

# A Strategic Approach for Sustainability and Resilience Planning within Municipalities

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## **Abstract:**

This research started by recognizing the role that local, municipal governments can play to reach the global goal of sustainability. In addition, a municipal community must be able to cope with change and disturbance in order to successfully achieve a sustainable future. This research investigates how improving municipal resilience can be a strategy to reach sustainability, and answers the primary research question “How can planning resilience help a municipal government lead a community towards sustainability?” Research was conducted through an inter-disciplinary literature review focusing on identifying key characteristics of resilience. Other methods included diagramming exercises to identify factors which foster or undermine resilience characteristics. Finally, implementable measures were identified which municipalities can implement to improve resilience and sustainability. These measures were selected using a synergy matrix, which helps select measures which most support principles for sustainability and resilience characteristics. The feasibility and current adoption of such measures was checked through interviews with municipal experts of Swedish, Canadian and Finnish municipalities.

**Keywords:** municipal planning, sustainability, resilience, TNS framework, municipalities, sustainable development

## **Acknowledgements**

**“Learning is not compulsory... neither is survival.”  
W. Edwards Deming**

**"They always say time changes things, but you actually have  
to change them yourself". Andy Warhol**

Big change and great paradigm shift are only possible when every individual starts with their own individual transformation. This inspiring and creative research process became for us a first considerable step and the first effort to change the world, starting from our own small, individual change. Life offers wonderful challenges and we, as individuals, can accept them in order to move on towards our goals.

We cannot change the world immediately. We cannot offer universal solutions or universal answers. We cannot prescribe people what to do, and we cannot say what is right and what is wrong. Still there is a “yes, and...” We CAN start from small steps, from changing our own attitude and our own lifestyle. We can be an inspiring example of resilient and sustainable living, then, others will be inspired. We believe that we shall start from very small steps on the path of sustainability. This is what we have done and this is what we have been proud of.

Our resilient research team would like to thank:

- God/Gaia/the Universe for giving us a chance to enjoy wonderful challenges of life.
- Each other for being together, supporting each other in many ways, tolerating each others ups and downs, learning from each other, sharing with each other, caring about each other, understanding each other, creatively arguing with each other, being a resilient team.
- To our colleague Andrew Outhwaite, who first enthusiastically brought the idea of resilience to our mind and from where this whole project got started.

- Our parents, who supported us in many ways , so that we could grow; and friends, who were of great moral support in periods of happiness, stress and emotional instability, i.e. Inna Russkova (Russian Federation), Grigoriy Rjadinskiy (Russian Federation), Charles Heffner (USA), Marjut Riite (Finland).
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- Mr. Éric Côté and Madam Myriam Marquis,
- Mr. Robert Cooke and Madam H  l  ne Jomphe,
- Veikko V  nsk  ,
- Madam Kristiina J   skel  inen
- The bands Amorphis and Great Big Sea, for their continuous inspiration during long nights of studying and research.

Precious learning experience and inspiration for future sustainable and resilient undertakings are the most important things which fill our minds and souls. We would like to end this part with one of the wisest quotes which reflects our inspirations and desires.

**“Live as if you were to die tomorrow. Learn as if you were to live forever.”**

**Mahatma Gandhi**

# Executive Summary

## Background

Municipalities are strategically positioned to influence citizens as they are the local body responsible for providing services, building infrastructure, and formulating policies and regulations that can promote sustainability. They are also close enough to citizens to hear their concerns and ideas. A proactive approach in that matter is certainly profitable for two reasons. First, there are risks associated with waiting for crisis situations before action is taken. Secondly, dealing with crisis situations rather than being proactive and avoiding them altogether tends to be more expensive for a community. If not prepared to face changes, such abrupt changes can have disastrous impact on community. That is why we suggest that a new quality may be required in order for a community to persist through time: Resilience. Resilience is the capacity to absorb shocks and cope with changes (Berkes et al. 2002).

For this thesis, three team members investigated how resilience as a concept may be aligned with the The Natural Step's (TNS) Five Level Framework for planning in a complex system, as described below, so a municipal government can effectively reach its goal of sustainability.

*Level 1: System.* To strategically plan for sustainability, a municipality must first understand the system they are a part of, including the interrelations and functions of the constituent parts and processes.

*Level 2: Success.* The success level describes the successful situation to be reached. To define success in terms of sustainability, a concise idea of the conditions that must be met for sustainability need to be defined. For this research basic principles for socio-ecological sustainability were used<sup>1</sup> (Holmberg 1995; Broman et al. 2000; Ny et al. 2006).

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<sup>1</sup> These basic principles are often referred to as The Natural Step Sustainability Principles after the charitable organization that promotes and supports their development.

To include resilience within the vision of success could provide an organization with the capacity to “bounce back” and adapt after encountering a perturbation. Resilience is the capacity of a system to handle disturbances and preserve its identity. It is also the capacity to learn from experience and self-organize (Gunderson and Holling 2002).

*Level 3: Strategy.* Municipalities can strategically plan for a sustainable future, and the TNS framework suggests an innovative way to do so using the approach of backcasting from sustainability principles (Holmberg and Robèrt 2000). Backcasting is the visualization of a sustainable future and from there, go back in the present, assess the current reality of the organization to clearly see the gap between that current reality and the envisioned future, and finally to strategically plan actions which fill that gap. The gap between the current reality and envisioned future creates a sort of “creative tension” which triggers actions towards the vision (Robèrt et al. 2005). This tension is constrained by the Sustainability Principles. After adhering to such principles, solutions are infinite. After backcasting, an organization can prioritize their actions by answering the following questions: “Are these actions leading our organization in the right direction (do they adhere to the four sustainability principles)? Are they a flexible platform for further improvements; and, Do they provide good return on investments?” (Holmberg 1998).

*Level 4: Actions.* Concerning actions, an organization, such as a municipality, decides which actions, or measures, should be undertaken to achieve their goal of sustainability.

*Level 5: Tools.* Tools, such as metrics to test the relevance, quality, and quantity of various activities to ensure that they are aligned with the principles of sustainability can help an organization accomplish actions (Robèrt 2000). They can also be designed to increase capacities of individual inside an organization, i.e. increase their understanding of sustainability and sustainable development (Robèrt et al. 2005).

### **Research Questions**

Our guiding question for this project, Research question #1, concerns the relationship between resilience and sustainability, as explored in the

introduction of this thesis document. The following questions are more detailed and concern specific interests of the research.

**Research question # 1:** How can planning for resilience help a municipal government lead a community towards sustainability?

Beyond that, four specific research questions were investigated in more details. They are:

**Research question #2:** What are some key characteristics of resilience in a community?

**Research question #3:** What are some common factors which might affect municipal resilience and sustainability?

**Research question #4:** What are some measures which municipalities can implement to effectively support resilience and sustainability?

**Research question #5:** Are these measures implemented in interviewed municipalities, and if so, how?

## **Methods**

The methodology used in this research consisted of a trans-disciplinary literature review, made to understand the concept of resilience and how it is related to sustainability. Each team member paid particular attention to a different aspect of resilience; that is, from ecological, social and economical aspects. The characteristics of resilience common to all aspects were identified and discussed by the group. From these characteristics, factors that positively and negatively influence these characteristics within a municipality as a system were found through diagramming exercises. Factors with effects on many characteristics were highlighted and perceived as synergistic. Measures which address these factors and support characteristics of resilience were found through further literature review. The most synergistic measures were selected using a synergy matrix, and are recommended as implementable measures which municipalities can use to support resilience and sustainability in their community. Finally, these measures were discussed with municipal representatives to learn if and how they are implemented in their respective communities.

## Results

The characteristics of resilience identified in this research are:

• Diversity	• Spatial scale interactions
• Redundancy	• Temporal scale interactions
• Memory	• Innovation
• Self-organization	• Self-reliance
• Networks	• Feedback
• Individual Capacity	

And the 10 most synergistic measures which we propose that a municipality can implement to support resilience and sustainability are:

1. Sustainability education
2. Create a Space for engagement
3. Co-create a shared vision based on a sustainable future
4. Sustainability steering committee
5. Community supported local energy production, businesses and services
6. Participatory governance
7. Early Warning Systems w/ yearly benchmark summits
8. Multi-use zoning and urban infill
9. Small loans programs for local, sustainable businesses
10. Support for local, organic food producers

These ten measures were then discussed with municipal employees from municipalities in Sweden, Canada and Finland. Through these interviews, the research team gained insight into the utility of the selected, synergistic measures and how they are actually implemented “on the ground.” These measures generated a positive response from most interviewees, especially in the Scandinavian municipalities. The overall idea of sustainability is more widely accepted and understood, and sometimes legally mandated, in that part of the world. In northern Europe, sustainability is a long-discussed issue, and no longer particularly controversial compared to Canada. Indeed,

the biggest challenge in the Canadian municipalities is a lack of exposure to and experience with sustainability.

The result is that more of the suggested measures have been implemented in Scandinavian municipalities, at least partially, with overall positive outcomes. It is noticeable however that they tend to use a top-down approach, and municipal employees tend not to involve citizens directly in decision-making. This seems more to be an effect of government structure than overall mindset of municipal employees, and a shift might be happening as can be seen from the interviewed municipal employees' will to involve the community members in the near future.

Regarding the interviewed municipalities, many factors prevent them to implement the suggested measures. First, there is a perceived lack of resources, particularly natural and financial, especially in the Canadian municipalities. Second, there is a lack of openness to community member's involvement. And lastly, some measures are perceived as beyond their sphere of responsibility.

## **Conclusion**

The aim of this thesis was to find practical and widely-applicable measures to support and increase resilience and sustainability within municipalities. If these measures, and all the processes by which they were derived, could simply contribute to an increased awareness on the role resilience can play in the sustainability endeavor, it would be a source of pride for us.



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# 1. Introduction

At the 1992 Rio-United Nations Conference on Environment, the role local governments can play to achieve the global goal of sustainability was highlighted. Municipalities are considered key actors to address global sustainability because many of the problems and solutions to be addressed have their roots in local activities (Federal Office for Spatial Development 2006).

Municipalities are strategically positioned to influence citizens as they are the local body responsible for providing services, building infrastructure, and formulating policies and regulations that promote sustainability. They are also close enough to citizens to hear their concerns and ideas. But more importantly, “they are [the] locally elected, representative, and accountable bodies responsible for community decision-making” (Roseland 2005, p. 193). A municipality’s commitment to sustainability may vary from complete disregard for such ideas, to active lobbying beyond their jurisdiction in order to achieve the regional and global goal of sustainability. A proactive approach in that matter is certainly profitable for at least two reasons. First, there are risks associated with waiting for crisis situations before action is taken. If not prepared to face changes, these changes can have disastrous impact on community, as was demonstrated by the aftermath of Hurricane Katrina in the southern United States. Secondly, dealing with crisis situations rather than being proactive and avoiding them altogether tends to be more expensive for a community. That is why we suggest that a new quality may be required in order for a community to persist through time: Resilience. Resilience is the capacity to absorb shocks and cope with changes. “Resilience is the potential of a system to remain in a particular configuration and to maintain its feedbacks and functions, and involves the ability of the system to reorganize following disturbance-driven change” (Walker et al. 2002).

“The future is moving so quickly that you can’t anticipate it. We have put a tremendous emphasis on quick response instead of planning. We will continue to be surprised, but we won’t be surprised that we are surprised. We will anticipate the surprise” (Malhotra 1999).

## **1.1 Five-Level Framework for Strategic Planning or TNS Framework**

To plan strategically towards sustainability, a five level framework has been developed through a consensus process with scientists and sustainability leaders (Robèrt et al. 2002). This framework has been developed to provide clear direction when planning in complex systems, based on backcasting from basic principles for success, and is therefore well-suited to strategic planning towards sustainability. We describe the The Natural Step (TNS) Framework below, as well as its application to municipalities.

### **Level 1: System**

To strategically plan for sustainability, a municipality must first understand the system of which they are a part. A system is a group of interacting, interrelated, or interdependent elements forming a complex whole (see e.g. Haraldsson 2004). Humans and nature are part of the same system and the recognition of this interdependence and the responsibility they have on preserving the system's integrity by human is crucial to achieve sustainability. Therefore, a municipality must understand the interrelationships and functions of the different people, parts and processes of which it is composed.

A system composed of humans and nature is named a socio-ecological system. This research focuses on municipal communities as socio-ecological systems. The municipal community refers to the municipal government (or municipality) and the broader population of citizens, businesses, and interests that exist within the boundaries of that municipality (James and Lahti 2004).

In order to facilitate a transition to a sustainable future, understanding how create change in a system effectively is valuable. Leverage points are places to intervene in a system in order to create big changes. Indeed, a small shift in one component can produce far-reaching changes due to the interdependent nature of systems. According to Donella Meadows (1999), there are twelve different leverage points in which to intervene in a system. The higher the level of intervention, the more leverage the intervention can

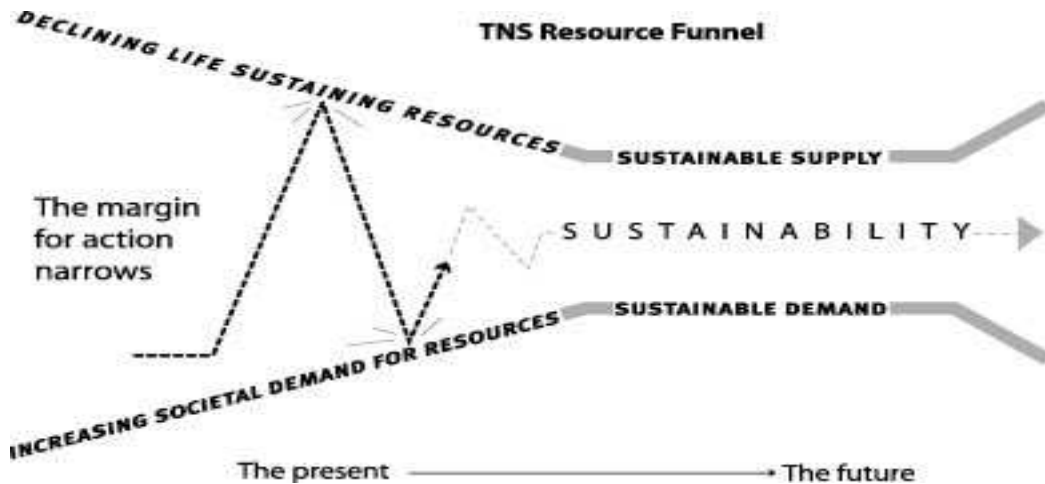
have (Meadows 1999). The higher leverage points concern the information and the control parts of the system. Lower leverage points are on physical parts.

A listing and a short description of these leverage points can be found in Appendix IV. Donella Meadows' leverage points can bring valuable insight on how it is possible to create change within a system

## Level 2: Success

In order to plan strategically, it is important to share a definition of success. Questions such as "How do we define success?" and "How will we know that we have reached it?" must be answered in order to guide strategies. For this research, principles for sustainability were used (Holmberg 1995; Holmberg and Robèrt 2000). These principles have been developed from the study of natural laws; specifically, the laws of thermodynamics and conservations. They also recognize the fact that humans are social species (Eriksson and Robèrt 1991; Broman and al. 2000).

A principle is a generic condition for something specific (Robèrt et al. 2005). Unlike laws, principles may be violated, but by doing so consequences will have to be faced and that is the un-sustainability. Un-sustainability is described in the TNS Framework with the use of the funnel metaphor.



*Figure 1-1. The TNS funnel metaphor*

Source : [www.naturalstep.ca](http://www.naturalstep.ca)

The upper, declining wall of the funnel represents the Earth's decreasing capacity to support economic and social development, or natural capital. Natural capital is defined as the natural resources and ecological services generated and sustained by ecosystems and their biodiversity (Berkes and Folke 1998). The declining wall represents also the decreasing social capital, which is "the relationships, networks and norms that facilitate collective actions" (OECD 2001) or "the shared knowledge, understandings, and patterns of interactions that of group of people bring to any productive activity" (Coleman 1988; Putman 1993). The lower wall represents the increasing societal demand for natural resources and increasing social tension. To this day, social and economic development is largely associated with increasing consumption of natural resources. The world's population is increasing and will likely do so for at least the next few decades, therefore increasing demands on natural resources and the risk of conflicts. Human activities have historically decreased natural capital by systematically encroaching on ecosystems, and by doing so, past and present people compromise future generations' capacity to satisfy their basic needs. The options and opportunities for human development and ecosystem health decrease dramatically, as represented by the narrowing space between the walls of the funnel.

Sustainability within the funnel is symbolized by the space between the walls as they stabilize. It is when humans live within the limits and means of the planet's capacity to regenerate. Humans will live within these limits when sustainability principles are followed. These principles are *necessary* and *sufficient* to achieve global sustainability (Robèrt et al. 2005, Ny et al. 2006).

In the sustainable society, nature is not subject to systematically increasing

- Concentrations of substances extracted from the earth crust;
- Concentrations of substances produced by society;
- Degradation by physical mean, and in that society...



- People are not subject to conditions that systematically undermine their capacity to meet their needs

The goal of sustainability, i.e. success, will be achieved when humans live within the limits and means of the planet's capacity to regenerate. In a sustainable world, generations of humans will have equal opportunities or more if restoration takes place through time (Office Fédéral du Développement Territorial 2006).

