation literature (Westley et al. 2013). The activity and influence of strategic change agents are instrumental in broadening the understanding of the role agency plays in shifting SESs. In the literature, leaders and frontrunners are necessary to push the innovation from the niche into the regime thus formalizing the informal networks that then vie for dominance or acceptance in the regime, often through the efforts of bridging organizations (Olsson et al. 2006, Geels and Schot 2007, Folke et al. 2005).

Leadership, as described by Olsson et al. (2006) provides many key functions in a transformation such as: "trust-building, sense-making, managing conflict, linking key individuals and initiating partnerships among actor groups, compiling and generating knowledge, developing and communicating vision, mobilizing broad support for change, and gaining and maintaining the momentum needed to navigate the transitions and institutionalize new approaches" (p14). "Frontrunners," generally means people from diverse backgrounds with particular skills, experience, and/or connections (visionaries, strategists, or social entrepreneurs) that are critical for engaging transition processes (Frantzeskaki et al. 2012; Loorbach and Rotmans 2010; Frantzeskaki, Loorbach, and Kooiman 2009a) and have a particular affinity for sustainable innovations (Nevens et al. 2013). Frontrunners also should exhibit an understanding of complex systems and can reflect on the current system elements and their relation to persistent problems (Frantzeskaki et al. 2012).

Olsson et al. (2010) states that SES transformations go beyond the capacity of individual actors, therefore efforts must be made to enhance the networking capacity connecting motivated and skilled actors, suggesting that networking capability is a necessary/central capacity for transformation. Formal networks (regime networks or social networks) are critical for information flow and dissemination, and have been

shown to be effective in ecosystem or resource management scenarios (Olsson, Folke, and Berkes 2004; Moore and Westley 2011). Networks can improve potential to respond to complex problems and ease the road to broad acceptance of innovations (Moore and Westley 2011). Networks are also key for the "mobilization and allocation of key resources for effective governance," however not all networks are created equal (Bodin and Crona 2009 p367). Often, for the spread of social innovation through barriers, across boundaries, and scales, networks need to be activated by leaders and innovators (Moore and Westley 2011).

Bridging organizations play a variety of functions in the transformation process, all having to do with linking otherwise separate entities. Berkes (2009) describe bridging organizations as providing "a forum for the interaction of…different kinds of knowledge, and the coordination of other tasks that enable co-operation: accessing resources, bringing together different actors, building trust, resolving conflict, and networking" (p1692). A key element of bridging organizations is their ability to link across scales (Folke et al. 2005). In this capacity they serve as catalysts and facilitators between governance levels, and across knowledge and resource systems (Folke et al. 2005; Per Olsson et al. 2006; Berkes 2009) for collaboration and knowledge co-production (Crona and Parker 2012).

3.5.4 – Cluster 3: Scalar Alignment: Shared vision, Stimulation of social learning, Long-term vision effects of short-term policy, Multi-scale system thinking in governance

A shared vision of the future of a community or region facilitates the transformation process in many ways. Loorbach and Rotmans (2010) state that a vision can help to engage the participatory process as it provides a common language, and "allows for a continuous integration, re-evaluation and adaptation" (p244). Though Frantzeskaki et al. (2012) argue that vision is useful in giving direction, warn against rigidity in the vision. An inspiring shared vision can initiate a change trajectory, indeed coherent visions can orient long-term, unite a diversity of actors, gain support for and facilitate the use of resources through transition management stages (Nevens et al. 2013).

Social learning is a learning-by-doing group based process, often synonymous with adaptive management, in response to uncertainty and complexity (Holling 1973; Berkes 2009; Cumming et al. 2012). Armitage, Marschke, and Plummer (2008)

describes three types of social learning: experiential, which is knowledge creating; transformative, which alters perceptions and consciousness; and reflective, in which experiences and ideas are shared beyond the network. Berkes (2009) highlights that in SES, these three learning processes can be effective in facilitating collaboration, joint decision-making, and co-management. Transformational learning, at its most effective, results in a shift in worldview or paradigm establishing a new set of behaviors and relationships (Cumming et al. 2012). However, assuming that social learning is about collaboration and practice, then the conditions for social learning can be created and planned (stimulated) i.e. through policy development, incentive programs, open workshops, or other initiatives (Cummings et al. 2012).

A transformation of a SES evolves over many years, even decades. Therefore, the ability to link long-term goals and vision with short-term policies is necessary for traversing a transition or transformation pathway. This process may include both forecasting and backcasting exercises that develop strategies to realize a shared vision (Frantzeskaki, Loorbach, and Kooiman 2009a). The actions that follow from these strategies have short and mid term targets reflecting the long-term goal (Nevens et al. 2013). Social learning, envisioning, and backcasting efforts together form a dynamic change process in which the entire system is incrementally transformed (Nevens et al. 2013).

Multi-scale thinking is critical in the aligning of policy and regulation between levels, as well as minimizing the impact of surprise events and uncertainty. In the transformation process the nature of cross-scale interactions can shift requiring a restructuring of governance relationships and patterns (Chapin et al. 2010). This argues for flexibility in governance structures especially as fundamental changes ensue producing non-linear patterns and dynamics through multiple levels (Loorbach, Frantzeskaki, and Thissen 2010). Therefore, governance and management bodies with an understanding of the dynamics of multi-scale interactions and nested systems will be more prepared for non-linear behaviors especially as they engage in an adaptation or transition process (Walker et al. 2004; Loorbach, Frantzeskaki, and Thissen 2010; Frantzeskaki, Loorbach, and Kooiman 2009b).

Table 3: Transformative capacity attribute clusters – definitions and sources color coded as follows:

Green = SES Perspective
Yellow = Novelty Creation Cluster
Blue = Agency Cluster
Tan = Scalar Alignment Cluster

CLUSTER / SPECIFIC CAPACITIES	DEFINITION	SOURCES
INTEGRATING THE ECOLOGICAL		
Social-Ecological Systems perspective	Broad understanding of the integration of ecological and social systems – that they are co-evolving and co-dependent.	*Chapin III et al. 2010; Olsson et al. 2010; Folke et al. 2010*
NOVELTY CREATION: *Important for the niche development*		
1) Innovation niches	Protected spaces where an innovation may safely develop	*Smith and Raven 2012; Schot and Geels 2008*
2) Shadow networks	Informal network, often an incubator/testing ground of innovation.	*Olsson et al. 2006; Westley et al. 2011*
3) Technical and governance experimentation	The purposeful testing of an idea, policy, technology, to understand effects/impacts.	*Farrelly and Brown 2011; Folke et al. 2005; Geels 2002*
AGENCY: *Connecting the niche to the regime*		
4) Leaders/Frontrunners	Individuals or groups who can inspire and direct change.	*Olsson et al. 2006; Frantzeskaki et al. 2012; Loorbach and Rotmans 2010; Frantzeskaki et al.. 2009*
5) Social/Formal networks	Established or formalized groups bound through some organization or agreement, critical for knowledge flow and dissemination. Function at the regime level.	*Olsson et al. 2004; Moore and Westley 2011; Bodin and Crona 2009; Geels and Schot 2007*
6) Bridging organizations	Individuals or organizations that facilitate collaboration and knowledge co-production across resource, social and governance systems. Can connect inter and intra-level.	*Folke et al.. 2005; Olsson et al.. 2006; Berkes 2009, Crona and Parker 2012*
SCALAR ALIGNMENT: Scaling up through the regime		
7) Shared vision	A broad agreement on the future vision for an organization, town, watershed, etc. that can provide long-term guidance and inspiration.	*Loorbach and Rotmans 2010; Nevens et al..2013*
8) Stimulation of social learning	Processes that aim at reframing or changing the perspective of actors.	*Holling 1973; Folke et al.. 2005; Berkes 2009; Cumming et al. 2012; Seyfang and Smith 2012; Armitage et al. 2008*
9) Long term vision affects on short-term policy	Future (>25 yrs) thinking /planning by leaders, decision makers, innovators, etc. that impacts current policy/regulation processes.	*Nevens et al. 2013; Frantzeskaki et al. 2009*
10) Multi-scale systems thinking in governance	Policies that take into account different spheres/scales of impact.	*Loorbach et al. 2010; Frantzeskaki et al. 2009*

4.0 – METHODS

In this chapter, a description of the research design is given to account for the following: 1) data collection and triangulation; 2) operationalization of analytical framework; 3) data analysis. For critical reflections and limitations of the research see Appendix 9.2.1.

4.1 – Research Design or Methodological Approach

This study uses a case study approach to understand the dynamics of transformative capacities as they are exhibited by a group of communities that aspires to fundamentally change their interaction with the environment. This was sparked by a climate induced crisis event. Three methods were used to establish validity and reliability of the results: semi-structured interviews, direct observations, and a literature review (Yin 2014).

Scales and cross-scale interactions are set according to the socio-technical transitions literature (Rotmans, Kemp, and Van Asselt 2001), which labels the micro, meso, and macro scales. The focal scale for this study, the meso/regime (Brugge and Rotmans 2006), is the region demarcated by the MRVPD. The micro scale represents individuals, networks, organizations; while the macro scale is the Vermont State government, the US Federal government, and beyond.

4.1.1 – Literature and Local Document Review

The study began with a literature review on the dynamics of transitions and transformations to uncover common characteristics linked to TC. Community response to disaster literature was used to identify potential trajectories of post-crisis change and their characteristics in order to develop an analytical framework for case testing.

Local documents reviewed covered legislative acts, reports, studies, town plans, archival records, local and state initiatives, databases, movements (e.g. Localvore or Farm-to-Plate), and documentation of impacts of tropical storm Irene (see Appendix 9.2.5). This documentation reveals the scope and depth of the actions of local governance bodies, non-profits, and NGOs. These documents also reflected local and regional culture and values from the past, present to the future.

The literature review also helped identify ecological data and knowledge used in change processes. A historical review was undertaken, looking for community interaction with the ecosystem, major development shifts, and ecosystem responses to landscape shaping, along with a review of current studies and reports on the local ecosystem.

4.1.2 – Semi-structured Interviews

A total of 24 semi-structured in-depth interviews with 29 individuals[5] were undertaken in the field. This interview technique was used to gather data that could help identify the TCs outlined in the data-collection framework below (Table 4). Interviews targeted key actors and included governance officials, business owners, heads of organizations, water, forest, and soil ecologists, farmers and other key stakeholders. This study utilized purposive sampling to select interviewees, deliberately selecting individuals that would provide the most relevant data (Yin 2011 p.88). Potential interview candidates were vetted through a process with the MRVPD (through which nearly all community changes, actions, or activities pass) to identify key actors in the region, paying careful attention to include a diversity of perspectives and opinions.

Interview questions were structured using an interview guide to ensure that key topic areas of the operationalized analytical framework were covered encompassing a wide variety of interviewee perspectives and areas of expertise (Bernard 2006 p212). The interview guide was structured as a matrix to incorporate the capacities in Table 4, spread over the scales and phases (see Appendix 9.2.6). The interview guide is aimed generally at uncovering the presence, development, and use of each capacity, and specifically at the following regarding phases of transformation:

- What capacities support each phase?
- Are capacities maintained but used differently in each phase?

This structure was highly adaptable allowing for questions to be geared to the specific interviewee and to pursue lines of inquiry discovered during the interview. Interviews were normally between 1 to 1,5 hours, with some near 2 hours, and one lasting only

[5] There were four group interviews: three with 2 interviewees and one with 3.

20 minutes. All recorded interviews were transcribed[6]. Extensive note taking accompanied all interviews. Immediate reflection on interviews was done to generate follow up questions and new lines of inquiry. In the final 10 interviews, clarifying and validating questions were used to support or oppose perspectives that emerged/were identified in earlier stages of the study (Yin 2011).

They were asked information on (but not limited to): changes in scale and types of participation in the community; changes in and development of social networks and NGOs; the growth and development of resilience ideas/thinking/research; changes in policy/legislation, and the shifting goals of organizations and decision makers. To understand the timing of events/changes, interviewees were asked about changes in the above areas over time stages: pre disaster event, immediately post disaster event, year one and year two from event.

4.1.3.1 – Anonymity Considerations

All interviews were accompanied by signed consent forms, which ensured that interviewees would be kept anonymous. Interviewees were assigned a number, see Appendix 9.2.7, with general categorical notes for each, concealing the identities of individuals. All in-text references to interviewees use these numbers.

4.1.3 – Observations

Direct observations were used as a supplement to the interviews focused specifically on how information is passed, the use and formation of networks (formal and informal), the introduction of issues and problems to governance bodies, and problem solving strategies of individuals and governance bodies (Yin 2011; Yin 2014). These included formal meetings of governance bodies, town and community meetings, and interactions/ conversations in public spaces. The direct observations were essential in understanding the dynamics of communication in the area, as well as revealing the processes alluded to in individual interviews and local documents. Field notes were taken during the observations and reflections, connections, and possible follow-up questions were noted immediately afterwards.

[6] Two interviews were not recorded as the situation did not allow for it.

4.2 – Operationalized Analytical Framework

The eleven components identified earlier and listed below (Table 4) constitute the Transformative Capacity of a specific social-ecological system. Each attribute was considered in terms of both successful and unsuccessful aspects. Also, key to this study, is some understanding of how and when particular attributes developed and/or were engaged. This framework served as a foundational guide to all methods of data collection.

Table 4: Operationalized analytical framework color coded according to cluster as follows:
Green = SES Perspective
Yellow = Novelty Creation Cluster
Blue = Agency Cluster
Tan = Scalar Alignment Cluster

CLUSTER / SPECIFIC CAPACITIES	WHAT TO LOOK FOR
INTEGRATING THE ECOLOGICAL	
Social-Ecological Systems perspective	Ecological drivers and functioning are studied, understood and disseminated through learning channels; ecological short and long-term health considered in policy, regulation, development and planning. Relationship to land is positive, broad, and socially encouraged.
NOVELTY CREATION: *Important for the niche development*	
1) Innovation niches	Openness to entrepreneurs; cultural diversity and integration; a general acceptance for "outside of the box"
2) Shadow networks	Social meeting places; informal attitudes; a neighbor friendly culture
3) Technical and governance experimentation	Small scale projects or workshops to generate knowledge (and potentially public awareness and interest)
AGENCY: *Connecting the niche to the regime*	
4) Leaders/Frontrunners	Innovative thinkers, social entrepreneurs, practitioners
5) Social/Formal networks	Organizations, forums, non-profits etc. that form an integral part of the relationships within the community.
6) Bridging organizations	Centrally connected individuals or organizations; go-to problem-solvers.
SCALAR ALIGNMENT: *Scaling up through the regime*	
7) Shared vision	Widely accepted terms, behaviors, life-style; equality; dividing lines on issues.
8) Stimulation of social learning	Community events, talks, meetings on current issues. Sponsored talks by 'experts'. Cultural willingness to engage.
9) Long term vision affects short-term policy	Balanced criteria for decision-making between short-term and long-term thinking. Policy and regulation that anticipates and allows for changes.
10) Multi-scale systems thinking in governance	Cross-scale networks; multi-level processes for policy and regulation; knowledge and understanding of multi-scale dynamics.

4.3 – Data Analysis

The data analysis used a thematic analysis method involving both an inductive and deductive approach (Fereday and Muir-Cochrane 2006) combined into a narrative analysis (Johnstone 2001; Fairclough 1989). In the thematic analysis structure, the deductive approach used themes predetermined from the theoretical review or framework, while an inductive approach found new themes while reviewing the data narrative (Boyatzis 1998 in Fereday and Muir-Cochran 2006).

The data was compiled into a narrative, discovering themes as they arose from the narrative itself (inductive), then the framework of Table 4 was applied to sort the data around the predetermined TCs (deductive) (Riessman 2003). A multi-level approach was used as a filter to sort the data into the three levels: micro, meso, and macro. The analysis then references the interview guide (Appendix 9.2.6) to identify the shifting use of capacities through the phases of transformation.

5.0 – RESULTS

These results are representative of 3 years before the flooding in August of 2011 caused by Tropical Storm Irene (TSI) to two years following the disaster up to the end of 2013. The results are grouped according to phases and in a scaled structure from the micro to the macro. Results reflect the 'story' format that was created through the analysis process. A summary matrix of the attributes across phases and scales can be seen in Table 5.

In this case, a culture of participation and place attachment were critical for the development and utilization of capacities, but were outside the scope of the TC framework. The results from these aspects, in Appendix 9.3.1,9.3.2, are presented to the extent in which they relate to TC, and are further elaborated on in the discussion.

There were a variety of smaller scale transformations occurring in this community. They are presented in limited context: in relation to the phases, the TCs evident, scale, and interactions with each other. The most relevant to this study, ecosystem management, is explored in section 5.4.1, while the others are presented in Appendix 9.3.3.

5.1 – Preparing Phase

A relevant functional period for the preparing phase begins with the tenure of the current Executive Director of the MRVPD in June of 2008, which coincides with the Great Recession of 2008.

5.1.1 – Micro

A primary activity of many actors in the MRV has been network building. They believe that relationships are key to effective and efficient governance, as well as problem solving and conflict resolution (1a,4,6,7). To that end, they spend time and energy building relationships throughout the MRV and the state.

For two reasons are relationships important: one so that you trust me so the work that I do is actually salient, important, and could happen; but the other piece is that I

don't have the answer and I've never had the answer. By building a relationship with you and then your relationship with others…Through this network of relationship building, we could come up with something greater and broader than I could ever come up with alone. [B]uilding those relationships…distributes the power and the brainpower to come up with ideas and solutions. It's about building a framework to have those relationships happen and have them directed towards the future. (1b)

I define a community's resilience as the strength of its relationships between itself, because it's those relationships that can enable it to respond to crises that come up. (14) Justice and fairness are not about making amends; they're about the capacity to be in a relationship with people who are a little bit different. (14)

Organizations

The Friends of the Mad River (FMR) is a non-profit scientifically grounded organization that monitors river health (building knowledge) and educates the public about threats to the Mad River through a variety of events, pamphlets, and other published materials (9a). They saw TSI as an opportunity to push their initiatives:

"We very much saw [TSI] as a window and the window is not open forever and we just kind of tweaked the way we were talking about the same work we were doing before Irene. We just repackaged it a little and put it out there because of this window and this opportunity. The same concepts, the same work but we are better able to connect with people based on their experience," (15).

The Valley Reporter newspaper is a primary vehicle for news, functioning as an information network throughout the MRV. It has a very high readership, and reports on a large variety of topics and issues of import to the MRV:

I think the role of the newspaper is huge. I've never known a newspaper in a community as small as this one that talks about land use planning as much as a Valley Reporter does; that has that amount of depth and that number of pages focused on the community. That helps move the conversation forward. (1b)

5.1.2 – Meso

The Mad River Valley Planning District (MRVPD)

A very significant foundation for the MRV is the MRVPD (see Appendix 9.1.1). The MRVPD is responsible for the planning, and development strategy of the MRV. The MRVPD is a formal partnership between the three towns, the main economic draw (Sugarbush ski mountain) and the MRV Chamber of Commerce. The MRVPD is *the* bridging organization for the MRV. It considers the long-term interests of the region, not just one town or one business. In that sense, the MRVPD is unique in its valley-wide big picture perspective (8a). Therefore its functional working network extends to many actors in the state and into the federal agencies and offices (1a). In its capacity of planner, the MRVPD works with every major and most minor projects, businesses, initiatives, enterprises, and organizations in the area (1a).

"If somebody's interested in something, they get together with [the MRVPD Executive Director] – 'What can you do to help push this along?' 'I can do that. We can get this grant. We can do this so I can try talking to this guy.' That's the way it happens. That's how it should work." (2)

Formal Partnerships/Networks

The MRVPD formalized a partnership with the Vermont Land Trust, and the FMR to form the Mad River Watershed Conservation Partnership (MRWCP) whose main purpose is to identify high priority areas for conservation and watershed health and to take steps towards the protection of those areas.

The MRVPD is heavily involved in building knowledge and stimulating social learning. It worked jointly with the Vermont Natural Resources Council to create the Forests, Wildlife, and Communities project which seeks the long-term sustainability of the forest/mountain/valley ecosystems including native wildlife. The project focused on *"ecological mapping, creating a watershed level approach to wildlife habitat, and coming up with policies to combat fragmentation of the forested landscape." (1b)* That study identified the largest recurrent threat to sustainability as increasing forest fragmentation due to new roads and driveways serving new

developments, and increased forest recreation trails (17a,b). Fragmentation is also a matter of homeowners who fence or post their land unknowingly closing an active and necessary wildlife corridor (17a,b). Therefore, resources are allocated in this project, as well as in the MRWCP, for social learning initiatives.

Semi-formal Networks

The Valley Futures Network (VFN) began in 2008 as a result of various actors in the MRV meeting at a locally based non-profit for a series of discussions on how to train and foster leadership in the MRV (11,12,14). They were seeing leadership entrenched in certain circles that were alienating the broader community. The VFN initially had monthly meetings, visioning workshops, and organized itself into various areas for development such as energy, agriculture, business, and habitat. The VFN, however, was never formalized as an organization so the initiatives it began were carried out by other entities/initiatives (12). In time, the VFN shifted to its current state as a large list-serve (digitally connected network) of highly engaged and interested residents working towards the vision they set out entitled "Thinking Like a Watershed":

To think like a watershed is to understand that everything is connected. To achieve a healthy, whole Mad River Valley means seeing the relationship between buying local food and sustaining our culture, and between affordable housing and seeing young people in our valley, or between conserving our land and wildlife and building a resilient business community. (VFN webpage)

Policy – Integrating the Ecological

In 2010, Waitsfield adopted Fluvial Erosion Hazard zoning (FEH) regulations, which effectively prohibits further development in the river corridor (1a,15). The river corridor is the space in which the river has potential to move through eroding banks. The state is experimenting with the FEH program, offering grants and other funding to municipalities adopting FEH regulations, for which the towns of the MRV are now eligible. However, there was one major carve-out in Waitsfield, the historic downtown, which sits squarely in the flood plain, maintaining the vulnerability of both the downtown and the main highway (15,2).

5.1.3 – Macro

The financial crisis of 2008 served as a window of opportunity for the MRVPD to jump into valley-wide discussions about the dependencies of the MRV, where it wants to go, and what it wants to be. A community reading of *The Transition Handbook* (2008) spurred existing local ideas about energy independence and a post-oil society (1b,11). Interviewees suggest that the 2008 financial crisis triggered a shift in paradigm of MRV residents.

"Those were the things that were happening during that time that shifted the conversation from, I would say, more feel good quality of life stuff to larger ramifications of our lifestyle." (1b)

5.2 Take-off

This phase is the brief period of time starting at the day of disaster and the subsequent months of cleanup and emergency restoration. TSI was a watershed event, touching every life in the MRV. It was large enough for people to begin to think differently about their relationship to the Mad River, letting go of the long held notion of controlling rivers: *"I feel like there was this switch, like the opportunity and political will to do this was greatly increased," (15).*

The community response to the extensive flooding from TSI was almost immediate. It is in this response that we see the activation of many capacities, their use, and functionality, e.g. the self-organization, spearheaded by volunteers, of the restoration efforts followed a innovative transition cycle (see Box 1). Importantly, these capacities are restorative because of their implementation. However, through this we can see the existence and development of capacities that are necessary in a transformation.

5.2.1 – Micro

Immediately after the event, there was a distinct "can-do" attitude that pervaded the community, which encouraged people to identify needs and to figure out how to fill

them. Significantly, people gathered on Bridge Street, in the historic downtown of Waitsfield to see the damage.

I saw the guy down the street from me, I was like, "Wow, stuff is bad! I better go grab my chainsaw." I just showed up with my chainsaw and I went to work and everybody did. People were just like, "Oh there's bricks on the street" and they start picking them up. (1a)

Personal/Professional Knowledge

The towns of the MRV have a variety of people who have knowledge of the residents and their likely situations in a crisis. In Warren, the town clerk becomes central in a crisis: "*when we have an emergency, she's up there manning it with the volunteer fire department knowing who lives alone, who is disabled, who needs to be brought up to the town offices, who needs this thing or the other thing (9a).*"

Box 1: Following an organizational innovation through the transition cycle.

Self Organization as a Transition cycle

Self-organization was a key piece of the ability of the region to respond well to the storm. There was a need for organization from the very beginning and a couple people picked up a table, cleaned it off, and said "ok lets see if we can figure this out," (1a). Busloads of volunteers came from a huge variety of places ready to help out, not to mention organizations offering a wide variety of aid. *"There were so many different organizations to keep track of in the very beginning. There's so many different types of needs that needed to be met and it was organizing that."(5a)* A few local residents (niche network) assumed the role of organizers, whose responsibilities grew, as did their effectiveness (through experimentation), until they became (formalized as) the Mad River long-term recovery group (MRLTRG). They modeled the Federal Emergency Management Agency's (FEMA) federal disaster recovery structure guidelines (multi-scale alignment) and became a local affiliate of FEMA (mainstreamed) able to receive grants and other funding; they became the liaisons (bridging organization) between individuals, the communities, and state and federal relief funding sources (FEMA and others) (5b). The MRLTRG was started and maintained by volunteers, *"all of the chairs in the long-term groups were volunteers. Some of them are still working and they're doing it for no pay and they've been doing it for two years." (5a)*

5.2.2 – Meso

Communication

Communication was an essential for the region's response to the storm. It required many types of communication utilizing previously established relationships and

avenues of information dissemination. In this, networks of many types were activated and new ones formed.