Even while making a transition to sustainability, an organization or community (such as a municipality) will likely "hit the walls of the funnel." This refers to disturbances affecting an organization that can slow its progress, or even cause it to disappear. This happens when a system component changes in an abrupt manner. This can be seen in an organization as increasingly strict legislation, and increasing cost of resources, taxes, or insurance. Changes are occurring at an ever-accelerating pace, obliging organizations to be more adaptive. Unfortunately many are not, bringing disastrous effects for these organizations. Changes can happen in a gradual manner, but can also occur in an abrupt way. Some examples of abrupt changes are: increasing occurrence and severity of natural disturbances like ice-storms, floods, droughts; pandemics; major industry closure in a small town, etc. These kinds of disturbances may have a major impact on organizations, as well as on society in general, if they are not sufficiently resilient.

Resilience is the capacity of a system to cope with disturbances and preserve its function and identity, as well as to preserve its capacity to increase its learning and to self-organize (Berkes et al. 2002). It is also preserving the system's capacity to provide goods and services on which society values and depends. In the TNS funnel metaphor, resilience can be seen as the capacity to "bounce back" after hitting the walls of the funnels. If an organization is not equipped to cope with disturbances, its long-term survival may be compromised. It is important to understand that disturbances will also happen in a sustainable world, because such changes are inherent to nature. However, by increasing resilience, their negative effects will hopefully be less severe.

By being resilient, a community can also better identify and make use of new opportunities as they present themselves (Folke et al. 2002). That is

because renewal occurs during the period of reorganization following disturbance. Hence, there is a dynamic interplay between reducing the impacts of change and at the same time taking advantages of the opportunities created by change (Berkes and al. 2002).

As for sustainability, a deep understanding of the system and idea of success is important for resilience. For a municipality, it is important to know which goods and services the community values and wants to preserve, because a system may be resilient but not desirable. Sustainability principles may be used as overarching goals to value resilient systems.

### **Level 3: Strategy**

In order to achieve success, it is effective for those working towards the goal to have a common strategy. The TNS Framework suggests an innovative way to strategically plan for sustainability: by backcasting from sustainability principles. Backcasting means to envision a sustainable future and from there, assess the current reality of the organization (Holmberg 1998). By doing so, the gap between the current situation and the desired, future situation can be clearly seen. The gap between the current reality and envisioned future creates a sort of “creative tension” which mobilizes actions towards the vision (Robèrt et al. 2005). This tension is constrained by the sustainability principles. After backcasting, an organization can prioritize their actions by answering the following questions: Are these actions leading our organization in the right direction (do they adhere to the four sustainability principles)? Are they a flexible platform for further improvements? And, do they provide good return on investments?

### **Level 4: Actions**

Concerning actions, an organization, e.g. a municipality, decides which actions, or measures, should be undertaken to achieve their goal of sustainability.

### **Level 5: Tools**

Tools are used in order to complete actions, such as stated above. Tools can be metrics which test the relevance, quality, and quantity of various activities to ensure that they are aligned with the sustainability principles

(Robèrt 2000). Several tools exist which help measure the impacts of activities on nature. Teaching tools can also be developed to increase the capacities of individuals or an organization i.e. increased their understanding of sustainability and sustainable development (Robèrt et al. 2005).

## **1.2 Thesis questions**

Our guiding question for this project concerns the relationship between resilience and sustainability, as explored in the introduction of this thesis document. It is:

**Research question # 1:** How can planning for resilience help a municipal government lead a community towards sustainability?

Beyond that specific research questions were investigated in more detail. They are:

**Research question #2:** What are some key characteristics of resilience in a community?

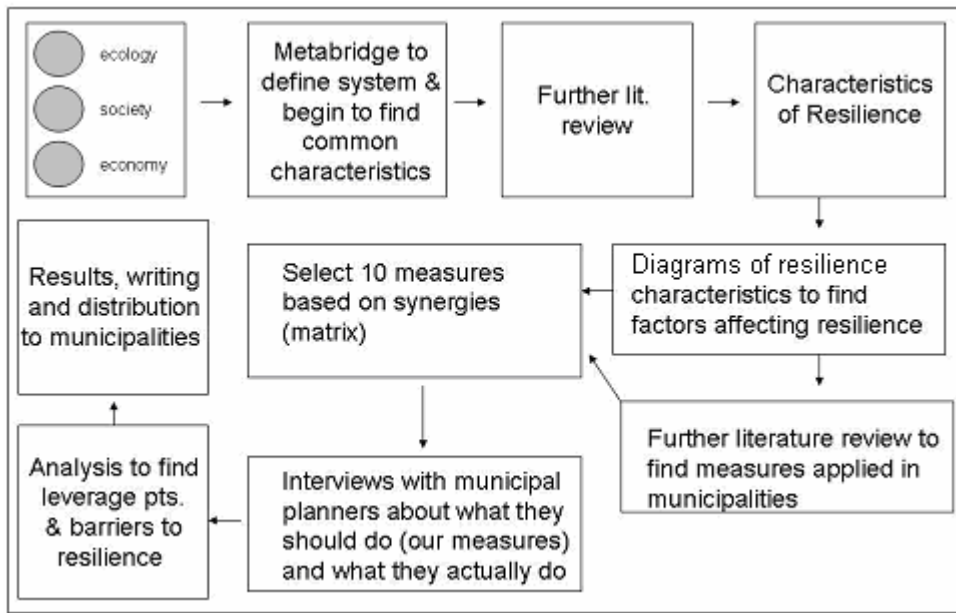
**Research question #3:** What are some common factors which might affect municipal resilience and sustainability?

**Research question #4:** What are some measures which municipalities can implement to effectively support resilience and sustainability?

**Research question #5:** Are these measures implemented in interviewed municipalities and if so, how?

## 2. Methods

This thesis contains three major research areas. The first being an extensive, trans-disciplinary literature review to discover how increasing community resilience can help a municipality move towards sustainability, and to discover key characteristics of resilience. The second area of research is a prioritization of measures which can promote principles for sustainability and the identified characteristics of resilience in a synergistic manner. The third area of research is about practical implementation strategies which municipalities use to promote sustainability and resilience, as well as finding barriers which municipalities may face when implementing measures to increase resilience (see Figure 2.1.).



*Figure 2.1. Research Design*

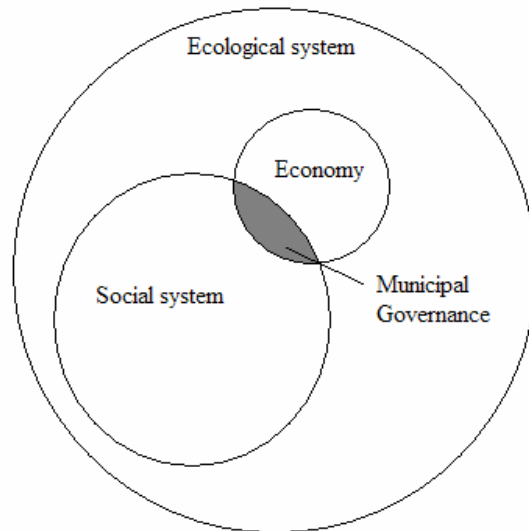
## **2.1 Question 1: Planning for Resilience and sustainability in Municipalities**

This first area of research was undertaken through a trans-disciplinary literature review of resilience and how it might relate to sustainability. It helped to create the lens through which the idea of municipal resilience was approached, and helped to form the assumptions upon which this thesis is based.

This literature review effectively started at the beginning of the Master's program for which this thesis was written. An in-depth and on-going study of the current state of the world, principles for sustainability, and the need to transition to sustainable modes of production and consumption was accomplished. The idea of resilience being directly related to sustainability arose out of discussions amongst the thesis group and other classmates. For this thesis, further research on resilience was conducted through literature review and thesis group discussions.

## **2.2 Question 2: Some Characteristics of Resilience**

To discover some key characteristics of resilience, the research team of three each took one aspect of municipal governance and investigated the literature published on each aspect. The three aspects, as diagrammed in Figure 2.2., are the ecological, the social, and the economic systems, i.e. what composes a socio-ecological system. The intent of studying resilience in multiple disciplines was to find the common characteristics which can promote resilience from an ecological, social and economic perspective.



*Figure 2.2. Ecological, Social and Economic Systems and Municipal Governance. (Adapted from Daly and Farley 2003).*

In the neo-classical model of economics, problems that influence the economic system, but have their origin from other systems, are called “externalities.” The assumption of this model is that these externalities are not significant in relation to the benefits of the economic system, as all human wants can be priced and are replaceable. There is no distinction however, between irreplaceable, necessary human needs versus wants, for example, clean air versus a new car. Some things cannot be priced, are not replaceable, and are necessary for human survival (Daly and Farley 2003; Robèrt et al. 2005).

As depicted in Figure 2.2., in the ecological economics perspective, all economic activity is recognized as being contained within the ecosphere. The by-products, or externalities, of economic production are often not felt in the immediate social system, but have far-reaching effects which can destroy ecosystems, for example chlorofluorocarbons (CFLs) destroying the ozone layer, or fertilizers leaching into water supplies. In the ecological economics view, all by-products of the economic system are contained within the overall system, and can therefore be addressed. This model also

recognizes the interrelations between the economy and society and the overall environment (Daly and Farley 2003, Robèrt et al. 2005).

To find the common characteristics between the ecological, social and economic perspectives, the team undertook a Metabridging exercise (see Figure 2.3.).



*Figure 2.3. Metabridge exercise*

Metabridging is a process for brainstorming, as developed by MetaBridge AB, a consulting company in Sweden (MetaBridge AB 2006). The intent is to visualize the system being investigated, and to visualize relationships between components within the system. For this thesis work, the process began with the thesis team individually investigating the concept of resilience through three different lenses: ecological, social and economic resilience. Then the team regrouped to discuss the themes and characteristics affecting resilience. Such themes and characteristics were written on tiles (see Figure 2-3 above), and grouped according to the relationships between such themes and characteristics. See Appendix I.

After further review of literature published on resilience, the research team identified 11 characteristics which contribute to resilience in systems (see Section 3.1.). Identified characteristics with a detailed explanation of each can be found in the Results section below.

## **2.3 Question 3: Identification of Some Common Factors Affecting Community Resilience and Sustainability**

To examine resilience from a more holistic and integrated perspective, diagrams based on the idea of Causal Loop Diagrams (CLDs) for each characteristic of resilience were created. Drawing such diagrams is another process by which the system under investigation can be understood. Specifically, feedbacks and causal relationships can be mapped out. When drawing CLDs, it is important to identify the boundaries of the system which is being studied (see e.g. Haraldsson 2004). For this analysis, the system boundaries were set as a municipality. It is also important to identify the appropriate question to ask when using a CLD to map out the system (ibid.).

For this exercise, true Causal Loop Diagrams were not drawn, as the feedbacks were not investigated in detail. Instead, the questions asked for each characteristic of resilience were “What supports building [the characteristic] in municipal communities?” and “What is a barrier to [the characteristic] in municipal communities?” The intent was to identify common factors which affect many characteristics of resilience. Such factors can be addressed to synergistically increase multiple characteristics of resilience. Diagrams were drawn with both barriers and enablers (beneficial factors) to the previously mentioned resilience characteristics. In drawing these diagrams, the barriers were sketched above the respective characteristic, and enablers below (see Appendix II).

The diagramming exercises resulted in the identification of some common factors which seem to affect multiple characteristics of resilience. These factors were summarized into a “synthesis table,” and are further discussed below (see Section 3.2.). By focusing on these factors, as well as individual characteristics of resilience, measures which improve sustainability and resilience in a synergistic manner can be identified.



## **2.4 Question 4: Selection of Measures and the Synergy Matrix**

Identification of common factors from the diagramming exercises led to the selection of measures which can effectively address such factors, thus increasing resilience and sustainability in municipalities. The research team undertook investigation of published literature and case studies on which measures can address such common factors (as well as individual characteristics of resilience) at the municipal level. Case studies came from published examples of cities and towns which have been successful at implementing actions which increase sustainability and municipal resilience. The selected measures were then combined into a master list (see Appendix III) to be further evaluated.

Each measure was evaluated using a “synergy matrix” (see Appendix III). The synergy matrix consists of three parts: a sustainability section, a prioritization section, and a resilience section. It was intended to be used to evaluate the effectiveness of each measure at supporting resilience (according to each characteristic) and sustainability (according to each sustainability principle).

In the sustainability section, each measure was evaluated on how well it fulfils each sustainability principle. That is, how well does the measure achieve the...

“...Reduction and/or elimination of materials extracted from the Earth’s crust from systematically increasing in the Biosphere” (Sustainability Principle 1),

“... Elimination of materials produced by society from systematically increasing in the Biosphere” (Sustainability Principle 2),

“... Elimination of systematic destruction of Earth’s ecosystems” (Sustainability Principle 3), and

“... Elimination of barriers to people meeting their needs” (Sustainability Principle 4).

Sustainability Principle 4 was broken into nine parts to address each of the basic human needs, as defined by Manfred Max-Neef (1991). These nine basic needs are: subsistence, protection, affection, understanding, participation, idleness, creation, identity and freedom. The scores were normalized to give Sustainability Principle 4 the same weight as the other three principles (see Appendix 2, Synergy Matrix- Sustainability; Sustainability Principle 4 Normalized).

In the prioritization section, each measure was evaluated on how well it achieves the following:

- A flexible platform for future development;
- A sufficient return on investment (financial or otherwise);
- Heading towards a sustainable future (Robèrt et al. 2005), as well as a resilient future.

While the sustainability section captures whether the measure is heading towards a sustainable future or not, this section also includes such a rating to provide a general and overall rating of the measure's effectiveness at achieving the desired future, including sustainability and resilience. However, after evaluating and selecting the list of measures, which interviews were based upon, it was recognized that by including the last variable in this section (heading towards a resilient and sustainable future), some redundancy occurred. Indeed, the selected measures are weighted more heavily according to how well they support resilience and sustainability, as there are two individual sections in the matrix to evaluate such characteristics and principles along with the last variable in this section.

In the resilience section, each measure was evaluated according to how well it supports each characteristic, with respect to ecological, social and economic resilience. The eleven characteristics of resilience for which each measure was evaluated were: diversity, redundancy, memory, innovation, self-organization, temporal interactions, multi-scale interactions, feedback, self-reliance, networks, and individual capacity. For each characteristic, each measure was scored according to how well it supports aspect of resilience. For example, how well the measure supports ecological

diversity, social diversity, and economic diversity, and so on for each characteristic.

Within each section each measure was given a rating of zero to three according to how well it addresses each sustainability principle, prioritization question, and resilience characteristic. Then each section was normalized so that each section counted equally. Each section was counted equally because the research team wanted to preserve the synergistic aspects of the measure and, more importantly, avoid placing greater importance on a particular section. It is important for a measure to reach all three goals: sustainability, resilience and priority. However, as discussed previously, a greater weight was placed on the measures effectiveness at supporting resilience characteristics and sustainability principles. Since the overall goal of the selected measures is to promote resilience and sustainability in municipalities, the research team decided to keep the selected measures rather than redo the matrix and reconduct interviews.

All measures were rated by the research team. Ratings were based on the research team's previous experience and four months of research on municipal resilience. It must be stated that this synergy matrix as a method of selecting measures is simply an evaluation tool. Therefore the results of the tool, though useful for this exercise, are subjective to a certain degree.

Those measures which resulted in the ten highest ratings were selected for further investigation through municipal interviews (see Appendix III).

## **2.5 Question 5: Implementation of Measures**

Interviews with several municipalities in Sweden, Finland and Canada were conducted to investigate the practical strategies which municipalities have undertaken to address the selected measures in their own localities. Municipal employees in Swedish and Finnish planning departments were contacted via e-mail. Some were contacted directly, and some were contacted based on the suggestion of other contacts. Municipal employees in Quebec had been contacted by one member of this research team prior to the formulation of this thesis project. A detailed description of this research was sent to interested and cooperative individuals, which included an explanation of methods, description of resilience characteristics, and

measures to be discussed. This was to ensure that interviewees had an understanding of the topic of discussion, the idea of municipal resilience and its link to sustainability, as well as an understanding of what the interview's exact purpose was. This ensured that the interviewees had adequate time to think about the answers to interview questions. Telephone interviews were conducted, with additional questions answered by e-mail.

From the first municipality in Quebec, Canada two individuals were interviewed: the Director of Environment and Sustainable Development and a Land Use Planner

From the second municipality in Quebec, Canada two individuals were interviewed: the Director of Urban Land Use Planning and Management and a land use planner.

From the Swedish municipality, an "eco-municipality" in western Sweden, the Head of Sustainability Steering Committee was interviewed.

From the Finnish municipality, two individuals were contacted through e-mail: the Chief of City Planning and a municipal revitalization project manager. In-person interviews were conducted with the same Chief of City Planning, and an urban sociologist. In addition, literature from two recently completed municipal projects concerning sustainability and municipal resilience was examined.

Questions for interviews with municipal employees were simply whether they already had implemented the measures that the research team in this thesis suggests should increase municipal resilience and sustainability. Questions were asked to generate open-ended responses. Further questions were asked about barriers for implementation of such measures. Results of interviews are found in Section 3.3 of this document.

## **2.6 Synthesis**

To synthesize information obtained from interviews, specific answers about implementation and barriers for implementation for each measure were extracted. Further insight into these measures and barriers was gained by

determining the leverage point at which they exist. The result of this analysis can be seen in the Discussion section of this document (Section 4).

## **3. Results**

### **3.1 Resilience Characteristics**

After an extensive literature review, eleven characteristics of resilience were identified. In the next section, they are described in detail with a short explanation of what they mean from a social, ecological and economic point of view. In addition, relevant case studies are also presented as examples of how specific characteristics have been supported in municipal communities.

#### **Diversity**

Diversity is the variety within a system, and is a characteristic of all complex systems (Robèrt et al. 2005). It is important to preserve diversity because during change, which is constantly occurring, some actors within the system may be destroyed, but another variety will be more suited to thrive. By having more varieties of actors, some “lie in waiting” to respond to unexpected changes that may decrease viability of others (Gunderson and Holling 2002).

In terms of ecological systems, we often hear of biodiversity. This means having a wide range of species, as well as having variations within the gene pool of species. All species provide some kind of function to an ecosystem. While a disturbance may negatively impact one species, another within the same function group may have the capacity to adapt effectively with that disturbance, therefore ensuring the viability of the overall ecosystem. Having a variety of actors and ecosystems in a municipality ensures that there is a variety of natural resources to enjoy and gain services from, such as water catchments and clean air. Preservation of diversity in ecological systems directly relates to system condition 3, in the sense that complexity within systems is brought about by diversity of actors. Systematic removal of some of these actors results in decreased viability and eventual destruction of Earth’s ecosystems (Berkes et al. 2002).

Diversity within society empowers the municipality. By having a diverse range of social institutions, it is ensured that a range of knowledge exists

within the municipal community. Cultural diversity also exposes individuals to new ideas and ways of living. Migration is becoming more and more prevalent in all parts of the world, and through exposure to local cultural diversity, individuals can be better equipped to understand and consider the diversity of ideas which exist in the world.

In a social system, a diversified decision-making processes can lead to better, more inclusive decisions. Diversified decision-making involves many actors within the municipal sphere of influence, as many actors are affected by such decisions. Decisions are made by a wide variety of stakeholders; for example, various government institutions, ordinary citizens, NGOs, schools, businesses, etc. (Walker et al. 2002). This is beneficial in the sense that many stakeholders are involved, contributing a diversity of experience and knowledge to ensure that the best decision is made and agreed upon by the entire community. Through diversified decision-making, human needs are less likely to be undermined as more opinions are considered in the process.

For the economic system, a diverse economy ensures that there is overall economic viability if one industry fails due to market conditions or resource scarcity. It is also important to have a diversity of skills and jobs within an economy, for “skills are an economy’s equivalent of gene pools” (Jacobs 2000, p. 41) and “it takes many kinds of work to develop an economy” (Jacobs 2000, p. 33). Creating the conditions for a diverse economy ensures that more individuals will be able to utilize their skills and resources to gain livelihood.

### **Redundancy**

Redundancy means having several actors within a system which perform the same function, or have overlapping functions. This allows the function to continue, if one actor fails.

Redundancy for an ecological system means there are many species that have the same or overlapping functions. Together, they form function groups. These are groups of species that have the same function in an ecosystem but where each species have a different response to disturbance which increase the system capacity to recover from a disturbance (Folke et

al. 2002). This relates to the third sustainability principle in the sense that healthy natural systems tend to have an adequate level of redundancy. By not homogenizing ecosystems through mono-cropping or removal of key areas, the overlapping functions of species and ecosystem processes are preserved and better able to handle disturbances.

Social redundancy can be that different groups or organizations share the same functions, or have overlapping responsibilities. It means that if one group fails, the responsibility will still be fulfilled. It also ensures against a “one-size-fits-all” scenario. Having many options how to fulfill a particular action ensures that more people will be able to complete that action. For example, having many types of learning institutions can better provide for the variety of learning styles and needs which people may have. For example, trade and job-focused education, experiential and place-based learning, and more traditional classroom style education are various types of learning which are better suited and more effective for some, but unsuccessful for others.

Another example is transportation options. Having several different options of transport, such as walk-able and bike-able communities, effective public transportation, and options for private vehicles, ensures that more people will be able to complete their daily activities. Redundancy in this sense relates to the fourth sustainability principle, in that more people will be able to fulfill their needs if they have many options of how to do so.

Redundancy within the economy ensures healthy competition among goods and service providers, and protects against the control which monopolies can exert. It also ensures that the community has access to such goods and services if one provider discontinues production or provision of service.

Redundancy as a characteristic for resilience can aid in achievement of sustainability in that more people are able to meet their needs by having many options of how to do so. Supporting redundancy in natural systems may increase chance that ecosystem functions will be carried out as change and disturbances occur.



## **Memory**

Memory is the ability of a system to preserve knowledge and information (Folke et al. 2005). This is one prerequisite for a system's ability to find its way back to its 'normal' range after a disturbance. "Ecological memory is the composition and the distribution of organisms and their interactions in space and time, and includes the life-history experience with environmental fluctuation" (Berkes et al. 2002, p.363).

As ecological memory is "stored" in the interactions which take place at the landscape level, constituent ecosystems must not be systematically degraded, as stated in Sustainability Principle 3.

Social memory is a way to preserve knowledge, experience and values to inform community decisions. Social memory is the accumulation of experience with practices and rules in use at the collective level (Berkes et al. 2002). It embeds long-term historical and cultural observations (McIntosh et al. 2000), of which cultural diversity and a diversity of worldviews linked to cultural evolution, may play an essential role in nurturing resilience and capacity to adapt to change. "Social memory is the arena in which captured experience with change and successful adaptations, embedded in a deeper level of values, is actualized through community debate and decision-making (Berkes et al. 2002, p. 21). It is a part of the cultural capital of human society, which is the product of shared experience through traditions, customs, values, heritage, identity, and history (Roseland 2005). Enhancing cultural capital is particularly important if a community has a long history, because it preserves cultural heritage and values which influence the modern perception of the world.

By being aware of what has been done before, and what positive and negative consequences occurred, one can carry out future plans and actions based on what was learned. A municipality can support the preservation and transmission of social memory by supporting libraries, educational institutions, and facilitating local discussions and workshops. Preservation of social memory allows a municipality to recover from disturbances, as it strengthens its "immune system." As the human body develops antibodies when exposed to disease which enable it to effectively fight it off with the

next exposure, a municipality can more effectively deal with change and disturbance if it has previous experience effectively dealing with change.

When memory is preserved, local actors in a municipality can use opportunities during times of economic growth due to information and skills they have from previous experiences. This can be considered as human capital (Jacobs 2000). A long-term community plan is advantageous to inform economic decisions, which tend to be based on short-term variables. Incorporating social memory (i.e., values, culture and experience) into economic decisions can help highlight long-term community trends which may highlight ongoing problems with misalignment of community goals. This knowledge gives the municipal community an opportunity to make the economic interactions more values-oriented (Robèrt et al. 2005).

### **Self-Organization**

“Complex systems are self-organizing when macroscopic system properties and patterns that emerge from the interaction amongst component feedback to influence the subsequent development of those interactions” (Folke et al. 2002, p.16), and “a self-organizing system tends towards organization from chaotic conditions” (Senge et al. 1994, p. 510).

Social systems are human activity systems and it is desirable that social systems are designed in such a way that human potentials and creativity can be realized (Fuchs 2004). Self-organization is the ability of humans to meet their needs through creative interactions between each other. Actors in the social systems can self-organize within the sustainability constraints and create networks to arrive to creative solutions.

A good example of self-organization is the case of Kristianstad municipality in southern Sweden. In order to protect a wetlands area, a few individuals self-organized to form the Ecomuseum of Kristianstads Vattenrike (EKV). They had the goal to help the municipality of Kristianstads manage its local wetland areas. The process was initiated by a local scientist who raised local awareness through community dialogues. From these dialogues, residents coordinated to increase information flows

and share knowledge about ecosystem dynamics, as well as participate in wetland management (Olsson et al. 2004a).

A self-organizing municipal economy ensures that individuals, businesses and industry can adapt according to market conditions, relatively free from legal restrictions. At the same time, the economy must function within constraints of sustainability, as not all ecosystem services can be valued by the market (Daly and Farley 2003). In a self-organizing economy, information about market conditions and the status of the local resource base is known to all players, and entry is allowed for those who wish to enter, thus not preventing the ability of people to meet such needs. Self-organized economies which are constrained by sustainability principles can possibly allow human needs to be met worldwide without diminishing the Earth's capacity to provide for future generations.

### **Networks**

The relationships between interdependent actors within systems form networks. Networks are those relationships through which energy, resources and information are exchanged and cycled.

Networks consist of non-identical elements, or actors, called “nodes.” These nodes are connected by diverse interactions, or “links.” There are two main types of networks: random and scale-free networks. Random networks are those in which all nodes (or any random node) have a similar number of links. Scale-free networks, on the other hand, are those where some nodes have a high number of links. Those nodes with a high number of links are called hubs. Any given node can have very many links to other nodes or very few, but the ratio of links to nodes follows a logistic curve. That is, only a few nodes are hubs with many links, while the majority of nodes are linked to hubs, but have few other links. On one hand, a scale-free network can transfer information more efficiently through fewer links (through the hubs). But on the other hand a direct attack against its major hubs can cause collapse of the whole, scale-free network. A random network has no more important or less important nodes and it is rather resistant against a directed attack (Barabási 2002).

In ecological systems, within the “food web,” for example, plants grow in soil, which rabbits eat, which foxes eat, which eventually die (as well as the plants and rabbits) and nutrients from their bodies return to the soil, in which plants grow and the cycle continues (Jacobs 2000). As ecosystems grow, self-organize, and become more diverse, the networks become more complex, i.e. the number of links between actors increases. Preservation of the links between species is crucial to the health of the overall system (Capra 1996). Preserving ecological networks, including natural corridors, prevents and reduces the fragmentation of habitats into small, isolated blocks separated by man-made barriers. Such barriers can be roads which truncate land migrations, or wetland destruction which ruin migratory birds’ migration routes. Urbanization is a major detractor in the vitality of ecological networks. This is also the reason why all species must be preserved. If species are thought of as nodes, extinction is the removal of nodes from the system. Removing too many nodes (species) from the system, or removing hubs (sometimes called “keystone” or “umbrella” species) can cause system collapse.

A social network can be thought of as the pattern of the relationships between people and organizations. If change or unexpected events occur in a system, a strong social network can help organize and mobilize a community to cope with that change (Folke et al. 2005). While communities should support self-organization of community networks, it could also be a wise choice to prevent only a few hubs from dominating the system. Scale-free networks might be less resilient if major hubs disappear and vice versa. Indeed, a certain level of redundancy among hubs should be preserved in order to maintain resilience, in case one or two major community hubs fails or falls apart. In that vein, major hubs should also be multi-functional, as well as interdependent with each other. It is important to also state that there is benefit for a community to be somewhat scale-free and have some more dominant hubs. This makes the transfer of information more efficient. During times of change, community hubs can act as centers to help mobilize people and lead a community to its desired future.

Having a large network of collaborating businesses could increase a municipality’s economic resilience by increasing the number of customers or clients a business has access to. These relationships, or links, should

extend beyond municipal boundaries and interact at a larger spatial scale as well. Moreover, increasing such links can increase the flow of information among businesses so they can remain up-to-date on the current state of affairs within their respective fields. And again, preventing the dominance of certain business or industry “hubs” can also be a good idea in case it fails. Also, if only one or two hubs dominate the economic system, they may become so powerful that they can control the market. In this sense, they would be monopolistic.

Creating social and economic networks can provide people with access to increased information, knowledge and experience. For example, most of the Swedish Eco-municipalities are today members of the Swedish Eco-municipality Association, SeKom. The goal of the SeKom network is cooperation between municipalities and with TNS- Sweden in order to raise awareness on sustainability, share information, and distribute useful information amongst municipal workers in order to implement sustainable community plans within each municipality (James and Lahti 2004; Swedish Eco-municipalities Association 2006)..

### **Individual Capacity**

Individual capacity refers to strengthening the individual actors within the system. As the old adage goes, “a chain is only as strong as its weakest link.” If all actors within a system are strong and resilient, then the overall system will be more resistant. Low resistance of most individuals in a system cannot be compensated by a few members having outstanding capacity. There should exist in a system as many sound individuals in order to not negatively affect the other individuals.

In an ecosystem, an old forest for example, a weak individual tree damaged by bark beetles could allow the density of invaders to reach a level that risk surrounding sound trees to be affected and then initiating an outbreak (Berryman et al. 1984).

This idea is also applicable in a social system. Individuals will be more likely to contribute positively to their community, through their labor, their knowledge, their creativity, or their resources, etc, if they are healthy and have good individual resources. Alternatively, a few sound or wealthy

individuals will not compensate for a majority of impoverished peoples inside a community. With such inequities arise social disorders, such as health problems and disease outbreaks; violence; and unsustainable use of resources which will affect negatively the overall system. Learning is a part of building individuals' capacity for social resilience. Indeed, "developing the capacity of individuals to learn effectively from their experiences is an important part of building knowledge and skills into organizations and institutions to increase social resilience" (Folke et al. 2002, p. 47).

Increasing individuals' economic capacity, i.e. having many individuals with marketable skills, will likely result in more economic opportunities for the overall municipality, as new businesses will appear to take advantage of that labor market. In addition, if an individual is functioning below the poverty level, their ability to contribute to the overall economic system is diminished, as they are struggling to subsist, rather than expending energy on innovation and development.

### **Spatial scale interactions**

Interactions take place between different spatial scales and hierarchical levels in socio-ecological systems. It is important to maintain these interactions in order to influence and respond locally to regional and global effects (Folke et al. 2005).

In an ecological system, spatial interactions contribute to memory preservation. For example, when an area is destroyed by a disturbance event, such as a forest fire, recolonization can occur in the affected area through mobile links like wind, streams or moving animals that will bring seeds from other areas that are part of the larger ecosystem (Berkes et al. 2002).

In a social system, such as a municipal community, members will advantageously be aware of their interdependence with communities. They will then be able to interact beyond their municipal boundaries by responding to feedback and consequently influence the results that might have an impact on their community. The municipal government may participate in regional and national governance as well as soliciting participation at the neighborhood level. They can create relationships or

partnerships with organization that have an influence on ecosystem valued by the community in order to preserve municipal integrity and its capacity to preserve goods and services.

The Lake Racken area in Sweden, is now known for its good water quality and excellent fishing opportunities. But in the 1980's a local scientist involved in water monitoring noticed the decreasing PH levels in the tributaries. He alerted other citizens of his concerns. Together they formed a special committee to study the current situation of the lake. Later, this group self-organized into the Lake Racken Fishing Association. The association was preoccupied with the problem of decreasing noble (sport) fish in the lake. The municipality of Arvika, located on the lake's shore, raised a campaign to finance the project of the lake's revitalization. This campaign gave a boost to active networking between different fishing associations and finally, the project extended to the international level, where Swedish and Norwegian municipalities shared experience and knowledge on preserving fish and clean water. Stakeholders include county administration boards, municipalities, rural economic and agricultural associations (Hushållningssällskap), local fishing associations, Swedish EPA, and the fishery departments of both countries. The project is funded by the European Commission's Interregional program, three Norwegian and two Swedish county administration boards, and several Norwegian municipalities. Thus, having started with local participatory governance, the example of Lake Racken management gave a boost to other municipalities for implementing this measure. (Folke et al. 2005; Olsson et al. 2004a).

Regarding a municipality's economy, local businesses can interact, influence and cooperate with regional supplies and demand. For example, local businesses can coordinate at the regional level to supply each other with products, thus creating a regional supply and demand chain, rather than operating as individual units, procuring supply and exporting their products far away from their own locality. In addition, this type of interaction can help to localize externalities of production.

### **Temporal scale Interactions**

Resilience is about preserving variables that contribute to the capacity of a socio-ecological system to provide goods and services *through time*. It

varies in a cyclical way through growth and decay phases that are not of the same length in time. In addition, different actors or organizations undergo growth and decay at different rates within the overall system. In the short run, a system may seem resilient. But a cycle may last over hundreds of years. Moreover, feedback can be delayed over a long period of time. Hence the necessity to have a long-term perspective and to recognize these system cycle variations. Also, knowledge and understanding of the socio-ecological system must be developed and preserved and transmitted through time (Folke et al. 2002; Gunderson and Holling 2002).

In ecosystems, “small and fast scales are dominated by biophysical processes that control plant physiology and morphology. At a larger scale of patch dynamics, interspecific plant competition for nutrients, light and water influences local species composition and regeneration. At a larger scale of stands in a forest, meso-scale processes of fire, storm, insect outbreak, and large-mammal herbivory determine structure and successional dynamics from tens of meters to kilometers and from years to decades” (Gunderson and Holling 2002, p. 69). Spatial and temporal scale interactions are interconnected, but for this thesis they have been separated into two characteristics for simplicity’s sake.

In a social system, temporal interactions can be intergenerational interactions, or as short-term projects embedded within a long-term, overall goal. In an economic perspective, a fast growing sector of the economy can be aligned with long-term economic and social goals.

An important way temporal interaction contributes to sustainability and resilience is by framing short-term plans, projects and actions within long-term objectives, and by using them as steps towards the long-term goal of sustainability.

## **Innovation**

Innovation is the reorganization of variables within a system in response to change. Disturbances, past and present, stimulate innovative new developments (Dörner 1996). As new opportunities are presented with new conditions, it is through innovation which these opportunities can be realized. Innovation is also the ability to experiment and learn. During



times of rapid growth, some innovations will fail while others succeed, based on their suitability to existing conditions (Gunderson and Holling 2002). However, failure of a new enterprise or innovation should not be viewed in negative terms; the innovation may fail but it will still provide a valuable learning experience so that innovation can be better adapted to conditions the next time it is tried. Balance between memory and innovation makes the system more resilient in periods of change by preserving what is good and innovating where adaptation is needed (Gunderson and Holling 2002).