Digital: VFN ➔ Facebook

During the storm one community resident went to the river and made a video of the river overflowing its banks. This was then posted to the VFN list serve. Immediately, hundreds of Valley residents were aware that a serious flood was underway (1a,11). The VFN became a central hub of updates as new/more information became available.

'That list serve played a really key role overall that Sunday, Monday, and Tuesday – the initial 'what is happening; where are we; and what can we do?' People were using it to communicate to say, 'Hey, I need volunteers over here' or 'Does anybody have this?' ...People were mountain-biking, taking mountain bike trails to deliver diapers and water; and all sorts of interesting things to get to people that were stranded. I think they were stranded for 3 days. (1a)

However, the VFN wasn't designed for multi-way communication. Therefore the organizers created a Facebook page where individual residents communicated instantly with the entire group. Needs could be posted and then resources directed efficiently (5a,1a).

Community Ties

Community Gathering

A very significant part of the early management of the crisis was an impromptu town meeting at a central town gathering venue set up by the MRVPD two days after the storm. This meeting served two key purposes: to get people from all parts of the MRV to talk about what was going on and what they needed, and as a reinforcing of community ties through mutual support. Individuals were able to connect as a group and from there take concerted action.

"*It was the first time that he had talked to anyone outside his community and it was the first time he was explaining what was happening. He emotionally broke down. It was an amazing moment and everybody in that room knew it." (1a)*

The MRV community fund: internal and external ties

The community fund, created in 1989, is for local residents who are in need of aid, which began when a chronically ill resident was in danger of losing her home (mrvcommunityfund.org). They immediately set up an MRV Irene relief fund that eventually raised over 1.2 million USD. Much of the money donated came locally but the majority came from out of the state.

We could've raised maybe $400,000 locally, but the big money came from out of town. That is the difference that you didn't find in some of those other towns. We pat ourselves on the back about being the neighbor that comes down with a pickup truck and a chainsaw but the real oomph came from these people that have a connection here. (20)

5.2.3 – Macro

Mobilization for Recovery

Outside of the MRV, state and federal organizations and agencies played a variety of restorative roles in the MRV, mainly allocating and distributing resources. Federal aid was available from FEMA as soon as the region was declared a disaster area. National non-profits also played significant roles, especially in terms of organizing aid based on need[7]. Ironically, the state's Emergency Operations Center was flooded and unusable for the disaster. The Irene Recovery Office was created, which coordinated and directed the recovery effort, and served as the primary bridging organization for activating state agencies and resources. The Department of Emergency Management and Homeland Security was created to provide guidance and technical support for crisis/emergency situations.

Restructuring and Expanding Networks

TSI also greatly affected state agencies. A flurry of initiatives, meetings, projects required separate agencies to work together. The flood forced many agencies to relocate, moving multiple agencies into the same building (well out of the floodplain).

[7] Volunteer Organizations Active in Disaster

"The inter-agency communication has historically been dismal...The Agency of Natural Resources got washed out of the town in Waterbury. They're now part of our building, which has really helped in the communication. That's also a by-product of doing these special projects. It forces you to have regular communication with those people. That way, you get to know the people. I think it's huge. It's all about building relationships." (8a,8b)

5.3 – Navigating

This section reveals a shift in focus from restoration to adaptive and transformative activities. At the community level, social, political, and economic spheres exhibit/develop TCs utilizing the momentum created by the storm. A shift in function of some capacities was notable e.g. shadow networks forming around obstacles and opportunities rather than novelty (see Box 2 below). Moreover, as the time from the storm increased, an element of reflectivity infused into decision-making, as one elected official stated:

I think the debate now focuses on 1: 'what should we do?' and 2: 'what resources are we going to bring to bear?' How much are we willing to invest in neutralizing climate change? How much are we willing to give, or give up? Its both a financial decision and its a lifestyle decision… So those are the active debates: what should we be spending, and the other is how much do we want to change our lifestyle. (7)

5.3.1 – Micro

Agricultural and Business Innovation: Mad River Food Hub (MRFH) and Small Business Incubator

The MRFH and the small business incubator are innovations that give MRV farmers and entrepreneurs a safe place to experiment with their products and resources with which to maximize their potential. The idea for the MRFH began in 2009 with a local entrepreneur who saw a potential within the local agriculture in terms of adding value to their products (1a,19):

"*If you start saying you want to help agriculture, then value added food companies is a way to help agriculture. You've only got so much you can produce. There is a very narrow season of the year for food production. If you value-add, you get more food out to people. I wanted to value-add*." *(19)*

The MRFH formed through a collaborative effort that included the VFN, MRVPD, Vermont Land Trust, MRV Chamber of Commerce, Localvores, Vermont Association of Conservation Districts, and Vermont Farm to Plate initiative. Through all, the drive and leadership of the entrepreneur continued to push this project (19,1a).

The MRFH serves as a food-based version of the already existing small business incubator started by the same entrepreneur. The incubator houses multiple businesses which then share resources, but also benefit from the business acumen of the owner who advises on business and marketing based obstacles. The food hub works in the same way providing a variety of processing and storage facilities as well as shared distribution. The distribution allows agricultural and small business clients to reach vastly more customers:

"I'm accessing this whole new demographic. Ninety percent of my CSA customers have never belonged to a CSA before. These are people who are just not gonna buy a share and come out to the farm every Thursday night. They want to support farmers, they want to eat locally, but they don't have the time. But if I can drop it off on their doorstep, they sign right up.[8] *"*

Innovation through Collaboration: The Mad Taco and VT Whey Fed Pigs Farm

Vermont Whey Fed Pigs is a MRV pig farm (owned by a cheese maker) that collaborates with the local dairy farmers for their whey, a waste product from cheese making, to use as pig feed. The Mad Taco began in the MRV with contracts with Vermont Whey Fed Pigs, and many prominent Vermont and MRV craft beer enterprises, while utilizing the MRFH. This collaboration pulls locals and tourists into supporting a network of local businesses.

[8] Jacobsen, R. (2013 November/December). From Farm to Table. *Orion.* Retrieved from http://www.orionmagazine.org/index.php/articles/article/7807

Expanding Economic Diversity

The MRV is currently marketing itself as a craft beer destination, offering "bed and brew" tours, and a burgeoning mountain-biking destination (1a,21,madrivervalley.com). With these collaborations, local businesses and farms support each other and make the MRV more of a year round tourist destination. Dairy agriculture is turning more towards artisanal cheeses, and they even have a fledgling wine industry. With the development of craft beers, fine liquors, wine, cheese, and meat often exclusively available locally, the MRV is diversifying their attraction and economic base (21).

Box 2: Formation, activation, and resolution of a shadow network.

Shadow Networks at work

At a MRVPD steering committee meeting, the new Chamber of Commerce Chairman made his first appearance. The steering committee chair was gracious at first but his frustration at the lack of Chamber participation and cooperation with the MRVPD became evident. After the meeting two key members of the committee stayed to have a quick word with the Chamber Representative (1a,6). Over the next week each had a long talk with the Chamber Rep:

"We sat down, having a cup of tea at the Big Picture [café] and hashed out the very broad stroke of what this cooperation might look like and frankly that's the way I like to do businesses: get somebody who you trust and you think is pretty bright and see if we can get momentum going. So, I can imagine within the next couple of months that a contract will be signed between the two organizations." (21)

Now I have to sit down with these folks with certain power in the community that don't want this to happen and I'm sure that I will better understand their reluctance, but that might be an obstacle. I don't see that as insurmountable. I think that if it makes sense to me I'm sure that I can convince others that there's lots of good reasons to do it. (21)

With the formalization of this contract the members of this shadow network will have begun navigating the transition of the relationship to a collaborative partnership and enhancing the potential of the two organizations.

Tension with TC Attributes

Resilience of Networks and Consistency of Governance:

The networks in a community are very dynamic. They are both personal and professional and both aspects are subject to change.

You have to keep renewing those relationships. People change on the various boards, the heads of this and that change, and you have to keep renewing it. You have to keep renewing your relationship with the landowners where you post the E. Coli results. All of that is important. (9a)

Organizations are also subject to shifts, especially governance regimes determined by elections. The results of these shifts can be unpredictable, with perceived positive or negative outcomes.

After the 1998 flood in Warren, "*it was decided that it would make sense to remove the dam in Warren village. The select board talked about it for a long time and then said, 'Okay, let's go ahead with this. This makes sense.' So studies were done, money was spent, and then there was a select board election. People got off and other people got on. A guy who used to own the dam got on. So they never did any of that. And now, the dam can't be permitted to be fixed or do anything, so it's going to fail. The houses behind it? Who knows? (9a)*

5.3.2 – Meso

A myriad of activities are applicable to this section, therefore only novel or in other ways significant aspects are singled out. Each of the following results reflect the activities of: bridging organizations, especially the MRVPD; networks, formal and social, (which are expanding and being utilized in a variety of ways); and leaders and frontrunners.

Policy – Integrating the Ecological

In the town of Warren, FEH legislation had very little support in 2010 and did not pass at that time. However, after the storm FEH legislation gained a lot of traction and was finally passed in 2013. *"Irene really changed their attitude about FEH zoning. So I feel like there was this switch, like the opportunity and political will to do this was greatly increased" (15).* The momentum of TSI notwithstanding, the leadership of a small group of residents was critical to this legislation (9a,15).

New Digital Networks

The Front Porch Forum (FPF), a membership based online forum, releases a daily list of communiqué from the member base. The FPF currently[9] connects 1503 residents of the MRV. This is used to advertise community events and opportunities as well as all manner of things to sell, buy, or trade from available farm goods to jobs to lost pets to apartments for rent.

Experimentation, Building Knowledge and Social Learning in Historical Contexts

The MRV Hill Farm project began in response to TSI as an exploration of the potential of the hilly plateau, which sits well above the floodplain, as viable farmland. The project's goal is to revitalize hill farming through by understanding its history in the MRV, and highlights the lessons learned to argue for the viability of hill farming today (1a,14). The project included a paper written by a local historian along with an hour long video, communally played twice to packed theaters.

MRV Economic Study – Building Knowledge

In late 2013, the MRVPD commissioned an economic study of the MRV through assessing data, interviews, and broad citizen participation through online surveys. This study produced statistical representation of the MRV's economic profile and health along with a large number of opinions and ideas that can be used by the MRV to inform future development. It also uncovered desirable areas of economic potential that residents and entrepreneurs could exploit (MRV Economic Study 2014).

Tension with TC Attributes

Infrastructure Shifts: Municipal Water and Municipal Wastewater

A large part of a functioning compact town-center is the infrastructure that can support it. The town of Waitsfield recognized this need and began the process of creating a municipal water system. Somewhat unexpectedly the process was fraught with contention and took over a decade to resolve, *"the Waitsfield water system seemed like a slam-dunk to me and it's been very difficult,"* (2) expanding a recognized rift in the MRV between "locals" and "newcomers" (1a,3,4,6,14) to include a debate on limits to growth (14). The town also needs municipal wastewater

[9] As of August 2014. The number keeps growing.

to support the compact downtown, however that process has also met serious obstacles and after a decade in debate there is a pilot project finally proposed for 2014.

"There's no one actually looking across the state at anticipated climate impacts to water and wastewater saying, 'These risks are statewide. We're going have major expenses in wastewater and infrastructure expenses statewide if we don't do something.' I think part of that is because Vermont water and wastewater systems are run by municipalities and very decentralized. So we see each community dealing with their own system. Most of them are making decisions to just defer maintenance and not really deal with it." (13)

5.3.3 – Macro

Policy Experimentation and Building Knowledge

Soon after the storm, the US Environmental Protection Agency (EPA) asked the Vermont Agency for Commerce and Community Development (ACCD) to apply for Smart Growth Implementation Assistance (SGIA) to develop smart growth strategies in flood prone locales. The ACCD chose the MRV as their case study location:

"The MRVPD is there. That's a unique organization in the state. It enabled us to look at flood resilience issues from a watershed point of view rather than just from a town-by-town point of view. It allowed more of a landscape level view, working down to recommendations from there. I think that was probably the best decision we made, choosing the MRV." (8a,8b)

This gave the MRV access to a panel of experts who completed a comprehensive assessment of the MRV in terms of development trends and local hydrology to apply in further development in a strategic and scalable way. The strategies from the SGIA study are meant to engage municipalities and residents in actively working towards flood resilience.