In ecosystems, innovation is termed novelty and corresponds to reorganization following disturbances. Connectedness and network relationships are very low between elements after disturbances so unexpected associations and combinations can occur. Some will survive and control subsequent renewals and others will fail, as they are not suitable to or competitive within the existing conditions (Gunderson and Holling 2002).

Innovation in social system is also brought by changing conditions as well. For example, many and various public services are conveniently available now via the internet because of an increasing number of people connected.

Many economic innovations occur due to new scientific or technological innovations (Kuhn 1996). The floor covering company Interface cooperates with David Oakey Design, for research and product innovations, in its attempt to move towards sustainability. Historically, producing floor coverings without synthetic materials and fossil fuels seemed at first as an impossible task. However, the CEO of Interface proposed the new condition that the company would phase out all harmful chemicals used. Under the new conditions, the chemical engineers at David Oakey Design innovated new floor covering materials, which became a source of great industrial successes for Interface (Doppelt 2003). The changed conditions, indeed changing in the “rules of the game”, forced Oakey to innovate a new and better product, and thus progressing the entire industry.

## **Self-reliance**

Self-reliance means satisfaction of basic needs (like food, energy, health care) locally with the aim to eliminate dependence on imported resources. Doing so, the effects of development are retained (such as capital and experiences). Negative effects of development are also localized (such as pollution and depletion of resources). Self-reliance has the advantage of strengthening the local economy, decreasing energy consumption for transportation, and directly contributes to the sustainability objective by internalizing externalities (Ekins 1986).

A self-reliant community produces its energy locally, in a sustainable manner (solar, wind power, biofuel, biomass heating systems, etc.) and fulfils community needs. For example, in 2001, the town of Övertorneå in the northern Sweden has totally eliminated its use on fossil fuel for municipal operations by creating a biomass district heating system and switching their transportation fleet to biofuels (James and Lahti 2004). Doing so, the community decreased its greenhouse gas emissions in the atmosphere and its contribution to climate change. Food can also be produced locally, in an organic manner, with respect to regional specificities. Agriculture could decrease its dependence on fossil fuels by eliminating fertilizers and pesticides.

In a self-reliant community, local businesses and services satisfy basic needs (e.g., food, water, affordable housing, jobs and means of livelihood, goods and services, energy, and mobility) of the community and make local economy stronger and less vulnerable to global economy fluctuations (James and Lahti 2004). Citizens find opportunities to earn their living in their community. And by providing employment for community members, local businesses many can help them satisfy their basic human needs as implied in sustainability principle 4.

## **Feedback**

All complex systems are interdependent (Dörner 1996). This means that when one part changes, it affects another part. All parts are constantly acting, and changing. The changed conditions and response which they generate is called feedback (see e.g. Haraldsson 2004).

There are two kinds of feedback. Positive feedback reinforces the action that provokes the response. Negative feedback provokes a decrease in the action that provokes the response. If unchecked by negative feedback (also called balancing feedback), the action and resulting actions of a reinforcing feedback system will systematically increase. Without negative feedback, the reinforcing system will sooner or later collapse by breaching a threshold of sustainability. It is important to also consider that feedback happens at varying time scales, i.e. some responses may be immediate, and some may occur at a much longer temporal scale (especially in ecological systems). The important part of feedback is recognition of the action that is causing the feedback response, and reacting to that action effectively (Meadows 1999; Haraldsson 2004).

Feedback is ubiquitous in nature, as ecological systems evolved checks and balances (Meadows 1999). Ecosystems are complex adaptive systems, and effects at higher levels emerge from local processes and may induce feedback to influence the subsequent development of those interactions. They are characterized by non-linear relations, threshold effects, historical dependency, multiple possible outcomes and limited predictability (Scheffer et al. 2001). It is therefore important that municipal management of ecosystems effectively react to these seemingly unpredictable feedback mechanisms through an increased awareness of the processes and effects which are at play in their locality.

Social systems can develop processes and interpret and respond to ecological processes, as well as social and economic changes. Indeed, it is often through citizen participation that social and ecological problems are voiced (Olsson et al. 2004b). By being open to citizen concerns, the municipality can respond to such concerns more effectively. Some municipal communities have devised mechanisms to respond to such feedback. These can include creation of a shared vision to establish what is important to the community and must be preserved; legislation that creates social space for ecosystem management; funds for responding to environmental change and for remedial action; tools for monitoring and responding to environmental feedback (such as EMAS or ISO); information flow through social networks; the combination of various sources of information and knowledge, and arenas of collaborative learning for municipal management (Olsson et al. 2004b).

Economic feedback is for example when actors respond to market conditions. An example of this is the response to market forces such as price, consumer demand, and resource availability through quarterly reporting, and readjustment of actions accordingly. It is important to consider the long-term trends which occur as well, which many economic reporting systems fail to include.

Feedback relates to sustainability in the sense that it alerts the community to change and disturbances which can affect long-term viability, i.e. hitting the walls of the funnel. Having effective monitoring mechanisms can alert the municipal community to trends and potential disturbances. This information alerts the community of changed conditions that may undermine what they value, so that the situation can be quickly addressed with innovative solutions. Innovation within the constraints of the four Sustainability Principles leads to solutions that support nature's long-term capacity to provide goods and services. Monitoring and feedback also highlights disturbances which have far-reaching effects. This awareness can motivate the community to interact with other communities in which the cause of the disturbance happened.

### **3.2 Factors that influence resilience**

As mentioned in section 2.3, the research team identified some common factors which affect resilience characteristics. These factors are represented in diagrams in Appendix II.

The main barriers which negatively influence characteristics of resilience are:

- Apathy
- Linear Thinking
- Lack of integration
- Resource Scarcity
- Intolerance
- Ignorance
- Lack of Participation
- Bureaucracy

- Poverty
- Short-term Planning
- Inaccessibility

Positive factors which help support each characteristic of resilience were similar for many characteristics and were synthesized into the following list:

- Community Engagement
- Raising awareness
- Support for small businesses
- Education
- Local development
- Participation
- Shared vision
- Multi-use zoning
- Monitoring and participatory governance
- Healthy ecosystems
- Feedback
- Shared values
- Leadership
- Space for Participation
- Participatory Budgeting

This exercise helped the research team identify common negative and positive factors which municipalities may face when making an effort to support resilience and sustainability. The fact that many characteristics had common barriers and common positive influences shows that there are some synergies in characteristics which help to support different measures. Basically, it means, that one solution could be suitable for several measures.

### **3.3 Measures that support Resilience and Sustainability in Municipalities**

The methods used to obtain these measures are described in section 2.4. In this section we describe each of these measures and give examples of how they have been implemented in various municipalities around the world.

#### **Sustainability Education**

Training on the principles of sustainability and the concept of systems thinking is important for municipal employees. A good understanding of sustainability principles (and the laws of nature which they come from) will allow municipal workers to make good choices in their everyday work, in line with sustainability goals. Many documented examples have demonstrated that when sustainability principles and long-term planning are used to guide actions, employees can efficiently contribute to significant money savings. When people understand problems, they can innovate solutions (Boiral 1998). Sustainability education is therefore an important first step for solutions to unsustainable practices. And as the education of municipal employees and outreach to community residents takes place, community changes can occur by aligning their behavior with their increased understanding of the system.

Some municipalities in Canada have offered training sessions on systems thinking and sustainability principles. It has been an effective measure to increase municipal sustainability in towns such as Canmore, Alberta and Whistler, British Columbia. The training program involved taking participants through the main components of the TNS Framework. The first workshop focused on awareness of the current state of the biosphere; an introduction to systems thinking; the basic science underpinning the framework; the TNS sustainability principles; and the concept of backcasting (Baxter and Hodgkin 2005). Indeed, the municipality of Whistler has been particularly effective at communicating this information with widespread acceptance and success, and recently was awarded first place in a United Nations-endorsed international competition for its long-term comprehensive sustainability plan.

In Robertsfors, Sweden, such training was aimed at school teachers. The training developed a network of representatives from all Robertsfors' schools and daycare facilities. This network meets monthly to discuss sustainable activities and how to teach such concepts in schools. Another outcome has been that almost all of Robertsfors' educational facilities have started work to qualify for national certification as sustainable schools (James and Lahti 2004).

### **Create a “Space for engagement”**

A space for engagement, in the physical sense as well as the figurative sense (meaning openness to community voices and concerns), can increase municipal participation and feedback. First of all, the municipal government and municipal departments must be receptive to hear citizen concerns. There should be a commonly known place where community members can voice their concerns and ideas for the municipality. The municipal government can also actively involve community members to participate and collaborate in budgeting, planning, and allocation of community resources.

The municipal government can expand opportunities for stakeholders and the larger community to engage in community life and the decision-making process. Concerns and knowledge (on social, economic and ecological issues and opportunities) should be freely shared with and acknowledged by the municipal leaders. Consultation processes, round table discussions, community forums, lectures, and workshops can be organized by the municipality. When different groups of stakeholders bring their voices regarding decisions for the community, it is more likely that decisions will be enlightened by a more complete understanding of the municipal community and therefore, they may be more appropriate for municipal sustainability.

The municipal government can also provide a physical space in which community groups and organizations can meet. Municipal government could serve as facilitator for meetings and workshops, and should prevent any particular interest group from dominating the space.

## **Co-create a shared vision based on a sustainable future**

The aim of this measure is to increase community participation and commitment to sustainability. The community's and stakeholders' participation in the process contributes to an increased understanding of the dynamic relationship between humans and nature. People can share their knowledge and understanding of their environment, which can bring a more complete picture of the whole system of which they are a part, as well as the challenges they are facing. The process of creating a shared municipal vision can allow greater project acceptance and ownership by community members, as they are all involved in creating the vision of what the future of their municipality will look like. Awareness of the sustainability challenge by the community members, combined with the compelling envisioned future can create the creative tension required to mobilize the community.

The municipality can engage stakeholders and community members to create a community vision, i.e. what they think a sustainable future “looks like” for their municipality. The vision includes shared community values, shared community purpose, strategic goals and sustainability principles. Education about sustainability (see above measure) and why it is important should be included during all stages of the visioning process, especially the beginning.

The municipality of Perth in Australia organized a large-scale engagement process with the community to create the vision of Perth in 2030. They started with a community survey on what individuals value within the municipality. They used TV and radio to increase awareness of the challenges the municipality was facing for the future. They invited those frequently left out of community to dialogue sessions to communicate their concerns and ideas. Participants were selected from lists provided by organizations addressing groups of interests, like youth, indigenous, and non-English speaking. They also organized school competitions of Vision 2030 (primary and high schools) to engage the city's youth. In addition, they organized “Dialogue with the City” forums, where a wide range of community stakeholders were invited to discuss possible futures for the municipality. After the forum, working groups were formed to develop strategic plans and assure implementation. Sustainable steering committee



(see below) could be formed after that process with community enthusiasts and representative participants. (21stCentury Dialogue 2006).

Resort Municipality of Whistler in British Columbia, Canada, is an exemplary model regarding the co-creation of a shared vision for a sustainable future. They used the TNS Framework and system thinking as a sustainability education base. Doing so, the community members shared a common knowledge and understanding of sustainability from which they collaborated through workshops to co-create the Vision Whistler 2020 and then planned strategically to its achievement. It is through partnerships among stakeholders that they implement and monitor actions to achieve success.

### **Sustainability Steering Committee**

A municipal government can facilitate the formation of a sustainability steering committee, responsible for raising awareness on sustainability within the municipal community, evaluating municipal decisions through the lens of sustainability, and responsible for monitoring, coordinating and updating municipal departments' actions towards sustainability. That committee should be composed of a variety of actors, such as municipal employees, business and industry representatives, community members, non-governmental organizations, and so on, therefore increasing collaboration among these groups (Walker et al. 2002). In order to preserve memory, the committee should be composed of some non-elected members who remain on the committee over a long period of time.

### **Community supported local energy production, businesses and services**

The municipality can encourage development of local energy production, businesses and services to improve self-reliance concerning basic necessities, like food, housing, health care and energy. If there are a great variety of goods and services providers, some overlap in their functions plus strong competitive market, this will increase diversity and redundancy. Having diverse and redundant market will encourage the community participation, innovation and creativity by developing their own solutions for better quality.

Several examples of local production exist in Sweden, as several Swedish municipalities have managed to successfully raise awareness on sustainability and support local suppliers (James and Lahti 2004). Changing to locally-developed, renewable energy sources is an important task local governments have to tackle to reduce dependence on imported energy resources. The national goal of Sweden is to eliminate use of fossil fuel for 2020 by making a full transition to bio fuels and wind power.

Local production creates space for community involvement, such as participation and new workplaces. It also supports diversity and redundancy through an increased number of businesses and services. It helps to develop networks and temporal and spatial scale interactions, as local producers can cooperate with regional and national organizations and businesses, thus localizing supply chains. It also strengthens self-reliance by decreasing dependence on imported goods and services, and encourages feedback about the market situation, prices on local food and services, and citizen concerns.

For example, the city of Umeå, in the northern Sweden found itself in an energy crisis in the 1990s. There was a power shortage due to the inability of the oil-burning plant to generate enough power and heat. The city had the possibility to buy oil and coal generated energy from Norway and Denmark, but the municipal government chose another solution. It was decided instead to construct a local power plant feeding on the city's solid wastes. This solution was synergistic as it solved the energy crisis, while at the same time decreased wastes sent to the landfill. It also eliminated the need to transport oil and coal from afar. (James and Lahti 2004).

The municipality of Falkenberg in Sweden has been implementing a municipal sustainability plan since 1995, and through continuous sustainability education raised the awareness among municipal employees and the community that the city should use wind and sun as energy sources. The cost of building the windmill farm and its maintenance is expected to pay for itself in 9 years through energy cost savings. The city also reduced the purchase of coal-generated electricity from Denmark by 50 percent. The ten turbines were built on agricultural land leased from local farmers. In exchange farmers receive 3 percent of the wind electricity revenues. Finally, the city established a non-profit cooperative that now owns the

wind farm. City residents and businesses can join it and buy wind generated electricity at half the market price. Thus, this measure promotes local production of renewable energy, builds networks, and raises sustainability awareness among community members. (James and Lahti 2004)

The municipality can also encourage local businesses and industries to mutually buy local products and services. For example, the municipality of Sala (about 110 km northwest of Stockholm), together with local businesses, developed an information center, called the Sala Eco-Center, for exchanging environmental products and practices. It assists local businesses to transition to renewable energy, and is a marketplace to buy the local organic food. It also facilitates networking between local producers and customers. The Sala Eco-Center also awards certificates to businesses and other organizations that succeeded to support the local suppliers using sustainable practices (James and Lahti 2004).

In addition to develop businesses and services locally, if a municipality choose to support sustainable businesses, it will have the beneficial affect to make multiple-use zoning more compatible and acceptable, with the ensuing effects describe in that section.

### **Participatory governance**

Participatory governance takes place when a municipality solicits (or requires a certain degree of) participation from the municipal community in decision-making, such as budgeting, land use planning, etc. This can increase resilience and sustainability in several areas. Participatory governance increases community involvement in the decision-making process. This allows community members to express their concerns and therefore influence municipal strategies and policies. It encourages feedback by encouraging citizens to voice their concerns to municipal employees, networking between municipal government and community members, scalar and temporal interactions, and provides space for innovation and self-organization.

A good example of participatory governance through participatory budgeting is a municipality of Porto Allegro, Brazil. Here, the idea of a “Participatory Budget” has evolved over the years into a two-tiered

structure of forums where citizens and interest groups (such as neighborhood associations, cultural groups, and special interest groups) participate throughout a yearly cycle. They express their opinions and decide on projects for specific districts, as well municipal investment priorities. Monitoring the outcome of these projects is also a community effort. The mayor and his staff attend these meetings to reply to the concerns of citizens about projects in the district. The total number of delegates for a particular interest group is based on the proportion of the number of attendees, and the proportion of persons from a specific neighborhood to that total. Neighborhood associations or groups are responsible for electing their own delegates. At the Regional Plenary, a vote among regional delegates determines who would be elected to serve on the Municipal Council of the Budget (Baiocchi 2001).

### **Early Warning Systems w/ Yearly Benchmark Summits**

Yearly benchmark summits are occasions when the municipality and community members gather to discuss the status of the community (for instance, environmental, social and economic aspects). It is also an opportunity to discuss community values and concerns. From there the community creates solutions to preserve values and creatively addresses concerns. An Early Warning System (EWS) is a mechanism which monitors those aspects identified by the community, which the municipality should be sensitive to. The goal of this measure is to inform the community and heighten awareness of disturbances or changes which may threaten the municipality's well-being. EWS is a coordinated action plan which should immediately be implemented in case of emergency. In many cities, municipalities work through the Emergency Action Plans. Emergency Plans should be tested and utilized as a tool in order to be efficient in case of unexpected danger.

For example, London Strategic Emergency Plan was developed in cooperation with London Resilience organization and includes 6 sub-plans for specific purposes such as Media Information Protocol, Disaster Fund, London Mass Fatality plan, London Command and Control Protocol, Large Scale evacuation plan, Site Clearance Plan, as well as specific responsibilities and actions of city agencies in case of emergency. The aim of the document is "to set out the strategic regional response of the agencies

that make up the London Resilience Partnership to incidents requiring multi-agency co-ordination on a pan-London basis” (London Strategic Emergency Plan 2005).

In order to discover potential business or factory closures, economic downsizing, or environmental hazards in order to prevent the community from being blindsided from unexpected events, EWSs can be set in place by the municipality. Closure of businesses and relocations, as well as environmental problems, are things that can often be identified before they get out-of-control. If the community is involved in identifying problems before they are widespread, then they can devise creative ways to avoid widespread disasters. The aim of the Early Warning System is for the municipality to devise a set of procedures that will gather information necessary to understand the local situation and why a problem might arise. This sort of intelligence requires a wide variety of sources of information, including key employers within the municipality, local land use managers and land owners, recreational naturalists, and municipal employees (Centre for Community Enterprise 2003).

### **Multi-use zoning and urban infill**

Zoning policies define allowable land uses in municipalities. The main idea behind zoning is the separation of incompatible activities. Among other things, it aims at preventing nightmare scenarios such as having a chemical factory located next to a kindergarten. In many cities, the trend is to separate urban uses into compartments such as residential neighborhoods, separated from retail and business areas, separated from transport areas.

Multiple-use zoning is that which combines multiple urban uses in the same space. Locating shopping and business areas in the same neighborhoods where people live directly reduces dependence on the automobile, as citizens can walk to work and shops. Another principle of multi-use zoning is that there should be a diversity of housing options available in the same neighborhoods. These should include single-family homes, flats, row-houses and low-income housing. This helps ensure that neighborhoods are diverse and reduces segregation.

Urban infill is the redevelopment of existing urban space that is old and underused, rather than clearing new ground for development. When combined with multi-use zoning, vibrant, walkable, urban communities can be designed by the municipality. This results in preservation of natural spaces outside the city, as well as strengthens the social fabric within urban areas as it vitalizes blighted areas.

An example of multiple-use and urban infill development is that of the European Union's ECOCITY initiative. An ECOCITY is composed of compact, pedestrian-oriented, mixed-use quarters or neighborhoods, which are integrated into an urban system with multiple "centers" in public-transport-oriented locations. An ECOCITY should be an attractive place to live and work. Such sustainable and liveable structures contribute to the health, safety and well-being of the inhabitants and their identification with the ECOCITY (Gaffron, Huisman, and Skala 2005). This increases self-reliance in the sense that it reduces citizens' dependence on automobiles and fossil fuels. It also increases redundancy in that multiple small shops can exist in different neighborhoods.

### **Small loan programs for local, sustainable business**

This measure is based on the idea of micro credit, which has been very successful at empowering people in developing countries. Micro credit is a financial innovation which originated in developing countries where it has successfully enabled impoverished people (mostly women) to engage in self-employment projects that allow them to generate an income (Acción International 2006). In this sense, the municipality can create a fund for such purposes, and give short- to medium-term loans to entrepreneurs who abide by principles for sustainability. The municipality can also encourage local financial institutions, such as credit unions, to install such programs.

An often-cited case study of an early micro credit program is that of Acción International in Brazil. In 1973 they focused their initiatives towards providing economic opportunity to poor people in order to create lasting improvements in their community. Their plan began to offer micro loans to poor people eager to start small businesses. Within four years, the experiment had shown its success in having provided 885 loans with a

repayment rate of over 90 percent. The loans also helped to create or stabilize 1,386 new jobs (Acciòn International 2006).

It is important to provide such resources for impoverished people with the necessary education about sustainability (see above measure Sustainability Education). The TNS Framework for sustainability is a practical and effective way to educate people on sustainability and how it can be achieved.

By providing such loans and other forms of support, municipalities can effectively reduce poverty, while at the same time increase the number of sustainability businesses which exist in the community. Doing so through small loans, they increase economic and social innovation, as well as self-reliance, self-organization and diversity. If the municipality does not have access to the financial resources necessary to create such a fund for sustainability start-up businesses, it can partner with existing financial institutions to implement such a measure. It is also worth noting that a municipality can support local, sustainable business start-ups in the sense that it can remove restrictions and ease the business registration process.

### **Support for local, organic food producers**

The aim of this measure is to increase self-reliance for healthy food, to improve the local economy, to eliminate the use of harmful chemicals, and to reduce energy consumption by decreasing food transportation. Organic food production will also have the advantage to create a healthier environment and a healthier population.

The municipality can support local, organic food producers by creating incentives to do so, such as tax benefits and subsidies. It can also place regulations on land use and public health to discourage pesticides and fertilizers, intensive land-use, monocultures, etc. In addition, the municipality can help create a market for local, organic foods by advertising the benefits from buying such products.

Community Supported Agriculture (CSA) is when a local farmer accepts subscriptions by the local community in advance, for provision of seasonal agricultural products. For example, a family can subscribe to a certain

amount of produce per week, and the farmer delivers what is in season. Doing so gives farmer more financial flexibility and locals are provided with fresh, seasonal, healthy food (Beatley 1997). The municipal government can encourage organic Community Supported Agriculture by playing the role of liaison between producers and consumers. The municipality can also promote community gardens by making garden spaces available throughout the city and encouraging their active use. Community gardens, in addition to growing fresh, cheap and healthy food, have the advantage to increase citizens' awareness to their environment, and connection with nature, as well as create a space for community participation.

The City of Seattle created a program of community gardens dedicated to an organic food bank for those in needs. These gardens are maintained by volunteers who can also collect for themselves multiple benefits, such as access to vegetables, flowers and herbs, and plant sharing with other volunteers (City of Seattle 2006). The city council took the resolution to add at least 4 new community gardens each year and focussed particularly to implement them in high density areas. It also hired staffs to support these gardens development.

A municipality can encourage and mandate organic farming through planning initiatives which are within their realm of their governance. They can also provide easements to farmlands adhering to conservation or organic methods. An example of local organic food production is a community-owned farm called Gäddvik in Luleå municipality. Here farmers work to improve initially poor soil conditions, use water-generated pump for irrigation, and get locally produced healthy products. Chemical-free farming includes topsoil development by mixing existing soil with compost, leaves, manure from sheep and chickens. In addition to being environmentally-friendly, farmers using these practices can also brand their products as organic with the KRAV certification. The main criterion for organic certification is no use of chemical pesticides, herbicides, or commercial fertilizers. KRAV is an organization run by an independent board of environmental experts, farmers and food industry members who jointly develop regulations for local organic food production. This board also promotes organically certified food throughout the country. Gäddvik



organic farm is working with KRAV in order to increase the sale of their food products (James and Lahti 2004).

### **3.4 Interviews**

After selecting measures which can assist municipalities to lead the way towards sustainability and resilience, interviews with municipal employees were conducted. Employees from Swedish, Canadian and Finnish municipalities provided feedback on the measures, as well as practical information on how these measures have been implemented in their respective communities. In addition, barriers to implementing such measures were discussed. Finally, the interviewees were encouraged to discuss their hopes for the future and sustainable development in their municipal communities.

#### **Municipality # 1**

This municipality in the southernmost part of Sweden has 122,000 inhabitants. It is one of Sweden's Eco-municipalities and has been implementing sustainability plan for several years. It actively cooperates with The Natural Step-Sweden organization, using their framework for sustainability. The municipal government managed to successfully implement some sustainable practices followed by outreach education on sustainability. The interviewee's position for the municipality is as the Environmental Coordinator, and he is a member of the sustainability committee.

#### *Sustainability Education*

There is a large campaign on sustainability education within this municipality. They started with educating municipal employees about sustainability using the TNS framework and approach. The interviewee himself has educated 500-600 people through a series of workshops and public lectures. An elected Civic Committee facilitates several informative events, such as the "Program for citizen's debate" and political discussions within the New Environmental Program. Businesses in particular are invited to "Environmental Business Breakfasts" which are meetings taking place monthly for local businesses, with members from small and large companies alike in attendance. At these breakfasts, a presentation about an

environmental issue is given with discussion following. For example, the topic of a recent breakfast was climate change.

*Create a “Space for engagement”*

The Civic Committee is responsible for involving community members into decision- making practices. The municipality has eight offices of Civic Committee Employees throughout the city, where citizens can come and voice their concerns, as well as bring new ideas for community development. The Civic Committee currently consists of politicians only, but in future they are willing to include community stakeholders.

The main barrier for community involvement is that people tend to actively participate only when there is an acute problem, or some negative consequences occurred. People are likely to tackle those problems which are evident and present. This prevents the community from being proactive and preventing problems in the first place.

*Co-create a shared vision based on a sustainable future*

There is an established vision for the municipality, which has been facilitated by the Civic Committee. It was founded four years ago, and is present in every district of the city.

*Sustainability Steering Committee*

The municipality has established a Sustainability Steering Committee, which is responsible for sustainability planning and sustainable practices for the municipality. They are also responsible for coordinating all environmental activities for the municipality. This committee works closely with the Civic Committee to hear citizen concerns and ideas.

*Community supported local energy production, businesses and services*

The municipality implements local energy production. It owns an energy plant which provides the city with district heating, by using biofuel (wooden). This reduces the dependence on fossil fuels and makes the city more self-reliant.

*Participatory governance*

Civic Committee is aimed to gather citizen input for decision-making, but citizen involvement continues to be a challenge. Currently decision-making

is a privilege of politicians, but the committee would like to open space for more stakeholders and involved citizens for participation.

*Early Warning Systems w/ Yearly Benchmark Summits*

Early Warning indicators are diverse. For example, every second year indicators are investigated, such as unemployment indicators, air quality indicators and so on. They are brought forward and monitored by the Steering Committee members.

*Multi-use zoning and urban infill*

Multi-zone land use is encouraged through “no sprawl” practices. Also, the municipality’s urban planners design for mixed-housing opportunities and building new areas close to the public transportation, i.e. “transit-oriented” development. Urban infill is undertaken by occupying and building on new lands between the old areas.

*Small loan programs for local, sustainable business*

This measure is not implemented, though municipal government considers it to be a very interesting measure and possible to support or implement.

*Support for local, organic food producers and suppliers*

This measure is not implemented because of the lack of awareness among food producers regarding advantages of organic farming.

**Municipality # 2**

That municipality is of medium size, located in Quebec, Canada, with around 125 000 of population spread between urban and rural areas. The interviewee is land use planner.

*Sustainability education*

An energy-efficiency committee encourages employees to save energy. The savings are returned to the community. The municipality uses the money saved to buy school materials for underprivileged children. At this time it does not provide sustainability education for municipal employees or for community in general.

*Create a “Space for engagement”*

The municipality offers citizens opportunities to express their opinions and ideas about municipal concerns on its municipal web site on the different aspects of the municipal life. In 2003, many committees had been created to consult stakeholders to help create the strategic plan. Twenty-four workshops were created on different themes. For example, one was on the environment, water and quality of life.

*Early Warning Systems w/ Yearly Benchmark Summits*

There is no such Early Warning System or indicators, and the municipality retains a largely reactionary approach to emergencies. However, an emergency procedure does exist and there is a fund allocated by the municipal budget for emergencies.

*Multi-use zoning and urban infill*

There is no mixed zoning, but residential areas are located near basic services. Small commercial zones are spread in between residential areas, and the municipality encourages residential development close to existing infrastructure.

*Support for local, organic food producers and suppliers*

Community gardens are supported by municipality. They also provide grounds for local farmers’ markets.

The measures co-create a shared vision on sustainable future, creating a sustainability steering committee, small loans programs to local sustainable businesses, and participatory governance are not currently implemented by this municipality.

**Municipality # 3**

The municipality # 3 is a relatively small town of 20 000 people in Quebec, Canada and is highly interested in implementing sustainable practices. The interviewee is the director of Environment and Sustainable Development Department.

*Sustainability Education*

So far, no education is provided to municipal employees or citizens about sustainability. The municipal government is in favor of such education

because they wish that information between departments and municipal employees would flow more laterally, and it would be easier if employees were educated about sustainability. The perceived constraint is the lack of financial resources.

*Create a “Space for engagement”*

A municipal employee meets citizens committees in their neighborhood to discuss short-term community projects. These projects, as decided by the municipal government are divided by sector, and money is budgeted with specific goals such as housing and integration.

*Sustainability steering committee*

There is currently no sustainability steering committee within the municipal community, but the idea was met with interest. The interviewee suggested that a member of the city council should be on the committee to encourage communication with town decision-makers.

*Community supported local energy production, businesses and services*

Local businesses are promoted, though the focus tends to be on economic outcome rather than the goal of community sustainability or resilience. The municipality supports local businesses by contributing to their promotion in various media. They also offer tax reductions for local business. Regarding the local energy production, nothing is done and they don't perceive it as part of their responsibility. In that area, the main energy source is hydro-electricity, which is a “clean” energy although it certainly violates Sustainability Principle 3. Additionally, the price of energy has always been relatively cheap, which effectively discourages energy efficiency. Wind power is becoming more and more popular in that area, and some municipalities are considering investing in wind power. This idea of developing wind-power sources seemed to be interesting for the interviewed municipal employee.

*Participatory Governance*

The municipal laws in the Province of Quebec, Canada, request citizens' consultation for municipal project approval. Public opinion or disapproval is welcomed for a limited period of time, after which it is not accepted. Otherwise, public consultation depends on the initiative of elected

members. It is not integrated in the organization's culture to consult the community. Though, municipal employees are open to citizens' concerns.

*Early Warning Systems w/ Yearly Benchmark Summits*

The municipality has not addressed this measure. Infrastructures are improved when they are completely worn out, rather than periodically improved. There is a reserve in the budget for such emergencies, but no real emergency fund exists. They are already overwhelmed by day-to-day operations.

*Multi-use zoning and urban infill*

The municipality is surrounded by highways and farmland, so their capacity to expand is limited but does not seem to constitute a problem. The city is not developed with multi-use zoning but some zones are mixed, meaning that multi-level residential buildings are allowed with the first floor having a commercial function, as long as they do not produce vibrations, dust, bad smell, etc. In residential, single-family zones, small commerce operations or offices are allowed. There is a good balance between new development and revitalization of old areas. In addition, municipal funding has been provided to help preserve the old sector's vitality and heritage.

In the past, some areas were zoned for multiple-use. However, the land developers which bought the land built only single-family, residential neighborhoods. Each neighborhood has a small commerce node to satisfy basic needs. The town is very small, and big centers are accessible by car in ten minutes, from everywhere. However, distances may be too long to be convenient to go shopping by walk.

*Small loan programs for local, sustainable business*

This measure is not implemented in full, but some steps have been taken. In partnership with the Local Development Centre, the municipality grants loans for local businesses development. However, there are no environmental and sustainability criteria that influence project selection.

*Support for local, organic food producers and suppliers*

This measure is partially implemented. Some community gardens exist, but are more for recreational purposes rather than food production. The municipal government considers that it is not part of the decision chain

regarding agriculture, as it falls under provincial jurisdiction. In addition, the Union of Agricultural Producers (UAP) is very influential on farmers and the methods they use.

Measures such as building a vision on sustainable future, creating a sustainability steering committee, support of organic food producers, sustainability education for municipal employees and the community, participatory governance, and early warning systems are not currently implemented by municipal government.

#### **Municipality # 4**

The fourth municipality used for this study is an old industrial centre located along a river in southern Finland. It is the largest inland community in the Nordic countries, with a population over 200 000, and is one of the most rapidly growing cities in Finland. For this interview two municipal employees, the senior architect and an urban sociologist, were met in-person. Also, project managers for two municipal projects were consulted via email. In addition, the project reports for the respective projects were studied.

The first project was EU-funded and aimed at designing sustainable settlements for specific sites. It was conducted in seven different communities throughout Europe. One of these was a new neighborhood for 13,400 inhabitants and 3500 workplaces within Municipality #4. The aim of this specific site was to demonstrate the feasibility and desirability of urban living compatible with sustainability requirements.

Another study in the same Finnish town was conducted, aimed at facilitating the exchange of information and experience between various local and regional authorities within the EU. Specifically, the study looked at preserving the rapids which flow through the city centre and are integral to its identity, as well as revitalization of the old industrial buildings which line the river.

#### *Sustainability Education*

Workshops for inhabitants of the sustainable neighborhood were organized during the project's pre-planning phase in order to educate area residents on

principles for the neighborhood's sustainable development. The city also organized several events for investors and business sectors involved in the realization of the community. However, the idea of and need for sustainable development and the values connected to it are not sufficiently discussed as far as the wider public of the city is concerned. "Depending on the case, the community can be active in making preliminary preparations and being supportive in different ways like for instance raising public interest towards the case. The most important role the community has is to make sustainability a natural aspect in all kinds of tasks and activities. That means, among other things, making sustainability a well known and understood point of view in all activities. This understanding can become a natural way to value different tasks, especially, if it is taught already to the children starting from the early age" (pers. comm., Project Manager for urban revitalization project, 24 May 2006).

*Create a "Space for engagement"*

The neighborhood planners actively organized citizen participation in community planning. Participation has been based on a collaborative working group, public meetings, interviews, inquiries and public surveys. A community committee was also established, responsible for representing community concerns to the municipal government. In addition, under Finnish law, if a citizen brings forth a concern to a city councilmember, they are required to present the concern to the city council, as well as ideas they have had about how to address the concern.

*Building vision on sustainable future*

Building the community vision has been the essential aspect in the sustainable neighborhood plan. The vision specific to the Finnish neighborhood contains ideas collected through several questionnaires, the results of workshops with local people and civil servants and material from the project. In the Europe-wide project states that the vision should include sustainability and resilience ideals, such as "City of accessibility for everyone; City of minimized demand for land; City as network of urban corridors; City of sustainable lifestyle; City for strong local economy; City integrated into global communication networks; and City of cultural identity and social diversity" (Gaffron, Huisman, and Skala 2005, p. 17).



### *Sustainability steering committee*

A neighborhood community committee was established in 2001. It was responsible for representing community concerns to the municipal government. Unfortunately this committee was not maintained, as many of the members on it were opposed to the sustainable neighborhood. They were residents living in a small village near the building site for the sustainable neighborhood. The site was a forested area, which many of the committee members used as a recreation area.