Smart Growth Vermont, in a context broader than flood resilience, refers to compact, concentrated development surrounded by open countryside (1a,8a,8b). The SGIA

project is built around this statewide goal. The problem for this goal is implementation:

"What you'd have to do is start with the towns. Start telling them to change their municipal plans so that the guy who wants 300 acres up there can't build a house on it; that he can't build a road up there; that he can't have community services up there. Because it's all gonna be concentrated." (7)

Building Knowledge Statewide – the ISC Report

As a result of TSI, the Institute for Sustainable Communities (ISC) was contracted by the state of Vermont to begin the Resilient Vermont project in 2012. The final report focused on adaptation and mitigation strategies, emphasizing the formation of collaborative networks, whole watershed management, social learning, integrated policy, and experimental case study areas. Its primary recommendation advocates for a statewide network, the Vermont Strong Network, to facilitate the cohesion of state efforts and the dissemination of information.

"When you're thinking about these capacities in a small state like Vermont, recovery from something like TSI is just all consuming. There was no extra people or brain-space to think more long-term. So they asked us to try to do that. In a lot of our documents, you'll see that we talk about either a pivot from recovery to resilience or a transition from recovery to resilience and that's – we're very much trying to make that bridge." (13)

Unifying of Vision

There was a unifying aspect of the storm on the state agencies. Instead of each agency pushing their own agenda there was an alignment behind an agreed upon one surrounding smart growth principles.

"Since Irene, agencies are recognizing that there's special status of villages and downtowns, which ANR[10] resisted for years. But they're all spouting the party line now. They all know how to talk about villages; they all are very supportive of

[10] Vermont Agency of Natural Resources

compact centers and downtown villages. Everybody's aligning and not just talking the talk.." (8a,8b)

5.4 – Tracking Ongoing Transformations

As part of this research, four transitions (three ongoing and one immanent) were identified in this community regarding: new region-wide land-use regulations, local food movement, ecosystem management, and cultural identity. As their dynamics directly reflect the use and activation of TCs, many of the aspects of the transitions have already been outlined above. The transformation of ecosystem management is discussed here (section 5.4.1) while the others are discussed in Appendix 9.3.3 regarding: relation to phases, the TC attributes evident, scale, and interactions with each other.

5.4.1 – Transformation of ecosystem management: relationship to the watershed

This transformation from top-down planning to more integrated ecosystem management, in the navigation phase, involves: long term planning, policy experimentation, a linked SES, shifts in development patterns, and a paradigm shift in individuals. Over the past 200 years, Vermonters have tried to control their rivers and streams, "by human-imposed changes to the width, depth, slope, and sinuosity" (Kline and Cahoon 2010 p4). The changes to the river have allowed development and farming in the floodplains, but have disallowed rivers access to them.

"The river did all of the incising on its own, as a response to straightening and armoring. I think that mostly people just wanted to be efficient and build roads and bridges where they wanted to build them, and farm where they wanted to farm, and the river's natural fluctuations were inconvenient. So attempts were made the hem the river in." (15a)

The two towns of the MRV that surround the Mad River have instituted FEH regulations (see above) which are an attempt to allow the river to eventually function the way it naturally would, shifting its channel over time and releasing discharge into the floodplain. The SGIA motto of "slow it, spread it, sink it" is a watershed scale plan to address how, and how fast, water flows through the watershed. This involves

rethinking how the MRV is developed, how people use their land, the placement and design of roads and ditches, and the value of healthy soils and forests. These concepts are sinking into the culture of the MRV (15a), but there is resistance:

"They still believe that taking gravel out of the stream is a better thing to do for the river, still after 30 years of 40 years. So it's entrenched ideas that people refuse to look at – not enough education. People think this is right when science says something else. That's a problem." (9a)

Table 5: Attribute matrix – across phases and scales. This table represents a summary of the results. The attributes are in bold, the focus of some attributes in capitals, and examples in parentheses. They are also color coded by cluster, aligning with Tables 3 and 4, as follows:

Green = SES Perspective
Yellow = Novelty Creation Cluster
Blue = Agency Cluster
Tan = Scalar Alignment Cluster

Part 1 – the Micro Scale

SCALE	ATTRIBUTES EVIDENT DURING THE PHASES OF TRANSFORMATION *ISSUES OF FOCUS (specific examples)*		
	PREPARING	TAKE OFF	NAVIGATING
Micro	**Innovation niches** **Informal networks** *around ISSUES/IDEAS (Energy Talks, Transition Towns, VFN)*	**Innovation niches** **Informal networks** around ISSUES/IDEAS and *ORGANIZATION /COMMUNICATION*	**Innovation niche** **Informal networks** *around OBSTACLES/ OPPORTUNITIES – (Food Hub)*
	-	**Experimentation** *around ORGANIZATION /COMMUNICATION*	**Experimentation** *(Mad Taco+VWFP)*
	Building Knowledge *(FMR, Forest + Wildlife)*	-	-
	-	**Leadership** *around ORGANIZATION*	**Leadership** *MRFH, Steering Committees, FMR*
	Social/Formal Networks *between individuals/ building relationships.*	**Social/Formal Networks** *around ORGANIZATION / COMMUNICATION*	**Social/Formal Networks** *around MAINTAINING/EXPANDING*
	Informational organizations *(Valley Reporter)*	-	-

Part 2: The Meso Scale

SCALE	ATTRIBUTES EVIDENT DURING THE PHASES OF TRANSFORMATION *ISSUES OF FOCUS (specific examples)*		
	PREPARING	TAKE OFF	NAVIGATING
Meso	**SES perspective** *(FEHz, Forest +Wildlife, FMR)*	-	**SES perspective** *(FEHz, Forest, SGIA)*
	Policy Experimentation (FEHz)	-	**Technical Experimentation** *(Hill Farm, Food Hub)*
	Building Knowledge (FEHz, Forest +Wildlife, FMR)	-	**Building Knowledge** *(Economic Study)*
	-	**Leadership** *around ORGANIZATION*	**Leadership** *(MRVPD)*
	Establish Formal Networks (VFN)	**Formal Networks** *around COMMUNICATION*	**Social/Formal Networks** *(VFN, FRF)*
	Bridging Organizations (MRVPD)	**Bridging Organizations** *around RESOURCE ALLOCATION AND MULTISCALE*	**Bridging Organizations** *(MRVPD)*
	Collaborations/ Partnerships (MRVPD, MRWCP)	-	-
	Social Learning *(FMR, MRVPD)*	-	**Social Learning** *(Hill Farm, Economic Study, FMR, VDAT)*
			Long Term Vision *(FEHz, Forest, SGIA)*
	Shared(?) Vision *(VFN)*	-	
	-	-	**Multi-scale Thinking in Governance** *(Forest + Wildlife, SGIA watershed)*

Part 3: The Macro Scale

SCALE	ATTRIBUTES EVIDENT DURING THE PHASES OF TRANSFORMATION *ISSUES OF FOCUS (specific examples)*		
	PREPARING	TAKE OFF	NAVIGATING
Macro	**SES perspective** *(FEH incentives)*	-	**SES perspective** *(SGIA)*
	Policy Experimentation *(FEHz incentive and policy model)*	**Policy Experimentation** *(EPA=>SGIA)*	**Policy Experimentation** *(SGIA)*
	-	-	**Building Knowledge** (ISC Report)
		Bridging Organizations *around RESOURCE ALLOCATION (IRO)*	
	-	-	**Formal Networks** *(ISC Vermont Strong Network)*
			Long Term Vision *(SGIA, ISC)*
	-	**Aligning of vision-**short term *(VT Agencies)*	
	-		**Multi-scale Thinking in Governance** *(Resilient VT, Watershed plans)*

6.0 – DISCUSSION

6.1 – Transformative Capacity Framework

RQ: *What are the attributes of Transformative Capacity in social-ecological systems?*

This study used qualitative methods to assess the efficacy of a newly developed framework assessing TC through a set of attributes. As this study progressed it became increasingly difficult to understand what changes or characteristics would apply towards transforming to SES sustainability in a community context (Carpenter et al. 2012). For example, cross-scale and cross-sector collaborations like the MRFH (5.3.1) exhibit many capacities, however there was no metric to include these as part of TC beyond instinctively understanding that supporting locally-based industry, businesses, and social trends will likely add to the sustainability potential of the region. The regenerative development literature shed light on this dilemma. Regenerative development has many parallels to the SES resilience literature. Regenerative development applies a permaculture perspective to development and aims to transition people's worldviews, with the goal of long term co-evolution of human and natural systems (Mang and Reed 2012). They assess how a change or characteristic affects the 1) vitality, 2) viability, and/or 3) evolutionary potential of the region or industry (Mang and Reed 2012), where vitality refers to the overall activity and energy; viability is of the social, economic, and/or political foundations; and evolutionary potential refers to the ability to change and grow in a proactive (versus reactive) manner. This model allowed for the spectrum of community aspects/activities to be evaluated and included in the capacity assessment.

6.1a – Regarding Attribute Clusters:

The grouping of attributes into clusters was both useful and significant in organizing the study structure as well as understanding the dynamics of change in the SES. Significantly, the clusters are interactive and interdependent in transformation scenarios e.g. it is likely that in order to have system change scalar alignment is necessary, because novelty without alignment may be confined/limited to the niche level, as is shown in Table 5, which shows the primacy of problem solving

(innovation niches and informal networks) and agency during take-off, asserting the restoration focus of this phase. Similarly, alignment without novelty may create a stasis that is resistant to change.

6.1.1 – TC Framework Cluster 1 – Novelty Creation:

This cluster is focused on the development of TCs through the formation and activation of innovations. Unsurprisingly, innovation niches and informal networks were well represented throughout the phases with significance on the shifting function/purpose (see 6.2).

Experimentation is most significant in the preparing phase as a main activity in the innovation niche (Rotmans, Kemp, and Van Asselt 2001) and for building knowledge of system dynamics (Olsson et al. 2006). However this study indicates experimentation may also occur outside of identified niches and in multiple phases (Table 5). Experimentation took a variety of forms primarily in the development and debate of new ideas and practices. For example, farmers experiment on their land, to find best practices. Experimentation was also exhibited by cross-sector collaborations, testing the viability of local sourcing for products (primarily food). Vermont municipalities are limited in their policy-making to land-use therefore, policy experimentation is a top-down process, in which state land-use and development goals are incentivized and offered to municipalities.

Building knowledge is a noted key aspect of the preparing phase and is often tied to experimentation (Olsson et al. 2006; Berkes 2009), indeed this study considered it an embedded aspect of experimentation. However, building knowledge was often utilized outside of the experimentation context by governance bodies and NGOs that highly value participatory and scientific studies to understand dynamics and trends. Furthermore, its appearance through the navigation phase indicates the value of building knowledge as its own TC in the framework, highlighting the significance of knowledge in the transformation process.

6.1.2 – TC Framework Cluster 2 – Agency:

This cluster focused on the agency aspects of TC highlighting leadership, social/formal networks, and bridging organizations. These are responsible for spreading the innovation from the niche through the regime. With the expanded complexity of a dynamic community and evidence of a variety of transformations occurring on multiple scales, the necessity of bridging organizations, social/formal networks, and leadership seemed to increase. Both social and formal networks were consistently in use for all manner of issues, conflicts, innovations, or governance. Social media platforms were especially useful and highly utilized in the crisis and restoration periods (Palen 2008). The VFN list-serve and subsequently Facebook provided on-the-spot communication greatly facilitating information dissemination and mobilization of resources. These, together with bridging organizations, revealed a high level of connectivity between residents.

The study revealed the importance of partnerships in the development and activation of TC. Partnerships have been shown to play a significant role in transformations to sustainability (Frantzeskaki, Wittmayer, and Loorbach 2014) as well as in polycentric systems (Galaz et al. 2012), concerning information sharing and synergies in collaboration, resource pooling, and governance. Formalized partnerships in the MRV are critical to its current functioning, most significantly the MRVPD (see 5.1.2). Partnerships are clearly representative of agency, however they are neither formal networks nor bridging organizations. The addition of partnerships to the agency cluster will enhance the ability of the assessment to capture the dynamics of these groups and their role in SES transformations.

Leadership became a limiting term as the attribute took a variety of forms often in a collaborative context, and therefore seemed a limiting term. It may be better served by the idea of the Institutional Entrepreneur (IE) especially in the complex problem domain of a group of communities sharing a watershed (Westley et al. 2013). The IE is an actor who works to create new or transform existing institutions (Garud, Jain, and Kumaraswamy 2002) and serves many functions in a transformative agency context (Garud, Hardy, and Maguire 2007): to “manage the context,” of the larger SES, increasing the potential of an innovation and widening its impact sphere (Moore

and Westley 2011 p5); to seize windows of opportunity and mobilize resources for innovations critical to transformations (Westley et al. 2013). The IE concept became a much more reasonable fit for this study as "leaders" shifted roles between visionaries to bridging entities to mediators to innovators. The work of the IEs was grounded in "good" personal/professional relationships, which were in turn grounded in trust. Trust has been shown to be a significant factor in effective leadership and networks, especially fostering collaboration (Olsson, Folke, and Berkes 2004). Collaboration was seen throughout this study area as the primary strategy for "getting things done". However, evidence suggested that one particular IE, serving primarily as a bridge connecting a wide spectrum of arenas (Berkes 2009), was the central node of connection in the region. The lack of functional diversity is troubling, where changes in this position can have serious reverberations through the working networks of the region.

6.1.3 – TC Framework Cluster 3 – Scalar Alignment:

This cluster focused on the manifestation of TC through cross-scale alignment in the following key areas: agreement of future trajectory (shared vision), shifting paradigms (social learning), and impacting governance patterns (long-term and multi-scale thinking).

The notion of a shared vision became complicated early in the study. The understanding of a shared vision as a common vision upon which all stakeholders agree (Loorbach and Rotmans 2010; Westley et al. 2013) does not apply well in a democratic context where many perspectives coexist, highlighting a contrast between the TM and resilience transformations literatures (Shove and Walker 2007), whose future vision of general SES resilience is ambivalent (Folke et al. 2010). While diversity in transformation is a boon in an innovation context (Frantzeskaki, Loorbach, and Kooiman 2009a), it can be a paralyzing characteristic when opinions clash (Adger et al. 2008), as shown by the prolonged difficulty in passing municipal water plans. The VFN, whose visioning exercises produced a strong narrative and future vision, became divisive because the vision was not broad enough to be inclusive (1b). Therefore, while acknowledging a shared narrative and mission for the

future provides a means to mobilize TC, vision in a community context may better be served though a "social imaginaries" lens, where community leaders create a shared set of macro scale goals/desires upon which there is broad communal agreement (Stephenson 2010). This would allow for a basis for conflict resolution without the need for universal agreement. However, on the level of the state government (macro), the disaster created an alignment of vision that was previously absent. With so much of the state in crisis, state agencies realigned behind a larger priority and began finding pathways of working together to achieve desired results.

Stimulating social learning is an essential attribute for both adaptive and transformative capacity, but difficult to identify given the complex nature of learning. However, if stimulation of social learning is interpreted as: knowledge sharing, facilitating access and participation, and openness of networks to discussion and debate (Berkes 2009), then there were many visible indications of social learning processes, such as a broad understanding of the connection between septic systems, flood/storm events, and e-coli dangers in the river. Also, discussions surrounding the passing of FEH regulations are evidence of a larger paradigm shift (Cumming et al. 2012), concerning the relationship to the river. The disaster event served as a learning motivator evidenced by the proliferation of resilience initiatives, studies, and debates post TSI. A key learning facilitator was a central meeting venue, which served as a gathering place for many social events e.g. alternative energy talks, auctions, film festivals, and music concerts.

Due to local limitations on policy-making, long-term thinking in short-term policy-making and multi-scale thinking in governance were restricted to land use examples. However, these areas were well represented in the study and found expression in multiple knowledge building projects whose purpose was to influence development patterns. Aligning with current literature (Frantzeskaki and Loorbach 2010b; Nevens et al. 2013), the long-term aspects of these projects include both forecasting and backcasting elements, that were intertwined with social awareness and learning efforts to create the momentum for change. Importantly, the study found a large capacity of the local governance to think and, significantly, network across scales, with a broad understanding of the need for open communication, information, and participation across scales. TSI forced a restructuring of governance on the state level,

creating a comprehensive emergency management structure, reconfiguring relationships to better deal with uncertainty (Chapin et al. 2010).

6.1.4 – Integrating the Ecological: the SES Perspective

Identifying this aspect in the capacity assessment took many dimensions. There was evidence that ecosystem based management motivation was propelled by the land ethic of individuals (Knight 1996; Leopold 1949), which was tied to their place identity (Stedman 2003). For example, farmers have a different relationship to the land, and therefore a different ethic, than recreationists or conservationists. Their differing perspectives can conflict or align depending on their understanding of the purpose of the land. At the meso level, this ethic expands to the identity of the region, which can again be varied/numerous depending on perspectives.

An expanding SES perspective was evident in many ways, especially when building knowledge to influence policy and regulations. TSI pushed the infusion of ecological knowledge, especially river, flood, and water dynamics across scales effectively shifting the conversation, linking previous ecological projects and goals e.g. a forest and wildlife study linked to smart growth principles i.e. the impacts of healthy forest and soils on water dynamics in steep terrain and compact concentrated development.

The potential transformation towards ecosystem-based management provides the soundest evidence of the integration of a social-ecological perspective. The adoption of FEH regulations denotes a new relationship to the river whereas the SGIA denote an understanding of a social-ecological structure in which the region exists. Together they form a new type of management structure, requiring new institutions, and generally reflecting a new paradigm which can be seen as a transformation (Frantzeskaki et al. 2010).

6.2 – Phases of Transformation

RsQ2: *When, and at what scale, are specific transformative capacity attributes mobilized during the transformation process?*

The phases of transformation have been shown to be quite useful in understanding the shifting change dynamics in SESs (Olsson et al. 2006). This study intended to inform on the specific capacities that dominate the different phases[11], and more generally on the dynamics of the phases, by exploring what attributes are being activated, developed, and mobilized in what scale.

This study confirmed expected patterns from previous literature (de Haan and Rotmans 2011; Olsson et al. 2006) that describe dynamics in the niche/preparing phase to propel the innovation into the regime level. Partnerships, such as the MRVPD and the MRWCP, built in the preparing phase were able to draw on synergies from multiple organizations and bodies (Frantzeskaki, Wittmayer, and Loorbach 2014) enhancing the ability to drive capacity enactment in the take-off and navigating phases.

The take-off phase is normally initiated by the innovation breaking into the regime level taking advantage of the window of opportunity (Brown 2013), in this case the flood event and as such became indistinguishable from restoration activities. In this phase, the framework attributes activated primarily around organization and communication (Norris et al. 2008): innovating and experimenting with a variety of tools, strategies, and technologies driven by the immediacy of need. Leadership and networks were essential for organizing the mobilization of resources, as were bridging organizations in making and maintaining vital connections across sectors and scales. The size of the event moved state government to prioritize restoration and to understand vulnerability, resulting in a shared vision of a flood-resilient Vermont.

In the navigation phase, results show increased attribute activity in all scales clearly visible in Table 5. It became obvious that different attributes are evolving by shifting focus but remain active:

Innovation niches and informal networks were very necessary beyond the preparing phase but shifted from novel ideas to communication and organization in the take-off phase to opportunities and obstacles in the navigating, which appear in a variety of

[11] However, the building resilience phase is not represented in this study as the transformation to SES sustainability is in its earlier stages.

modes including business and political collaboration/partnerships, which in themselves are experimental. Experimentation stretched beyond the niche to the macro governance scale, as the state addressed vulnerabilities with new strategies, which were employed on the regime scale, potentially indicating a reversal of the "normal" transition trajectory from a bottom-up to a top-down model.

Social and formal networks evolve from establishment to maintenance and expansion in the navigation. They are more active, often splitting into separate nodes as they connect deeper through the regime, but iterative by consistent reinforcing or reestablishing of relationships as actors change over time. Bridging organizations remain vital and central and the work of the IEs becomes more widespread as they continue to serve multiple functions. Overall, the aspects of agency are clearly evident, especially through the micro and meso levels, as key agents engage in problem solving (novelty cluster) and scalar alignments.

Meanwhile the integration of a SES perspective is underway in this phase. The social learning potential of the crisis event was not lost, and regulation such as the FEH and initiatives like the Hill Farm Project were examples of a shift in understanding towards a linked SES. Long-term vision in short-term policy and multi-scale thinking in governance make their appearances in the navigating phase which is evidence of a beginning alignment of temporal and governance scales.

6.3 – Deployment of Capacities

RsQ1: *How are transformative capacity attributes exhibited and activated in post disaster-event contexts?*
RsQ2: *When, and at what scale, are specific transformative capacity attributes mobilized during the transformation process?*

The post-disaster context of this study necessitated unraveling the use and development of capacities into restorative, adaptive, and transformative. An essential question involved determining if all three aspects were activated by the event at the same or similar time, or if there was some succession in their activation. The study found that restoration and recovery were primary goals on all scales in the early

aftermath of the event. Restorative capacity is the ability of the system to recover to normal functioning after a crisis or disturbance (Ouyang, Dueñas-Osorio, and Min 2012). The restoration of this region was relatively quick and effective, drawing on internal and external resources, arguably driven by an intense place attachment (discussed below).

Organization, and allocation and distribution of resources were top priority for many weeks. Although opportunities for transformational changes existed within this time period, the urgency of need pushed against traction for novel ideas. Development restrictions further prohibited transformational change in this period e.g. FEMA regulations that required rebuilding on the previous footprint to the previous state. The findings show that it is critically important to restore a sense of community before acting to bring about change. The reestablishing of community ties may be a prerequisite for the effective grassroots activation of restoration, adaptation, and transformation processes. This aspect is neglected from writings of transitions and transformations and therefore would require further study to develop an understanding of the connections between disaster events, capacities, and sense of community/community ties.

Mitigation efforts followed, evidenced by the addition of riprap to armor especially vulnerable river shore through the historic center. When the restoration became less urgent, adaptation efforts spread across the region and the state, with a surge of "resilience" initiatives, including some social and ecological scientific studies on adaptations to climate change[12]. Two years after the event, FEH regulations were passed where they had previously failed, signaling a potential SES perspective shift. While adaptation efforts continue through the region, they have begun to think about the nature of vulnerability in local historic development patterns and have engaged social learning efforts to shape how residents understand the complex relationship dynamics that create vulnerable scenarios. This is not to say that capacities switch from restorative to adaptive to transformative, but that over time, their understanding evolves to activate capacities; while still prioritizing restoration, they engage adaptation and embark on transformation (Figure 3). Said another way, this study

[12] University of Vermont's Research on Adaptation to Climate Change project

suggests that in a disaster context the typology of capacity for activation may depend upon the level of restoration completed.

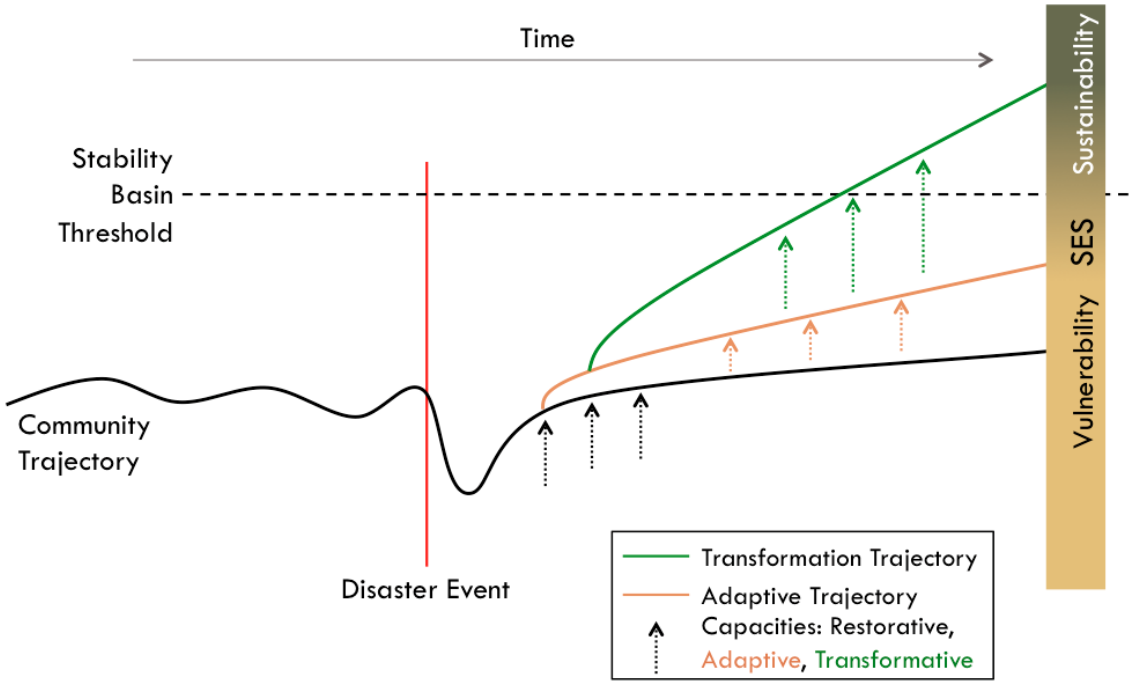


Figure 3: The activation sequence of capacity types in post-disaster communities of the MRV.