At the municipal level, this municipality has a special department and a full-time employee committed to coordinate and evaluate the city's activities through the lens of sustainability. In Finland, a federal law requires that the sustainable development perspective is weighed in each public decision, whether at the municipal, regional or national level.

### *Community supported local energy production, businesses and services*

The neighborhood focuses on energy saving technology and energy-efficient design (passive solar heating). Ground source heating and active solar systems supplement district heating. However, use of renewables is not considered economically profitable and has limited application in the district heating plant. Wind conditions are considered to be not suitable for wind farms.

Office space for local business was planned into the sustainable neighborhood project to encourage residents to live within walking or biking distance of their workplaces. Small-scale agricultural production and manufacturing are located near the residential areas.

### *Participatory governance (budgeting, planning)*

The pre-planning stage of the neighborhood project included the establishment of general planning principles and guidelines according to the needs and wishes of citizens, based on methods outlined above in *Creating a Space for engagement*. A framework for future participation in the neighborhood development is under development. The city also intends to create new opportunities for participation via the Internet.

One such opportunity has been developed with the sustainable neighborhood project. This internet tool allows participants to suggest areas

suitable for development and areas which should be preserved. Highly resolute aerial photos are displayed on the computer screen, and the user can place a “+” on areas which have a high environmental value or special meaning, or a “-“ on areas which are viewed as suitable for building. In addition, the user can highlight areas of particular concern, for environmental reasons or otherwise. The user is allowed to comment on such areas, and all submissions are evaluated by a municipal employee. This tool has been particularly successful among the 25-40 year old set. In order to improve the internet skills of residents, the municipality has a special bus which drives around the town to teach internet navigation.

*Early Warning Systems w/ Yearly Benchmark Summits*

Not implemented as such in either project. However, 34 indicators for urban sustainability were developed as part of the overall EU project.

At the municipal level, the sustainability coordinator (as mentioned in *Sustainability steering committee*) is responsible for monitoring sustainability indicators. In addition, for all public projects, an impact assessment is required. For this assessment, all foreseeable impacts are evaluated, and public opinion is welcomed for a set period of time prior to project commencement.

*Multi-use zoning, urban infill, and mixed housing options*

High mixture of uses is promoted to develop its own identity and self-reliance as a community. The community is composed of compact, pedestrian-oriented, mixed use neighborhoods with socio-economic diversity. The community is integrated into a polycentric urban system in public-transport-oriented locations, which allow residents to remain car-free. At the municipal level, all new residential areas are designed with public transport in mind, including leaving areas for development of a light-rail system in the longer-term future.

Through the revitalization project, old industrial buildings have been converted to other uses and the city is committed to preserving the heritage of the industrial area by reusing vacant industrial buildings. Indeed these areas are vibrant and unique, contributing to the municipality’s identity and economic vitality.

*Small loan programs for local, sustainable business*

Not implemented as part of either projects. At the national level, Finland has a well-developed low-rate loan program for entrepreneurs. These loans have no specific criteria for sustainability.

*Support for local, organic food producers*

Small-scale agricultural production is located near the residential areas. Organic food production is a “hot topic” in Finland, though large scale organic farming is not practiced. In most grocery stores, local and organic options are available, though more expensive.

Finland has a strong cultural heritage of central markets in almost every town and city. Here, residents buy locally grown produce, including mushrooms and berries gathered from the forests. These products tend to be cheaper and fresher than those sold in grocery stores.

### **3.5 How our suggested measures have been implemented in municipalities**

Our suggested measures generated a positive response from most interviewees, especially in the Scandinavian municipalities. The overall idea of sustainability is more widely accepted and understood, and sometimes legally mandated in that part of the world. In northern Europe, sustainability is a long-discussed issue, and no longer particularly controversial compared to Canada. Indeed, the biggest challenge in the Canadian municipalities is a lack of exposure to and experience with sustainability.

Regarding our first measure – sustainability education – Municipality #1 in Sweden has taken a lead in educating its citizens about sustainability. In the other three municipalities, however, at the municipal level, education about sustainability is not a widespread practice, though its importance is recognized at some level on both continents. A major barrier for these municipalities is the perceived lack of resources, especially financial.

In the course of our interviews with the four municipalities, we discovered that the most widely-implemented measure, at least in a partial sense, is creating a space for engagement. In hindsight this is not particularly

surprising, as all four municipalities are within democratic societies. However, in order to achieve its full synergistic effect in supporting municipal resilience and sustainability, this measure should be combined with participatory governance. It is more likely that citizens will become engaged if their participating has a direct effect on local decision-making. In addition, creating a space for engagement can be more effective if implemented in conjunction with the co-creation of a shared sustainability vision. When citizens lack a complete understanding of how a specific project is to be aligned with the overall aims and objectives of the community, or they have not been able participated in their creation, they are more likely to resist the changes implied. When different groups of stakeholders are able to air their views regarding decisions concerning the community, it is more likely that decisions will be enlightened by a far more complete understanding of the municipal community in question, and hence be more appropriate for municipal sustainability.

By establishing a sustainability steering committee, municipalities can coordinate municipal activities, together with engaging local residents. In the municipalities that were interviewed, such a committee, if one existed at all, was more of an entity within the municipal government, than one composed of local citizens or non-governmental organizations. By including the latter, and including overlapping terms of participation, the memory of such a committee can be increased. Indeed, existing decisions and actions taken by the previous government should be retained.

In the Scandinavian municipalities, energy production is at the municipal level, and the tendency is towards district heating. In Sweden, they have taken the local energy production a step further. Indeed the federal government is committed to the sustainability objective of eliminating all dependence on fossil fuels by the year 2020. Such initiatives have been discussed in Finland. In Canada, energy is a provincial responsibility, and the major energy provider is publicly owned; therefore local governments regard energy as beyond their sphere of responsibility.

With respect to the participatory governance measure, we found all municipalities we interviewed tend to use a top-down approach, though Municipality #4 is making plans to directly involve citizens in the decision-making process. The case studies we used in Section 3.2 might provide a

useful model to follow. The Porto Allegra example, as described under participatory governance, appears to be a particularly innovative way of including citizens in the decision-making process.

In the municipalities interviewed, we found Emergency Warning Systems, and other types of monitoring systems, where implemented, tend to go largely unreported, unless there is an imminent crisis. There is no community-wide forum for convening a meeting at which municipal employees and residents together can discuss the trends in their particular community. Also, exactly what is monitored is decided by municipal employees, rather than by the community-at-large.

Concerning multi-use zoning and urban infill, the Finnish municipality we interviewed provides an excellent example of how vacated industrial areas can be revitalized in order to preserve community identity and preserve unique features, as well as conserving building materials. It has also resulted in less urban sprawl and a more convivial neighborhood. The idea of multi-use zoning is gaining acceptance in the Scandinavian municipalities interviewed, but the idea tends to be met with resistance in Canada where commercial and light-industry areas are not seen as being compatible with residential areas, and the concept is seen as undesirable. Such incompatibility occurs because negative externalities, such as pollution, are perceived as normal and the acceptable side effects of economic development. As described in the self-reliance section (3.1.), we consider that by developing locally, that industries and businesses can internalize their externalities, thereby impacting on and reducing the negative effects of production. Thus, we suggest that a municipality can promote the establishment of sustainable business and industry, which will make zoning for multiple uses more acceptable.

The small loans programs with the criteria of sustainable business practices is not yet implemented in the municipalities we interviewed, and seems to be the least considered of our measures. However, as economic development programs exist at some level in all the municipalities interviewed, the addition of sustainability criteria for awarding loans is a distinct possibility.

On both continents, municipalities consider that intervening in agriculture is beyond their sphere of influence and responsibility, although they are all concerned about the sustainability issue it raises.

## 4. Discussion

A common interest of team members, previous to this research, was in how an organization can manage, over time, changing conditions. As we have learned in our training throughout this Master's program in Strategic Leadership towards Sustainability, to be truly effective, sustainability requires a major shift in the way people and organizations think and behave. To become more sustainable, it is necessary to instigate changes in organizations and communities. However, changes also come from the environment outside the organization or community which cannot be planned for. Sometimes change comes in an abrupt way, thereby challenging a municipality's or organization's capacity to adapt. To face such an abrupt change adequately, a specific quality is needed: Resilience. Resilience is the capacity of a system to adapt and cope with change while preserving its function and identity.

As a team, we agreed to apply our thesis research to the municipal context. Indeed, we were interested in having an applicable and practical result for municipalities to use, as they are strategically positioned to influence local actions. From these two interests came our primary question: How can planning for resilience help a municipal government to reach its goal of sustainability?

To answer that question, our first step was to acquire a good understanding of the concept of resilience and how it relates to the context of a municipal community. It was through our research that we came to realize that resilience is a feature of all systems, to some degree. A resilient system is a well-functioning system which subsists through time and upheaval. If a system is not resilient, the very function of the municipal system will change. By being resilient, a municipal community can preserve the functions which it values. According to the TNS funnel metaphor, organizations are likely to face disturbances during their journey towards sustainability, and hit the funnel's walls. In order to "bounce back" after abrupt disturbances without losing the ability to function, they should find themselves able to cope with these disturbances. In other words, they should be resilient. A non-resilient organization could well collapse

following a disturbance – hence the idea of supporting resilience as a strategy to reach sustainability.

To be able to support resilience we thought it was necessary to have a better understanding of what characterizes resilience, in order to know how best to support it in municipal systems. It is important to emphasize that understanding resilience in systems is quite complicated and many professional researchers in many various fields have spent entire careers studying the concept. We were limited in this thesis not only by time, but coming from various professional and academic backgrounds as a thesis group we had different ways of understanding the concepts involved. Our research strategy was to find common characteristics of resilience in well-functioning social, economical and ecological systems, as per our second research question. If there are documented examples of these characteristics within these three systems, we can be confident of their relevance to this research. Some of them were explicitly named and recognized by authors. Others were more subtle: individual capacity, self-reliance, and networks, for example, required more research and discussion on how they relate to resilience. We suggest that resilience should exist normally in a system, and that its characteristics be inherent to a system. If resilience is low, for any reasons, is it possible to increase it again? That brought us to our third question: what are some common factors which might affect municipal resilience?

We thought it would be more practical and efficient to look for measures that promote positive factors and alleviate negative factors that influence resilience than trying to find measures that only address each of the resilience characteristics *per se*. As mentioned in Section 2.3, we created diagrams identifying positive and negative factors influencing each characteristic of resilience. That is to say, some factors enhance resilience and some act as barriers. We brainstormed these factors and looked for redundancies among them. We realized that some factors had synergistic effects, i.e. they influenced many resilience characteristics. Brainstorming such factors that influenced municipal resilience and sustainability with a wider group of sustainability fellows could have open up a lead to more factors and therefore, might have influenced the results. However, as it was, we were satisfied with our list of factors complementing the characteristics of resilience. Our desire to retain synergistic effects by finding measures to



support resilience and sustainability instigated the creation of the synergy matrix to aid in selection.

For the purpose of answering Research Question 4, a list of measures was compiled throughout our literature review and internet research on sustainable communities and sustainable development (see section 2.4). However, it was by no means an exhaustive list, and perhaps others could find better, more synergistic measures with more research and investigation. The synergistic effect of each of our list of measures was tested using the synergy matrix. However, due to an error, some redundancy exists in the matrix regarding the measure's ability to support sustainability and resilience. Although giving an increased weighting to this aspect was unintentional, the effect of this weighting error is reasonable due to the fact that the goal of these measures is to support resilience and sustainability.

For the ten measures with the highest synergy matrix ratings, we researched examples to illustrate how they can be most effectively implemented. An interesting attribute of our list of ten measures is that not only does each of them have a synergistic effect on positive and negative factors for resilience and sustainability, but they also have synergistic effect upon each other.

Our final research question was about how some municipalities implemented our measures. What we particularly noticed from our analysis of our interviews was that, although many of our measures have been implemented in different municipalities, often it has been only partially done, particularly in respect of the space for engagement measure. A top-down approach was used and had influenced the outcomes in many of the measures implemented, such as the co-creation of a shared vision, the sustainable steering committee, and the early warning system. We think that it may have prevented them from achieving the synergistic results we described in the section 3.3.

We also noticed that because some of our suggested measures have been implemented, and others not, those implemented did not fully benefit from the synergistic effect they might have had on each other. For example, having sustainability education objective alongside the space for engagement objective can enhance the visioning process with increased

commitment and participation. On the other hand, should one of our suggested measures had already been implemented, we would like to think that it would also pave the way to the implementation of another one, which in turn might further improve the effect of the first one. For example: the “space for engagement” measure can pave the way to “co-creating a shared vision of a sustainable future” or “small loans program for local, sustainable businesses” to “community supported energy production, businesses and services” or “multi-use zoning and urban infill”.

Finally, we analyzed the already-mentioned barriers to implementation brought up in the interviews, which were basically of three types: (i) a lack of resources (financial and otherwise), (ii) a lack of municipal governments’ openness to citizens’ involvement, (iii) and action beyond the scope of municipal jurisdiction. We can offer some simple suggestions as possible solutions to overcome such barriers. Regarding the first one, experiences have demonstrated that large amounts of money can be saved when education on sustainability has been made a priority. People can then contribute to monetary savings by suggesting new, more sustainable ways of doing things (Nattrass and Altomare 1999). Regarding the second one, municipal leaders might look at citizen engagement as a means to increase acceptance of public projects, as well as instigating citizen collaboration on such projects. Finally, some measures have not been implemented because they are perceived to be beyond the jurisdiction of municipal government. It is evident that citizens could influence municipal affairs. Likewise, the municipality itself, through its representatives, can become involved in decision-making at a regional or national level.

To bring another perspective to our suggested measures, we found it interesting to look at them through the lens of Donella Meadows’ leverage points (1999) to see at which levels they intervene in the system and what kind of changes they can foster (see Appendices IV and V). Most of them intervene at quite high levels, like the overall goals of the municipal community (Level 3) and the power to add, change, evolve, or self-organize system structure (Level 4). Higher levels are about paradigm shift. We can not assume that our measures will directly intervene on such high levels, but as has been demonstrated by the community of Whistler in British Columbia in Canada, many small actions can add up to reach the proverbial “tipping point,” which can bring about a paradigm shift. Whistler is also a

model of community engagement where such a paradigm shift emerged through the community planning process. Whistler was recognized by the Federation of Canadian Municipalities (FCM) in May 2005 for its leadership in engaging its community in the long-term planning process for sustainability, and also earned the “LivCom” (Liveable Community) Award for long-term planning.

While Whistler has been a leader in achieving municipal sustainability, any community can be successful at promoting resilience and sustainability. A municipal government, in cooperation with its greater community, can implement our recommended measures to instigate a community-wide shift towards sustainability through increased resilience.

## 5. Conclusion

The aim of this thesis was to find practical ways to support and increase resilience and sustainability within municipalities. We looked for widely-applicable measures which would be strategic moves to such an end. These measures were selected for their capacity to enhance factors which promote resilience and sustainability, as well as alleviate obstacles to such goals. The results of these measures should therefore be a more resilient municipality. In such a municipality diversity exists, interdependence is recognized and networks are developed. People feel a sense of belonging and engage themselves in the realization of a better future. Regional, organizational and temporal interactions are recognized for the important lessons which can be learned. Citizens share a sense of place and belonging within their municipality, and can creatively grasp opportunities and bring solutions to unsustainable practices. But most importantly, these municipalities should be armed with a better capacity to face and cope with unforeseeable disturbances. We now know that regarding ecological systems, upheavals will occur at an ever increasing pace as a result of climate changes. In the face of this fact, we believe that a resilient and sustainable world can only come from the sum of actions undertaken at local levels, according to each local reality.

As mentioned earlier, our suggested measures to support resilience and sustainability have been designed to be widely applicable. What we suggest can be taken forward as further research, is to try to be more specific about what suits an individual municipality's situation. That was one of our original research goals; to assess the resilience of a specific municipality and to strategically plan actions to support resilience during the transition towards sustainability. For a complete method of resilience analysis, we suggest the article of Brian Walker et al. 2002.

As mentioned in the Results section, a system comprised a team of strong individuals makes the system more resilient. As such, municipalities can regard themselves as individuals who, by being stronger and resilient, would contribute to making the global system, our planet, more resilient and ultimately sustainable.

After interviewing four municipalities, the selected measures generated very positive feedback, and the interviewed municipal employees were confident of the measures' effectiveness at supporting municipal sustainability. We were met with enthusiasm especially in municipalities which embrace, or are starting to embrace, the idea of sustainability. While many measures are still not implemented, the ideas which the measures hold generated interest during conversation. We want to specify though that we certainly do not consider our measures as prescriptive, but would like them to be considered as suggestions to municipalities. If these measures, and all the processes by which they were derived, could simply contribute to increased awareness of the role resilience can play in a sustainability Endeavour, it would be a source of pride for us. Municipal governments could use them as a source of inspiration when they envision, along with their community members, their own sustainable future.

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## 7. Appendices

### 7.1 Appendix I

Results of Metabridging Exercise: Some common themes and initial characteristics of resilience from a transdisciplinary investigation

Cluster 1.

Social resistance

Education and awareness of sustainability

System thinking

Investment in infrastructure and educations

Flexible taxation scheme

Cluster 2.

(economic) specialization = poverty & environmental degradation

Economic- high level of resistance to change

Governance has low level of latitude

Cluster 3.