6.4 – Aspects that support/hinder TC

RsQ1: *How are transformative capacity attributes exhibited and activated in post disaster-event contexts?*

The data indicated that the ability of TCs to manifest, and the nature of that manifestation, depended on other foundational aspects of the community: individual resilience and place attachment on the micro scale, and community resilience and economic viability on the meso scale. The character of these aspects may support or hinder transformation processes, potentially requiring concurrent transitions to enable a system wide transformation (Gunderson and Holling 2002; Marshall et al. 2012).

6.4.1 – Tension with TC Attributes

There seemed to be a mismatch on temporal scales especially concerning consistency of governance, infrastructure change, networks, and leadership in a SES transformation (Shove and Walker 2007). Transformations are long-term processes that can involve a large amount of turnover in networks and leadership, which can

greatly affect the persistence of networks, and organizational and professional relationships. This, in turn, can affect medium term goals/projects that depend on consistent support, such as infrastructure shifts. Alternatively, it may be necessary for entrenched networks and leadership to undergo significant change and reorganization to allow for necessary innovations (Gunderson and Holling 2002).

6.4.2 – Individual and Community Resilience

Individual resilience looks at a variety of aspects of individuals e.g. relationships, personality, self-esteem, education, access to health care, and safe neighborhoods, all of which affect the ability of individuals to adapt to new and/or surprise scenarios (Brown and Westaway 2011). Equity and justice are also shown to be significant for assessing community resilience (Bahadur and Ibrahim 2010). These quality of life and well being attributes (IPCC 2012) are above normal for this study region (MRVPD Data Report 2013), as evidenced by the scale and duration of volunteerism post-disaster.

Community resilience can be seen as a set of indicators (Cutter et al. 2008), a network of capacities (Norris et al. 2008), or a set of characteristics centered around agency and self-organization (Berkes and Ross 2013), the depth of the development and potential for mobilization of which create the community's ability to recover from shocks. While both individual resilience and community resilience are positive for restorative capacities, it is unclear as to whether a resilient community is a transformable one where resilience focuses on recovery, constancy, persistence, and robustness. Whereas, resilience in a co-evolving linked SES has adaptability and transformability embedded into the resilient system (Folke 2006). Aspects of community resilience, therefore, may make the system highly resistant to change. Place attachment is one of these aspects and is discussed below.

6.4.3 – Place Attachment

Place attachment merits discussion, as it was a dominant recurring presence throughout the interviews (see Appendix 9.3.2). Place attachment is the emotional bond that individuals associate with a specific geographical space (Stedman 2003). Place attachment played a very significant role in the restoration of the MRV, with many interviewees citing their love of the valley and various community ties as

motivation for widespread post-flood engagement confirming current literature (Devine-Wright 2013; Norris et al. 2008; Tidball and Stedman 2013). However, place attachment's role beyond restoration into adaptation and transformation became convoluted as research continued. The NIMBY[13] response of residents to a proposed wind farm (see Appendix 9.3.2) is well predicted by current research (Devine-Wright 2013), reflecting the positive connection between high attachment and resistance to change (Lewicka 2011) including beneficial adaptations (Marshall et al. 2012). Indeed, the backlash expanded to include all discussion of alternative energy as a threat, indicating that place meaning, in addition to attachment, is highly significant in the change scenarios (Tidball and Stedman 2013). On the meso scale, a shift in the dominant meaning, as the MRV crossed the 50% second homes mark, may have considerable significance to the overall identity of the region (Stedman 2014, personal communication), signifying a potential transformation (Folke 2006; Walker and Salt 2006). The implications of place attachment and place meanings for transformation are relative unknowns[14], though this study indicates that transformation processes will likely encounter conflicting attachments and meanings that can severely hinder TC, perhaps reinforcing the strategic value of common social imaginaries (see 6.1.3).

6.4.4 – Economic Viability

Norris et al (2008) discuss economic development and resources as vital to post-disaster wellness. However, this does not include long-term resilience scenarios. Economic viability, separate from issues of equity and poverty[15], seemed an exceptionally vital aspect of resilience and transformability in this region. Many regions are dependent on dominant economic sectors that provide the employment and related vitality. The MRV is no exception, being highly dependent on winter resort tourism. However, with climate change predictions being unfavorable for the long-term viability of winter resorts, there is a huge question of long-term economic

[13] Not In My Back Yard.
[14] Lyon (2014) and Marshall et al. (2012) have made entries into the place attachment and transformation arena but there is some distance to go for clear assertions to be made
[15] Shown to be significant in community resilience, recovery, and adaptation (Bahadur and Ibrahim 2010) .

viability. As is seen in instances where the primary employer disappears, the dependent communities can collapse. Economic viability, in this case, can refer to a diversified economy, which may necessitate transformation.

6.5 – Theoretical implications of findings

This study indicated that current research on TM and SES transformations can be effectively combined in an analytical framework assessing TC. The capacity clusters were a useful tool in isolating aspects of novelty creation, agency, and scalar alignment as well as in filtering the experiences, actions, and decision-making of actors, networks, organizations, and governance bodies. The clusters also revealed the changing focus of many attributes through the transformation phases. Furthermore, the multi-level perspective model was essential in understanding TC connections/ interactions across scales. Important insights were gained on the engagement of restorative, adaptive and transformative capacity regarding the stages of activation after a crisis. The research process made it clear that TC is dependent on multiple factors beyond the identified attributes. The community identity, economy, culture and wellbeing matter, as does the depth and types of connection with the biophysical place. While the analytical framework was shown to be effective in identifying system elements associated with transformation, further case studies would be necessary to establish broader application. Despite the limitations, the findings of this study contribute to research in three main areas:

1) Integrating transition management and resilience transformations literature (Olsson, Galaz, and Boonstra 2014)
2) The mobilization of TC attributes in disaster recovery and response to climate change contexts (Adger et al. 2008; O'Brien 2011; Moser and Ekstrom 2011)
3) Community aspects that support/hinder restorative, adaptive, and transformative capacities (Norris et al. 2008; Cutter et al. 2008; Marshall et al. 2012; Tidball and Stedman 2013; Berkes and Ross 2013)

6.6 – Limitations Of Study

- Divisive social aspects negative for community resilience e.g. inequality, poverty, and unemployment (IPCC 2012; Bahadur and Ibrahim 2010) were controlled for in

this study by the choice of locale, which does not exhibit extremes in these areas (MRV Data Report 2013). This allowed for capacities to be explored from a more even baseline, while recognizing this limitation.

- Other attributes such as a willingness to change or ability to envision alternative futures, e.g. as a result of a dissatisfaction with status quo, were not explored though elsewhere shown as positive for transformative change (Wilson et al. 2013).

7.0 – CONCLUSIONS

This thesis has presented a method of assessing the TC of a coupled SES as an interconnected framework of attribute clusters Each identified attribute was significant for TC development and mobilization, and each cluster significant for assessing overall TC. Ecological, social, and economic knowledge coupled with resident participation and inclusion, was strategic for alignment across-scales and key to enable SES decision-making, planning, and development in short and long-term scenarios. Integrating the ecological perspective was facilitated by the crisis, reiterating crises as windows of opportunity especially for affecting human-nature paradigms. Furthermore, this study showed the complex but critical nature of emotional biophysical and psychological attachments in transformational change scenarios.

The understanding of transformative capacity and transformation dynamics is incomplete but there are logical next steps that would build off of this research:

- A combined TM and resilience perspective should highlight the dynamics of the agency cluster, focusing on the proactive role agency through strategic planning and engagement. Further studies should scale-up to examine TC in urban centers in climate vulnerable areas such as deltas and coastlines. Furthermore, the inclusion of power dynamics in transformative agency research seems prudent especially in light of disaster predatory economics e.g. disaster capitalism[16].
- There are three areas of significance to TC for further exploration: place attachment, meanings, and identity in transformations; the importance of community ties in restoration and recovery; and the effects of interacting/conflicting transitions on SES transformation trajectories.
- Research in the MRV could continue in the transformation in response to climate change context from a TC or agency perspective, focused on high community engagement, place attachment, and community resilience.

[16] Klein, Naomi. 2007. *The shock doctrine: the rise of disaster capitalism*. Toronto: Alfred A. Knopf Canada.

Adaptation and transformation efforts in response to climate change are occurring throughout the world especially in post-disaster areas. Giving the growing threat of climate change and its effects, there is a pressing need for stakeholders and change agents to more strategically engage their time and resources. Ultimately, the analytical framework for TC and the findings from this case study allows key actors to create informed long-term strategies to both prepare for and navigate dramatic change processes by identifying specific underdeveloped attributes, facilitating strategic mobilization, and anticipating future obstacles and opportunities.

8.0 BIBLIOGRAPHY

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9.0 – APPENDIX

9.1 – Case Site Description

9.1.1 – Mad River Valley Planning District (MRVPD)

The MRVPD is a unique (in Vermont) governance body, which unites the three towns of the watershed (Warren, Waitsfield and Fayston[17]) in a formal partnership with Sugarbush ski resort and the MRV Chamber of Commerce (see Map 3). The MRVPD, whose communities cover 72% of the Mad River catchment area or 267 km^2 (www.mrvpd.org/land_conserv.php)[18], was created in 1985 as a response to the pressure that the Sugarbush ski resort was putting on the Mad River through its use of river water for snowmaking (4,23 Town Plans). The MRVPD is supposed to "carry out a program of planning for the future of the Mad River Valley. The planning program shall be directed toward the physical, social, economic, fiscal, environmental, cultural and aesthetic well being of the member Towns and its inhabitants," (www.mrvpd.org). The MRVPD has a paid Executive Director that is guided by a *steering committee* made up of a *selectboard* and planning commission member from each town, a representative of the MRV Chamber of Commerce, and a representative from Sugarbush ski resort. This body allows for the alignment of goals and policy throughout the watershed. The monthly meetings force town policy-makers to meet with each other and representatives of the larger business communities regularly, to discuss issues and problems, and develop problem-solving strategies.

9.1.2 – Governance

The state of Vermont has two levels of government: state and municipal. There are no county governments. Therefore there are no regional governance bodies that would function on a watershed level or to handle disputes between municipalities. There are 237 towns and therefore 237 town governance systems. Most of these, including the

[17] A fourth town of the MRV, Moretown, is currently undergoing the process of integrating with this governance body. With Moretown, the MRVPD will administer nearly the entire watershed and include over 90% of the valley residents.
[18] The southernmost part of the MRV and the last section of headwaters are in the town of Granville. Nearly all of this region is both National Forest and National Wilderness, and therefore under very restricted use regulations (http://anrmaps.vermont.gov/websites/anra/)

towns of the MRV, are governed by a group of elected officials that make up a *selectboard.* The duties that fall to the selectboard are broadly the "general supervision of the town" (VLCT Selectboard Handbook 2006), which importantly includes: land use, zoning and permitting, local roads, and all town expenditures. Various other bodies such as a planning commission, development review board, and a zoning board often support the selectboard. No members of selectboards are paid employees of the town; in fact very few positions in town governance are paid positions, meaning that the essential governing of towns is by volunteers.

Significantly, the MRV, and Vermont as a whole, has for the breadth of its history had a culture of direct democracy (Bryan 1995). This is manifest in Town Meeting day, which citizens of each town attend a singular meeting where issues are presented, such as the town budget, discussed, and voted on (Bryan 1995, Waitsfield Town Plan 2012). This culture of democracy is a cornerstone of governance in the MRV and requires the participation of a wide spectrum of the town's residents.

9.1.3 – MRV Demographics

The towns of Warren, Waitsfield, and Fayston generally have a higher median income compared to the rest of Vermont. They have very highly rated school systems, which increases the desirability of the region, and therefore real estate prices. Despite high property values and taxes the population growth of the MRV is at 6.6% (2010 Data Report), which is more than twice the average for Vermont. The primary employment industry revolves around tourism (51% of every dollar (1d)) including the largest employer and tourist draw of the region: Sugarbush ski resort. Property values in the MRV are high for Vermont making it difficult for workers in the service professions and to afford to live in the MRV. Sometime in the past decade the percentage of second homeowners in the MRV crossed 50%, though the non-resident property taxes are high. There is a growing sector of people who work from home, currently at 23% (V-DAT project report 2013) as well as a healthy and growing professional and business services sector (MRVPD Data Report 2013). Agriculture is more significant culturally, as an identity marker, than economically accounting for only a small percentage of the region's jobs and annual earnings (MRVPD Data Report 2013). There is very little racial diversity (90+% Caucasian) in the region, although it is roughly average for the state of Vermont.

9.2 – Methods

9.2.1 – Critical Reflections and Limitations of data and methods

This study attempts to develop a new framework for analyzing capacities that support community transformations. Change processes that are not a planned and directed process but rather one triggered by a crisis event and that are navigated. As this is a one case study, there is a question of generalizability and transferability of insights. This study does not seek to generalize results for communities broadly, but constitutes an opportunity to test the new framework and inspire other studies in other contexts or/and serve as a basis for comparative studies (Hirschman 1986).

This study was time-sensitive: it had been two years since the crisis event, therefore recall of past actions, experiences, and decisions are questionable. However it has been shown that with extraordinary events such as natural disasters, reliability of personal accounts is maintained for at least two years (Norris and Kaniasty 1992).

9.2.2 – Sampling considerations

A limiting factor is that it is not feasible for this study to interview everyone involved in the collective capacity of a region. However, care was taken to ensure that interviewee perspectives were representative of the diversity of stakeholders to be able to confidently analyze the data through the context of this study's analytical framework. Because the interviewee pool was vetted though purposive sampling there were no interviews where the individuals perspective and experience was not valuable to this research. However, it is recognized that this method is dependent on the unbiased recommendations of one central office in the MRV. To allow for this, referrals were requested from interviewees, which were then assessed for relevance, controlling for scale, redundancy, and scope.

9.2.3 – Challenges with qualitative interviews

Qualitative semi-structured interviewing can be quite challenging and requires the interviewer to have, not only a high level of working knowledge on the topic, but also the skills to analyze in the moment and know how to pursue an unforeseen idea or perspective (Kvale 1996). This was achieved through extensive preparation before the interview process began, as well as previous to each interview. Further triangulation of evidence from various sources (Yin 2011 p81) enhanced the credibility of interview data.

The culture of the area is very warm and welcoming which allowed for an ease of manner in the interviews as well as the opportunity to ask follow-up or clarifying questions. Moreover, the study design allowed me to forge friendly relations with the townspeople. I was introduced to many interviewees through my local contact, who opened many doors to me. I also presented my research topic at a governance meeting of the MRVPD, which allowed me to meet and speak with many interviewees previous to our interview.

9.2.4 – Alternative methodologies

This study is designed to be a qualitative study because it is specifically looking for attributes of the community that are difficult to uncover quantitatively. An understanding of the history and the culture of the area as well as the dynamics of interpersonal communication are essential to this study. Therefore the use of surveys was determined to not be effective, as the information available through surveys would not capture the complexity of human-environmental interactions.

Using focus groups as a method was discussed and eventually discarded mainly because the area is both proactive and not unstudied, meaning that there had recently been focus group research projects, all surrounding resilience issues, resulting in a bit of research fatigue. However, the results of the focus group studies were made available to me and used to help select individuals for the interview sample group.

9.2.5 – List of local documents surveyed.

Document	Year	Type	Explanation
Local Land Use Planning	2007	Handbook	Vermont guide for local land use planning and regulations
Selectboard Handbook	2007	Handbook	Vermont guide for local elected selectboard officials
Fayston Town Plan	2008	Handbook	Outlines past + present with future planning/development goals
Warren Town Plan	2010	Handbook	Outlines past + present with future planning/development goals
Orange Book	2011	Handbook	Vermont Agency of Transportation guide for local officials
Waitsfield Town Plan	2012	Handbook	Outlines past + present with future planning/development goals
Community Strategies for Vermont's Forests and Wildlife	2013	Handbook	Guide for community actions to support local forest and wildlife
MRV Watershed Map	2010	Map	Map of MRV towns and watershed
MRV Ecological Conservation Focus Areas Map	2013	Map	Visual of areas for conservation in MRV
MRV Tiered Ecological Priorities Map	2013	Map	Visual of areas by ecological priorities
VFN Next Stages	2010	Meeting minutes	Summary of Valley Futures Network future trajectory
Warren FEH regulation	2013	Municipal regulation	Details of regulating development in the Mad River corridor for town of Warren
Mad River Dynamics	2011	Presentation	Understanding the science of river processes and flooding
Flood Talk History Irene	2012	Presentation	History of flooding in the MRV
MRV Hill Farm Research Project	2013	Presentation	Explanation and description of MRV Hill Farm Project
Safer Areas: Plan and Direct New Development	2013	Presentation	Highlights areas for development not vulnerable or detrimental to flood/water management
Addressing Flood Resilient Communities	2014	Presentation	Strategies towards flood resilience in the MRV
Best River Ever	1995	Report	Friends of the Mad River's conservation plan for MRV watershed
Fluvial Geomorphology Assessment	2007	Report	Friends of the Mad River's fluvial geomorphology assessment for the MRV watershed
Upper Mad River Corridor Plan	2008	Report	Friends of the Mad River's corridor plan for the upper reaches of the Mad River
Natural Heritage Inventory	2008	Report	Natural heritage element inventory and assessment for Warren
MRVPD Data Report	2010	Report	Demographic data for the MRV
Resilience	2011	Report	Agency of Natural Resources health of Vermont's environment status
Climate Change Vermont	2011	Report	Assessment of climate change projections for Vermont from Agency of Natural Resources
Comprehensive Energy Plan	2011	Report	Overview of Vermont's energy plan
The Mad River	2011	Report	Overview of the Mad River ecosystem effluent

			and other runoff effects
Community Recovery Partnership Report	2012	Report	Outline of community based recovery efforts
Lessons from Irene	2012	Report	Summary of damage and changes in state from Irene
Irene Recovery Report	2012	Report	Outline of statewide disaster recovery efforts
Vermont Environment Report	2013	Report	NGO report of main issues affecting Vermont ecosystems
Farm to Plate Executive Summary	2013	Report	Outlines the Farm to Plate initiative
Lake Champlain Water Quality	2013	Report	Assessing effects of unpaved roads on lake Champlain water quality
MRVPD Data Report	2013	Report	Demographic data for the MRV
Irene Recovery Office	2013	Report	Summary of Irene recovery efforts in the state
ISC Focus Group Report	2013	Report	Summary of Institute for Sustainable Communities results from focus group studies
ISC Roadmap to Resilience	2013	Report	ISC's final report on assessment and recommendations for a resilient Vermont
ISC Taking Stock	2013	Report	The scope of issues/areas covered in ISC final report
Winooski River Basin Plan	2013	Report	Winooski river basin water quality management plan
Watershed Restoration and Resiliency Project	2013	Report	Storm water management regulation in MRV review and recommendations
Post-Irene Habitat Assessment Report	2013	Report	Impacts of Irene on stream habitat and fisheries
Smart Growth Implementation Assistance Report	2013	Report	Policy recommendations for state agencies for 'smart' development
Flood Resilience Checklist	2014	Report	Checklist for municipalities to assess flood resilience efforts
SGIA Report	2014	Report	Planning for flood recovery and long-term resilience in Vermont
MRVPD Economic Study	2014	Report	Current and potential economic directions in MRV
Municipal Authority to Regulate Private Property	1967	State Legislative Act	Summary of Vermont laws regulating municipal authority over private property
Act 16 Summary	2013	State Legislative Act	Vermont Act requiring municipalities to have a flood resilience plan

9.2.6 – Interview Guide

The following table is color-coded: Green = opening questions-light - get to the story/narrative; Blue = specific questions-detailed – events, strategies, ideas; Red= reflexive questions - synthesis - why, connections, etc.

WHERE TC LIES – Novelty Creation: Innovation niches; Innovation incubators; Shadow Networks
This sections purpose is to uncover the diversity represented by alternate ideas etc. to the regime and the process through which those ideas changed as a result of the crisis event.

	SCALE			To Capture
PHASES	Micro	Meso	Macro	
Preparing	Can you tell me about your main interests in the MRV? What excites or inspires you about this place? Can you tell me from whom you first heard the idea and describe how that conversation/ series of conversations took place?	Can you tell me about organizations NGOs that were perhaps considered alternative before the storm but are more recognized today? **Look for constraints here…	How much of an impact do you think things like the global climate change debate and the economic crisis affected the MRV pre-Irene? How did the MRV respond to these "events"? **Look for opportunities here…	What was happening in the innovation spaces? What were the conditions that allowed those spaces to exist/develop?
Navigating	How did you see the storm as an opportunity to try something different? What were the conversations about beyond the safety and care of families?	Can you tell me about new organizations/ NGOs that are now active in the MRV?	How far reaching was the national response and did that allow for avenues of action that would not otherwise have been available?	Did the niche/s "break into" the regime space? What were the conditions that allowed that to happen? How was the Window of opportunity utilized?
Building Resilience		Does this area consider it a cultural value to engage in local governance; to organize; a do-it-yourself attitude?		Can actors influence the institutional dynamics of the societal system? - Regulative, Normative, Culturo-cognitive How are these ideas translating into policy?

WHO ARE THE TC CARRIERS and HOW DO THEY OPERATE – Agency: Networks; Bridging Organizations; Leaders/Frontrunners
The purpose of this section is to uncover the connectivity between actors etc. and key figures that are the driving forces behind the mobilization of TCs.

	SCALE			TO CAPTURE
PHASES	Micro	Meso	Macro	
Preparing	Can you tell me who laid the groundwork for this initiative/idea/etc.?	Can you tell me why this organization chose to engage in this issue?		What networks does the community already have in place? What are their functions/purposes?
Navigating	Can you tell me about the people whom you would consider essential to the success of this initiative/org/etc.? Can you think of individuals or organizations that made vital connections between different areas, agencies, etc.? Can you describe the change in activities and focus of your family/ work place after Irene?	Can you describe the change in activities and focus of your organization after Irene?	Are there new offices or agencies that deal directly with climate change issues/disaster management? How have existing structures changed their focus; expanded; etc.?	How/if and when did the networks mobilize post event? Did they shift functioning? Did they expand, contract etc.? What elements/actors served as central nodes/drivers of this activity?
Building Resilience		What strategies are being developed to integrate resilience throughout the communities?		Are there new organizational structures/institutions appearing/forming as a result of this event?

HOW TC MANIFESTS – Scalar Alignment Common vision; Social learning; Long-term vision; Multi-scale systems thinking
The purpose of this section is to uncover the main ways that the event has changed thinking/behaviors/goals/outlook.
***Consider for this grouping doing the Historical Timeline: framed as major events, turning points, etc. – how the ideas and solutions now in place were influenced…
This section is about the evolution of ideas – the process of understanding – what issues or priorities have FALLEN OUT of the discourse?
How have ideas changed etc. from domain to domain – spillover?

	SCALE			TO CAPTURE
PHASES	Micro	Meso	Macro	
Preparing	What were the reasons you came to the MRV/that you consider the biggest reasons why you stay/live in the MRV?	How is the MRV engage with/exhibit the goals/priorities of the region? How would you describe the main issues facing the MRV before Irene?	In what ways do you see the MRV as insulated or isolated from the rest of the nation, and in what ways connected?	What were the main priorities of the region pre event?
Navigating	Has Irene changed your thinking regarding climate change in the MRV? When did you first hear about resilience and what were your first impressions of the concept?	What is the effect that Irene has had on the communities of the MRV: re goals, policy, and priorities?	Has there been an expansion of initiatives regionally/watershed that have come about post Irene?	How have these goals etc. changed? Is there a broad consensus on the needs of the area in re: climate change?
Building Resilience		Are there initiatives that engage people in understanding climate change and its effects? In schools etc.…		This aspect is about vision of the future. How are they going to make changes stick? That is about - institutions and etc.…

9.2.7 – Coded Interview List

Interview #	Functional Professional/Personal Perspective
1a, 1b, 1c*, 1d**	Regional Governance
2	Regional Governance, Local Business
3	Regional Governance, Entrepreneur
4	Regional Governance
5a	Governance, Local business
5b	Governance, Local and State
6	Regional Governance
7	State Governance, Entrepreneur
8a	State Governance
8b	State Governance
8c	State Governance
9a	NGOs, Former Local and State Governance
9b	Hydrologist (Municipal)
10	NGO
11	NGO, Farmer
12	NGO
13	State NGO
14	Farmer, NGO
15, 15a*	NGO, River Ecology
16	Ecological History
17a	Ecology – Forest Biology
17b	Ecology; Former local governance
18	Ecology – Soils, Agriculture
19	Business owner, Entrepreneur
20	Local Business Owner
21	Business NGO, Entrepreneur
22	Local Business CEO
23	Local business

* Email follow-up communication
** Phone follow-up communication
Note: Interviews 5, 8, 9, 17 contained 2, 3, 2, and 2 people respectively.