Co-management

Traditional knowledge

Extension of social networks

Reduce barriers to communication

Regional economic coordination

New governance

Shared knowledge

New municipal structure

Multi-scale and cross scale management

Preserve economic base & sustainable yield

Thresholds and irreversibility

Extractive vs. 'others,' e.g. service and IT

Prevention [of disturbance] rather than reactions

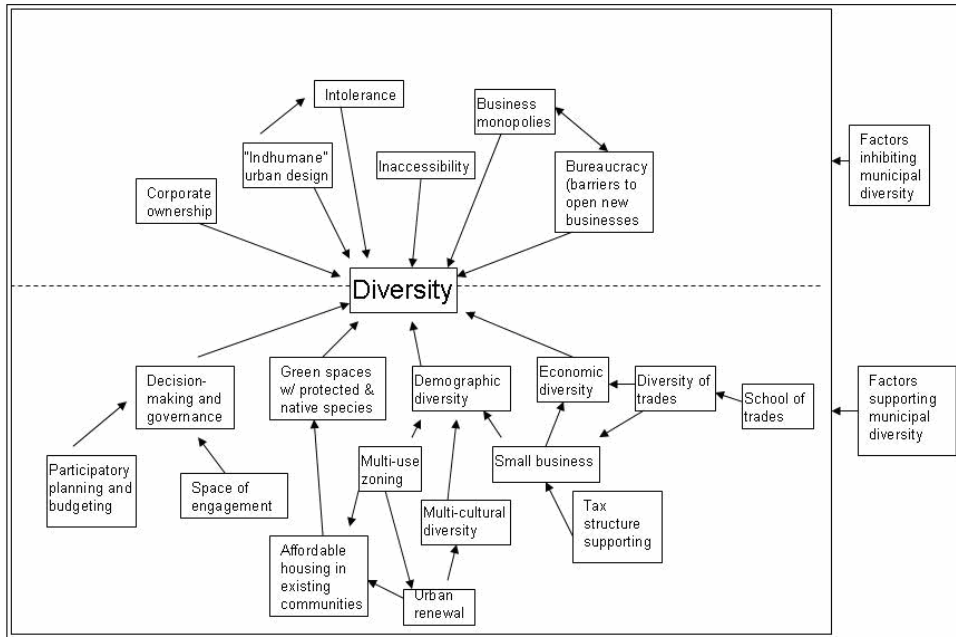
Environment supports economy

Environment supports economy support human well-being  
Dynamic equilibrium  
Capacity to adapt  
Change (fluctuation) is inherent (flow with it)  
Cluster 3 (cont.)  
Diversity & redundancy  
Economic substitutability

## 7.2 Appendix II

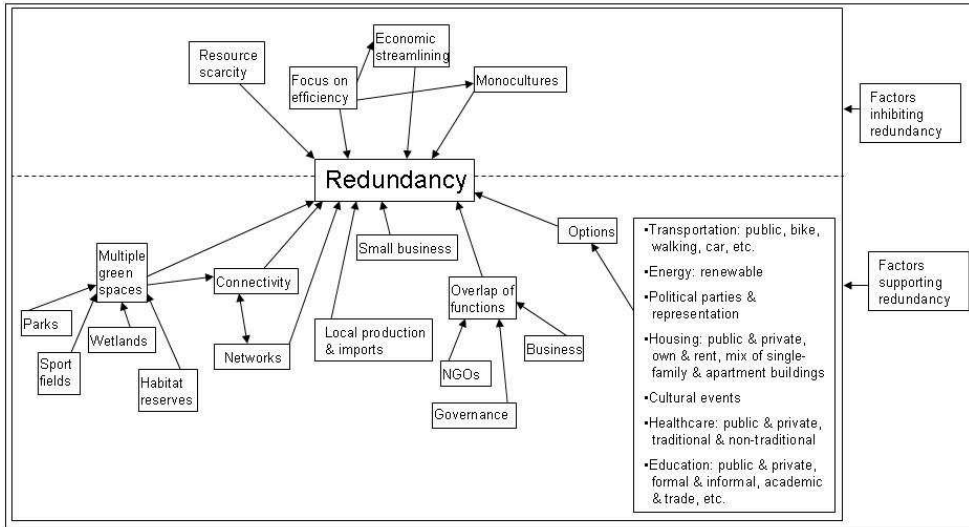
### Diagrams for Factors Supporting and Barriers to Characteristics of Resilience