9.3 – Results

9.3.1 – MRV Culture of Participation

The MRV has a long tradition of participation and engagement in the social, political, and economic aspects of the community (Waitsfield/Warren Town Plans 2012/2010). Many of the aspects of capacity are likely founded in the culture of the region where patterns of behavior and thought have developed for many generations (Norris et al. 2008).

"I was amazed that it was a community that was looking at building leadership through the VFN, engaging people in real questions about the future of this place and our role in it and our understanding of its history; that's all real and intentional. It might be small in population but a very good percentage of the population is engaged." (1b)

Direct democracy, very much present MRV, is symbolized by Town Meeting Day where the townspeople meet to discuss and vote on local issues. These are invariably well attended and often include spirited debate (1b). The MRV, a region with fewer than 5000 residents, has 87 NGOs. *"It makes it easier to talk about real things and have people want to move them forward." (1b)* There is a certain pressure that living in both a rural/agricultural area and a long, feather-shaped, steep sloped valley exerts on residents. The hardships of water, snow, mud, and cold have forged a neighborliness that still permeates valley culture (1a,16). People know their neighbors, and there is the knowledge that they will likely need each other sometime in the near future.

"No matter how much you and I may disagree on something, and you're my neighbor, there's a time when you're going to find yourself in a ditch, stranded. You're going to need my help. So no one ever pisses anybody off to the point that they don't get help anymore. That's part of the culture, and that we're small enough that if you piss somebody off, then you got to live with it everyday. You can't escape it." (1a)

Other interviewees, however, noted that there is a trend away from this neighborly culture, as the MRV turns more recreational (or more consumer, less producer (14)). Also, as roads and technology advance, people 'need' each other less and less.

Additionally, the culture of participation manifests as an attitude of self-reliance, where the self is the community or the state, creating an idea of an 'in-group' comprising 'locals', separate from others:

The 1927 flood was the most devastating flood in the history of Vermont. If you look at all the bridges in the state of Vermont, they're almost all built in 1930 after the 1927 flood. The state of Vermont refused any money from the federal government after the '27 flood. The state of Vermont said, 'No, we do this ourselves. We take care of ourselves.' The hardscrabble Vermonter who takes care of themselves is such a part of the culture (1a).

Two or three days after [Tropical Storm] Irene a friend was talking to her mom on the phone on Bridge Street. There were all these vehicles going by and her mom asked, 'What is that?' She said, 'Weird, it's the National Guard coming to town.' Her mom said, 'Thank goodness. You guys are going to be saved.' She said, 'What are you talking about? We don't need to be saved! We're already taking care of ourselves.' I think that sort of ethic became really clear when FEMA came to town (1a).

9.3.2 – Place Attachment

One of the most heard comments from interviewees had to do with their choosing to live in the MRV. The vast majority of MRV residents were not born there. Instead, they moved to the MRV because it encapsulates the ideal place for them to live (1a,2,4,6,11). That has created a very large place attachment.

My son asked me recently: 'Dad, if you could live anywhere in the world where would you live?' and I said 'I'd live right here'. I can say it with the utmost confidence…I think that I'm far from alone in that. I think there's a lot of people who've chosen to live here and really really want to be here and will find ways to make it work well and

are thinking long-term about it…There is a culture of volunteerism and participation and building a stronger community because everybody wants to be here. (11)

Place attachment refers to an emotional connection or bond with the one's home city, town, or neighborhood (Stedman 2003; Norris et al. 2008). Place attachment has a wide variety of implications from the personal: sense of stability and self-definitions, to the communal: a shared desire to revitalize/restore, which can contribute greatly to a community's resilience (Norris 2009). However, when faced with uncertain change, place attachment created some areas of sincere contention e.g. when a proposed windmill installation crashed into people's place meanings triggering an intense NIMBY[19] response to the perceived threat to the look and feel of the landscape.

"In late 2009 early 2010, somebody came in with a proposal for a wind turbine project and it completely shifted the conversation. It went from a proactive 'Where are our opportunities?' to a threat that somebody else was proposing. A very strong anti-wind group was formed with a fair number of certain NIMBY elements. It brought a lot of concern and the entire energy conversation drifted from a pragmatic approach to a reactionary approach, which made the need to do an energy plan even greater but also much harder because at this point now, heels are dug in." (1a)

9.3.3 – Tracking on-going Transitions

9.3.3.1 – Transition from floundering small farms to viable local agriculture and foods

This transition involves vital connections between a variety of different sectors of the region, all centered on the viability of agriculture. This transition seems to be in the late navigation phase. The Mad River Localvores (MRL) began in 2005 in an effort to invigorate local food awareness and the local food economy (micro). Agriculture in the MRV had been declining as a viable industry for decades, aligned with the decline small scale farming across the USA. When the MRL began, there were a handful of family farms left in the MRV. The MRL was started by "newcomers" to the MRV, which often triggers a knee-jerk negative response in "old timers": *"one of the old-time farmers was really kind of like, 'Who are these people talking about local food?*

[19] Not In My Back Yard

Bullshit. I've been doing local food forever and it's not going anywhere.'" (14)
However, the MRL approach was different:

"It's a great example of someone who bridged the gap. Localvore has succeeded here because she presented it in a way asking some of the key old-timers, 'How do we make you be more successful?' 'How do we help you to do what you do better?' as opposed to a conventional newcomer attitude, like 'Things are really backwards here. I'm going to bring my marketing capacity and my Westport Connecticut smarts to help you.' And he said, 'If you really care, what I need to do is to be able to slaughter chickens in my own home and sell them to American Flatbread[20].' She said, 'We can do that. We can change that law.'" (14)

There has been significant momentum on this front in the past decade. Many farmers have diversified their farms, and have begun value adding to their products. This transition is not only on the farms themselves, but also in the way the community shops, thinks, and does business in relation to local agriculture. The Mad River Food Hub (see above) is a very significant step. Local businesses have also contributed, such as the Mad Taco (see above), and Merhuron's grocery store that sells local products from a variety of MRV farms.

"I credit the Localvores and the whole movement that's been happening around us. All of our produce is sold right here in our valley – all of our blueberries and all. The only things that we ship out of here are hides and yarn and blankets, which is a pretty small percentage of our business." (14).

On the state level (macro) the Farm to Plate Investment Program (F2P) legislation was passed in 2009 to increase employment and development in the food and farm sectors by encouraging policies and investments for their long-term viability (F2P Executive Summary).

[20] American Flatbread is a thriving restaurant and frozen pizza business with a national market.

9.3.3.2 – TMDL Transition from current agriculture practices to no-till farming

This is a potential transition, as regulations and legislation have not been passed, and therefore is in the preparing phase. The state has determined that Lake Champlain is threatened by phosphorous loading. Therefore, they are in the process of instituting regulations that will limit the Total Maximum Daily Load (TMDL) of phosphorous that flows into the lake. These regulations may have significant effects on the entire watershed, which includes the MRV. If regulations are applied to agricultural land it will hit individual farmers directly, shifting long held practices, equipment, and beliefs (18).

"So for a lot of these guys, that will be a huge transition. They don't have the equipment; they don't have the know-how; they don't believe it's going to work; they don't know how to integrate that in their cropping system; they're afraid it might ruin the field; it will bankrupt the farm; make them go out of business. I mean it's huge economic realities." (18)

Farmers may have to switch to no-till farming, something they are unfamiliar with:

Their whole job would be to get farms to transition from this tillage addiction to no-till and cover cropping and they would spend less money over time, they get better soil health, they would be more profitable. The numbers are out there; the realities are out there but you just can't get somebody to change what they've been doing for 30 years overnight…But right now, you've got this paradigm of the people who work in the land and feel that they are being oppressed and persecuted." (18)

There are educational and incentive programs available for farmers to learn and understand these new practices, but few experimental sites where farmers could see the results before they invest. Farmers, natural resource managers, the MRVPD, and local select boards are all aware of the potential (1a,6,14,18). However, if the regulations do target farmers, there may be less push back in the MRV than in other places:

"[One local farmer] is going to hydroponics – he's made a huge investment in hydroponics and [another] is always experimenting with different kinds of things.

They're the old generation. I'm really impressed with the younger generation of farmers – the way that they're thinking and the risks that they're taking. [One farmer], the money – she's willing to go into debt to create a milking parlor. It's pretty exciting. It has energized us to think about our work. What risks can we take to do things better here? (14)"

9.3.3.3 – Transition from producers to consumers

This transition is slow and involves the identity of the MRV, or the collection of identities, and which identities have what kind of presence. This transition is in the navigating phase and has been there for decades. Farmers settled the MRV and agriculture had been the dominant activity for generations. However, with the decline of the dairy industry and the rise of ski resorts, the MRV has become a very different place. As a farming community, the MRV was not very affluent. *All the valley was before the ski lifts came was poplar trees and poverty (20).* Currently, farming makes a small contribution to the MRV's GDP (MRVPD 2013 Data Report), but it remains a big part of the MRV aesthetic. As fewer and fewer residents of the MRV are farmers however, a gap between the pastoral atmosphere of an agricultural landscape and the more difficult and contentious aspects of actual farm work becomes evident.

We can't live in the past. There is that part of it, this nostalgia, there is this feeling that it doesn't have to be this way. It could be like it was before. The way it was before was pretty gritty and not very pleasant. This valley was pretty dirt poor for a long, long time. The haves and have-nots; who is participating in the positive trends? Who is being left behind? You got to be really sensitive to that. (6)

There is a perceived threshold that the MRV is currently crossing: where 50% of the housing in the MRV are second homes. This seems symbolic of the diminishing of the producer culture, and the dominance of a consuming, ski/tourism/resort focused one.

We become more suburban, not only in settling patterns but in behavior. People arriving here, wanting to consume this idyllic vision they have of a rural life that doesn't include actual production; it doesn't include turning on the tractor at 6:30 in

the morning, or extracting lumber and doing all of these things sustainably and thoughtfully, but doing them. That's what threatens us, is people who don't understand what it actually takes to produce that food and to produce a working landscape, not just an ecologically beautiful or an aesthetically pleasing landscape. (14)

The producer/consumer debate stretches beyond the agricultural into other aspects of the MRV community:

"Intellectually, I think of the back to the landers, and the [Prickly Mountain[21]] type and the mad geniuses and they really had a lot to do with building companies, infrastructure, ideas, and employment. A lot of those people have left or are leaving and we're not getting the backfill that we could. They talk a lot about the hipsters and the millennials and they're urban people. They want to be in a community. They want to be with other people like them. They're not the back to the landers, they're interested in good food and being healthy but they don't want to grow it." (20)

A struggle for the MRV is staying in that grey space between a producer culture and a consumer one, because that is where they seem to want to be.

"The tension does exist but I think we are both and I think as individuals, we are both. I like [one resident's] statement that says 'we are a dynamic, interesting community that just happens to have really great skiing.' Yes, $0.51 of every dollar comes from outside of this community but we're in this middle place. I think there's a lot of opportunity for both." (1b)

[21] Prickly Mountain was an enclave in the MRV that hosted an architectural revolution in the 1960s through the 80s, where. This space attracted some incredibly innovative people (nearly all architects) to the MRV who spawned a variety of successful enterprises. The design/build idea still flourishes today in the MRV in the form of Yestermorrow Design/Build school.

9.3.3.4 – Smaller scale transformations and their phase, scale, and interactions

Interacting Transitions in the MRV				
Transformation	**Aspect**	**Phase**	**Scale**	**Support/Conflict**
A: TMDL – Regional Phosphorous Loading	Land-use regulation	Preparing	Macro	Conflict B Support D
B: Localvore + Farm to Plate	Local food movement	Navigating	Micro + Macro	Conflict A Support C, D
C: Producer to Consumer	Cultural identity	Navigating	Meso	Conflict B, D
D: Ecosystem Based Management	Ecosystem management	Navigating	Meso	Support B