#### Diversity

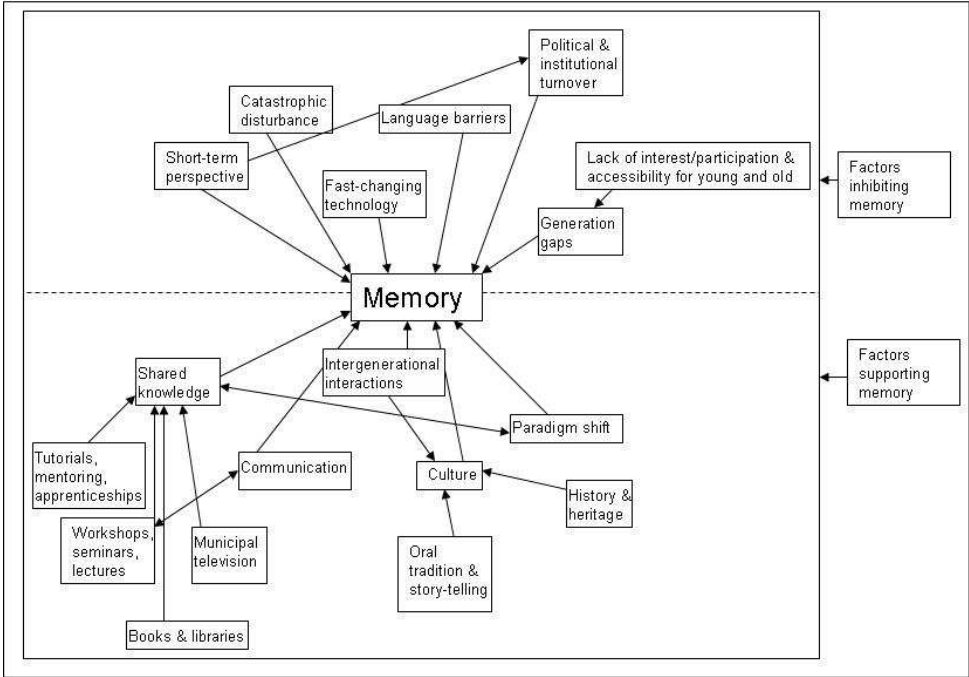




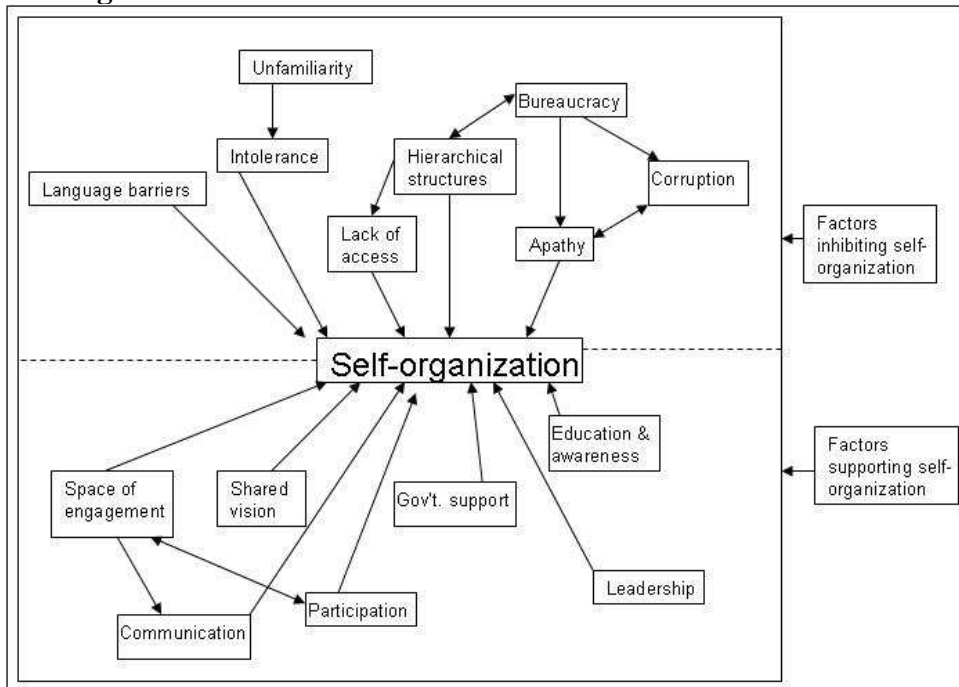
# Redundancy



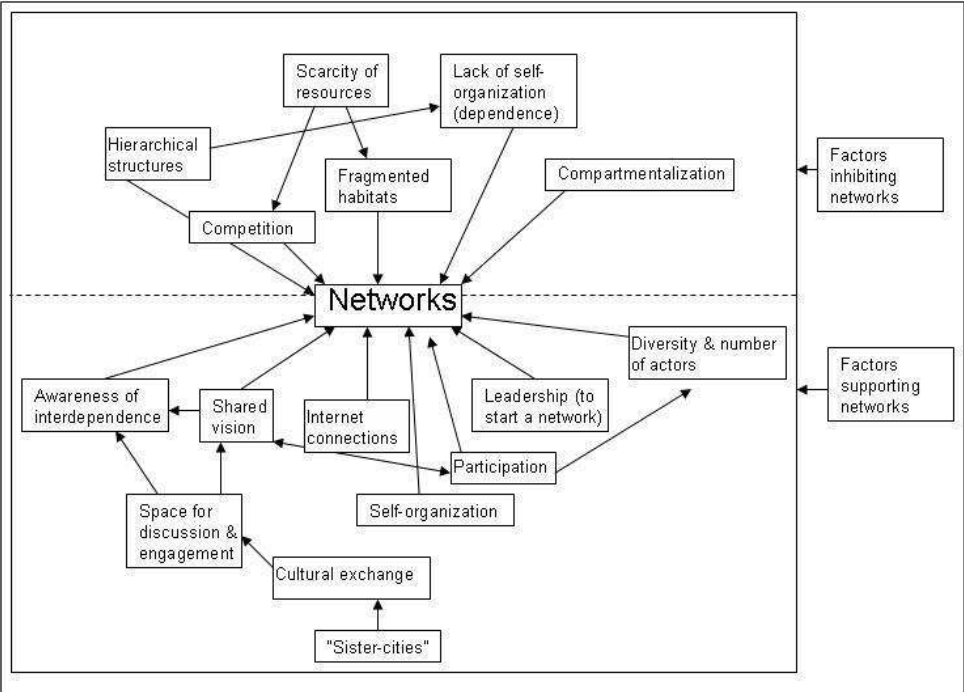
# Memory



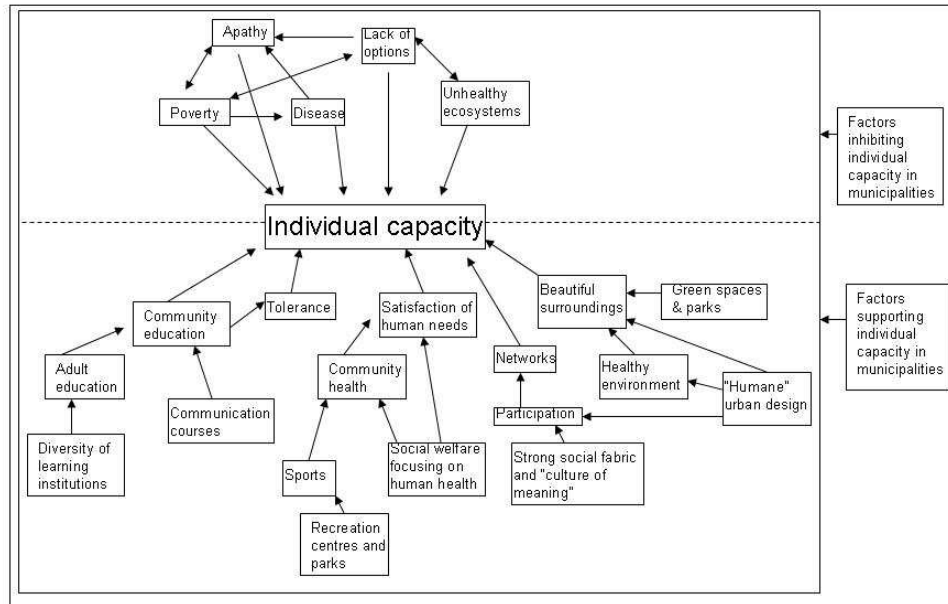
## Self-organization



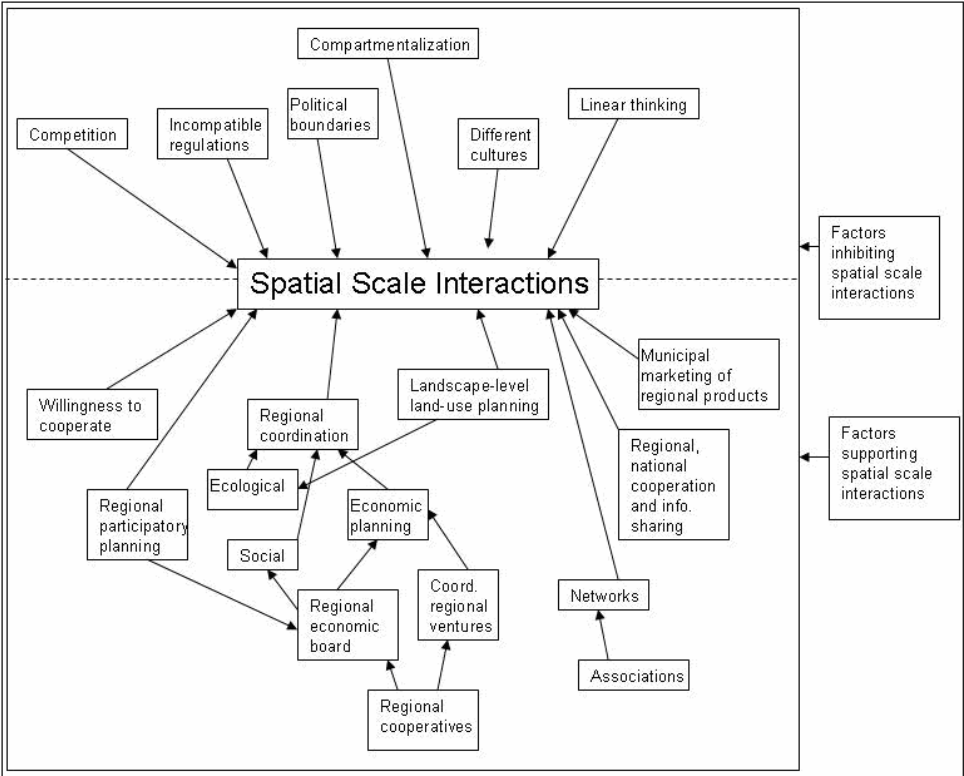
# Networks



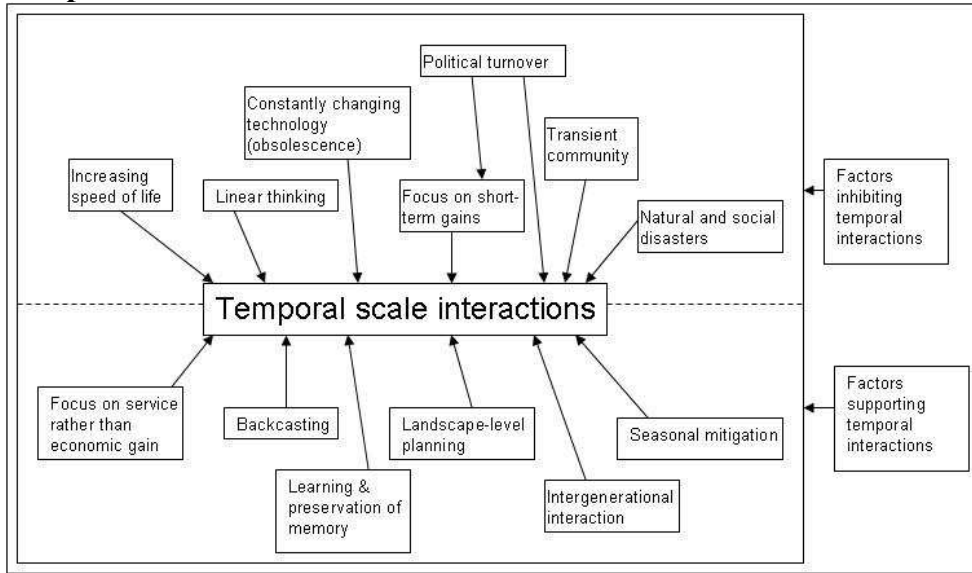
## Individual Capacity



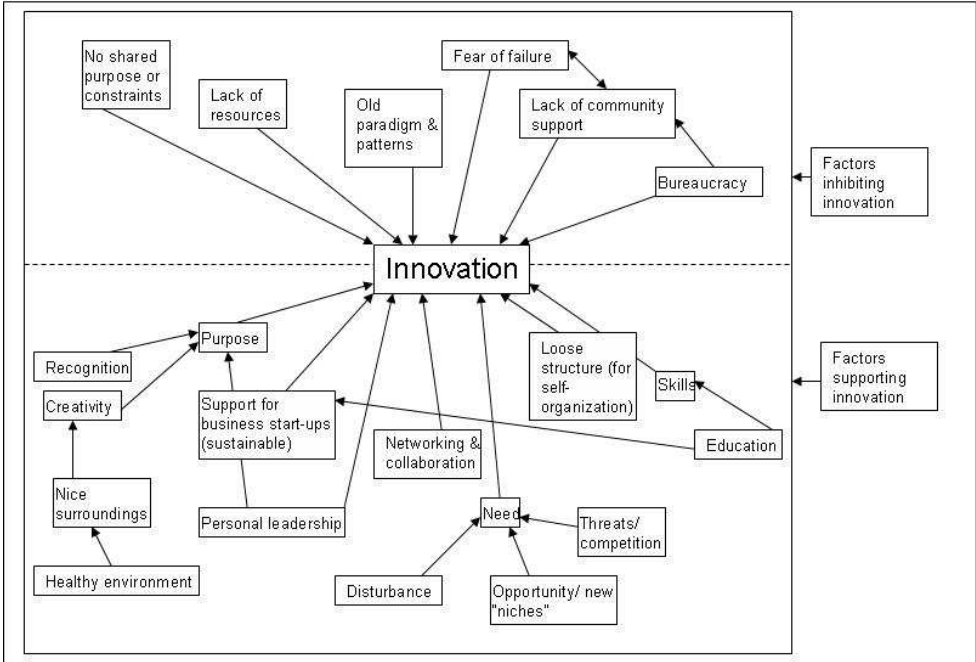
# Spatial Scale Interactions



## Temporal Scale Interactions

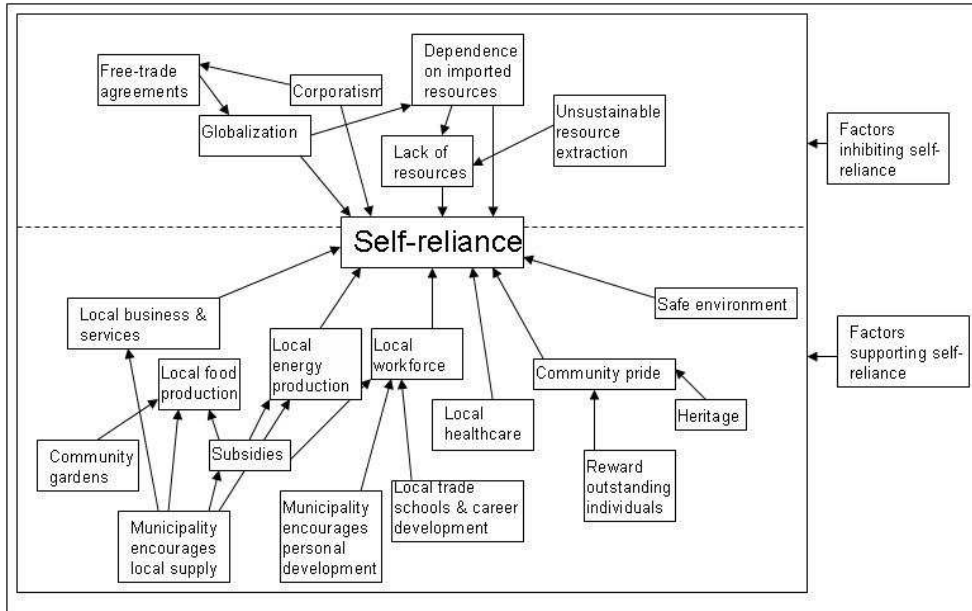


# Innovation

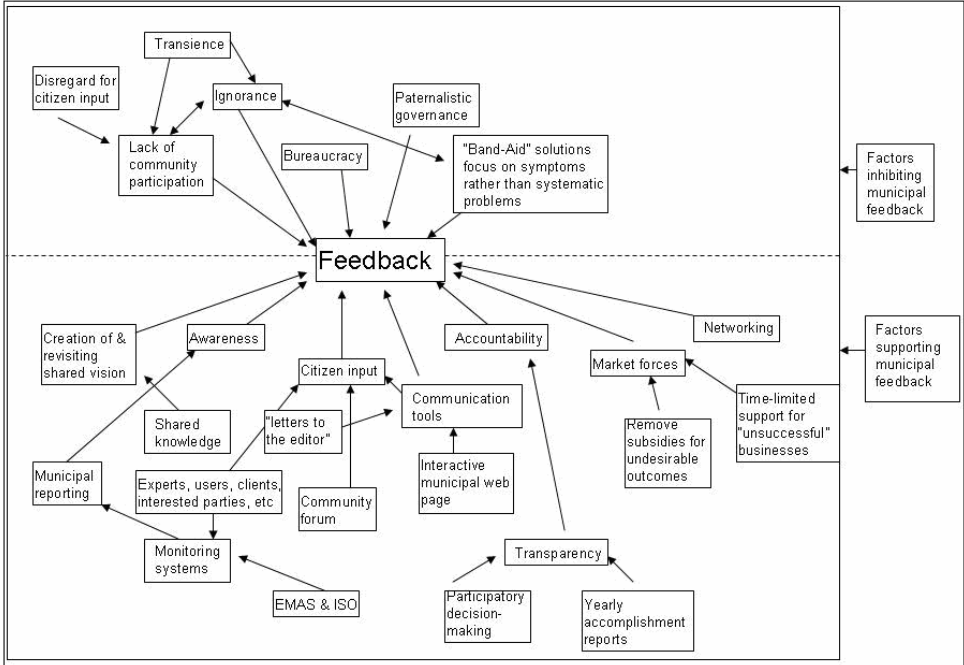




## Self-reliance



# Feedback



## 7.3 Appendix III

### The Synergy Matrix

#### List of measures evaluated in Synergy Matrix

##### Measures

Neighborhood roundtables  
Community organic gardens  
Urban infill with affordable housing (increase density)  
Cultural events  
Neighborhood newspapers  
neighborhood visions w/ municipal representative  
Building vision on sustainable future  
Online community forums  
Provide space and schedule “community” events  
Prohibit harmful pesticides and fertilizers... no chemical use  
Youth development programmes  
Community-supported local energy production, business & services  
Bike to work campaigns  
Reduce taxation for producers for organic food  
Sustainability education  
Participatory governance (budgeting, planning..)  
Financial assistance program—business improvement areas  
Beautification and urban restoration/revitalization  
Bio-regional planning  
Sustainability steering committee  
Taxation reduction for businesses creating employment  
Taxation reduces environmental pollution by local industries  
Bike trails and walking paths  
Early Warning Systems (w/ Yearly Benchmark Summits)  
Multi-use zoning, urban infill, and mixed housing options

Community supported agriculture+manufacturing  
 Wetland preservation and restoration  
 High ease of business entry  
 Small loan programmes for loan, sustainable business  
 Provide adequate information to community

**Synergy Matrix Scores- Sustainability**  
*Synthesis Matrix- Sustainability Totals*

Measures	Normalized Sustainability score
Neighborhood roundtables	0.52778
Community organic gardens	2.36111
Urban infill with affordable housing (increase density)	1.80556
Cultural events	0.61111
Neighborhood newspapers	0.44444
neighborhood visions w/ municipal representative	0.44444
Building vision on sustainable future	3.00000
Online community forums	1.41667
Provide space and schedule “community” events	1.33333
Prohibit harmful pesticides and fertilizers	2.08333
Youth development programmes	0.52778
Community-supp. local energy prod.,business+services	2.75000
Bike to work campaigns	2.47222
Reduce taxation for producers for organic food	2.80556
Sustainability education	3.00000
Participatory governance (budgeting, planning..)	1.33333
Financial assistance program—bus. Improvement	2.77778
Beautification and urban restoration/revitalization	1.61111
Bio-regional planning	2.00000
Sustainability steering committee	3.00000
Taxation reduction for businesses creating employment	0.44444
Taxation reduces environmental pollution by locals	2.44444
Bike trails and walking paths	2.77778
Early Warning Systems (w/ Yearly Benchmark Summits)	2.08333
Multi-use zoning, urban infill, and mixed housing	2.61111
Community supported agriculture+manufacturing	1.75000
Wetland preservation and restoration	1.63889
High ease of business entry	0.52778
Small loan programmes for loan, sustainable business	3.00000
Provide adequate information to community	1.13889

*Synergy Matrix- Sustainability; Sustainability Principles 1 - 3*

Measures	S.C. 1	S.C. 2	S.C. 3
Neighborhood roundtables	0.00	0.00	0.00
Community organic gardens	2.00	2.00	3.00
Urban infill with affordable housing (increase density)	3.00	0.00	3.00
Cultural events	0.00	0.00	0.00
Neighborhood newspapers	0.00	0.00	0.00
neighborhood visions w/ municipal representative	0.00	0.00	0.00
Building vision on sustainable future	3.00	3.00	3.00
Online community forums	1.00	1.00	2.00
Provide space and schedule “community” events	1.00	1.00	1.00
Prohibit harmful pesticides and fertilizers	3.00	3.00	2.00
Youth development programmes	0.00	0.00	0.00
Community-suppl. local energy prod.,business+services	3.00	3.00	3.00
Bike to work campaigns	3.00	3.00	3.00
Reduce taxation for producers for organic food	3.00	3.00	3.00
Sustainability education	3.00	3.00	3.00
Participatory governance (budgeting, planning..)	1.00	1.00	1.00
Financial assistance program—bus. Improvement	3.00	3.00	3.00
Beautification and urban restoration/revitalization	1.00	1.00	3.00
Bio-regional planning	2.00	1.00	3.00
Sustainability steering committee	3.00	3.00	3.00
Taxation reduction for businesses creating employment	0.00	0.00	0.00
Taxation reduces environmental pollution by locals	3.00	3.00	3.00
Bike trails and walking paths	3.00	3.00	3.00
Early Warning Systems (w/ Yearly Benchmark Summits)	2.00	2.00	2.00
Multi-use zoning, urban infill, and mixed housing	3.00	2.00	3.00
Community supported agriculture+manufacturing	3.00	1.00	1.00
Wetland preservation and restoration	0.00	2.00	3.00
High ease of business entry	0.00	0.00	0.00
Small loan programmes for loan, sustainable business	3.00	3.00	3.00
Provide adequate information to community	1.00	1.00	1.00

*Synergy Matrix- Sustainability; Sustainability Principle 4 Normalized*

Measures	S. C. 4 Normalized
Neighborhood roundtables	2.11
Community organic gardens	2.44
Urban infill with affordable housing (increase density)	1.22
Cultural events	2.44
Neighborhood newspapers	1.78
neighborhood visions w/ municipal representative	1.78
Building vision on sustainable future	3.00
Online community forums	1.67
Provide space and schedule “community” events	2.67
Prohibit harmful pesticides and fertilizers	0.33
Youth development programmes	2.11
Community-supp. local energy prod.,business+services	2.00
Bike to work campaigns	0.89
Reduce taxation for producers for organic food	2.22
Sustainability education	3.00
Participatory governance (budgeting, planning..)	2.33
Financial assistance program—bus. improvement	2.11
Beautification and urban restoration/revitalization	1.44
Bio-regional planning	2.00
Sustainability steering committee	3.00
Taxation reduction for businesses creating employment	1.78
Taxation reduces environmental pollution by locals	0.78
Bike trails and walking paths	2.11
Early Warning Systems (w/ Yearly Benchmark Summits)	2.33
Multi-use zoning, urban infill, and mixed housing	2.44
Community supported agriculture+manufacturing	2.00
Wetland preservation and restoration	1.56
High ease of business entry	2.11
Small loan programmes for loan, sustainable business	3.00
Provide adequate information to community	1.56

*Synergy Matrix- Sustainability; Sustainability Principle 4 (part 1)*

Measures

	subsistence	participation	idleness	creativity	affec
Neighborhood roundtables	0.00	3.00	0.00	2.00	2
Community organic gardens	3.00	3.00	3.00	3.00	1
Urban infill with affordable housing (increase density)	3.00	0.00	0.00	0.00	(
Cultural events	0.00	3.00	3.00	3.00	2
Neighborhood newspapers	0.00	3.00	0.00	3.00	1
neighborhood visions w/ municipal representative	0.00	3.00	0.00	3.00	1
Building vision on sustainable future	3.00	3.00	3.00	3.00	2
Online community forums	0.00	3.00	1.00	1.00	(
Provide space and schedule "community" events	3.00	3.00	0.00	3.00	2
Prohibit harmful pesticides and fertilizers	0.00	0.00	0.00	0.00	(
Youth development programmes	1.00	3.00	0.00	3.00	2
Community-supp. local energy prod.,business+services	3.00	1.00	0.00	2.00	(
Bike to work campaigns	0.00	1.00	2.00	0.00	(
Reduce taxation for producers for organic food	3.00	3.00	0.00	3.00	(
Sustainability education	3.00	3.00	3.00	3.00	2
Participatory governance (budgeting, planning..)	1.00	3.00	0.00	3.00	2
Financial assistance program—bus. improvement	3.00	3.00	0.00	3.00	(
Beautification and urban restoration/revitalization	1.00	1.00	0.00	3.00	1
Bio-regional planning	3.00	2.00	0.00	2.00	(
Sustainability steering committee	3.00	3.00	3.00	3.00	2
Taxation reduction for businesses creating employment	3.00	3.00	1.00	2.00	1
Taxation reduces environmental pollution by locals	1.00	0.00	0.00	0.00	(
Bike trails and walking paths	1.00	2.00	3.00	2.00	1
Early Warning Systems (w/ Yearly Benchmark Summits)	2.00	3.00	0.00	3.00	1
Multi-use zoning, urban infill, and mixed housing	3.00	2.00	2.00	2.00	2
Community supported agriculture+manufacturing	3.00	3.00	0.00	3.00	1
Wetland preservation and restoration	2.00	0.00	1.00	1.00	(
High ease of business entry	2.00	3.00	2.00	3.00	1
Small loan programmes for loan, sustainable business	3.00	3.00	3.00	3.00	2
Provide adequate information to community	1.00	2.00	0.00	2.00	(

*Synergy Matrix- Sustainability; Sustainability Principle 4 (part 2)*

Measures	identity	protection	understand	freedom
Neighborhood roundtables	3.00	3.00	3.00	3.00
Community organic gardens	2.00	1.00	3.00	3.00
Urban infill with affordable housing (increase density)	3.00	2.00	0.00	3.00
Cultural events	3.00	3.00	3.00	2.00
Neighborhood newspapers	3.00	1.00	3.00	2.00
neighborhood visions w/ municipal representative	3.00	0.00	3.00	3.00
Building vision on sustainable future	3.00	3.00	3.00	3.00
Online community forums	3.00	2.00	3.00	2.00
Provide space and schedule “community” events	3.00	3.00	3.00	3.00
Prohibit harmful pesticides and fertilizers	0.00	3.00	0.00	0.00
Youth development programmes	3.00	3.00	2.00	1.00
Community-supp. local energy prod.,business+services	3.00	3.00	3.00	3.00
Bike to work campaigns	1.00	1.00	1.00	2.00
Reduce taxation for producers for organic food	2.00	3.00	3.00	3.00
Sustainability education	3.00	3.00	3.00	3.00
Participatory governance (budgeting, planning..)	3.00	3.00	3.00	3.00
Financial assistance program—bus. improvement	3.00	1.00	3.00	3.00
Beautification and urban restoration/revitalization	3.00	3.00	1.00	0.00
Bio-regional planning	3.00	3.00	2.00	3.00
Sustainability steering committee	3.00	3.00	3.00	3.00
Taxation reduction for businesses creating employment	3.00	2.00	0.00	1.00
Taxation reduces environmental pollution by locals	0.00	3.00	2.00	1.00
Bike trails and walking paths	2.00	3.00	2.00	3.00
Early Warning Systems (w/ Yearly Benchmark Summits)	3.00	3.00	3.00	3.00
Multi-use zoning, urban infill, and mixed housing	3.00	3.00	3.00	2.00
Community supported agriculture+manufacturing	3.00	1.00	3.00	1.00
Wetland preservation and restoration	2.00	3.00	3.00	2.00
High ease of business entry	3.00	1.00	1.00	3.00
Small loan programmes for loan, sustainable business	3.00	3.00	3.00	3.00
Provide adequate information to community	2.00	3.00	3.00	1.00



*Synergy Matrix- Prioritization Questions; Totals*

Measures	Normalized Priority total
Neighborhood roundtables	3.00000
Community organic gardens	2.66667
Urban infill with affordable housing (increase density)	1.00000
Cultural events	2.33333
Neighborhood newspapers	2.00000
neighborhood visions w/ municipal representative	3.00000
Building vision on sustainable future	3.00000
Online community forums	3.00000
Provide space and schedule "community" events	3.00000
Prohibit harmful pesticides and fertilizers	2.66667
Youth development programmes	2.66667
Community-suppl. local energy prod.,business+services	2.33333
Bike to work campaigns	3.00000
Reduce taxation for producers for organic food	2.66667
Sustainability education	3.00000
Participatory governance (budgeting, planning..)	3.00000
Financial assistance program—bus. improvement	2.66667
Beautification and urban restoration/revitalization	2.00000
Bio-regional planning	2.00000
Sustainability steering committee	3.00000
Taxation reduction for businesses creating employment	1.66667
Taxation reduces environmental pollution by locals	3.00000
Bike trails and walking paths	2.33333
Early Warning Systems (w/ Yearly Benchmark Summits)	3.00000
Multi-use zoning, urban infill, and mixed housing	3.00000
Community supported agriculture+manufacturing	2.00000
Wetland preservation and restoration	2.66667
High ease of business entry	2.00000
Small loan programmes for loan, sustainable business	2.66667
Provide adequate information to community	2.00000

## Synergy Matrix Scores- Resilience

### *Synergy Matrix- Resilience Totals*

Measures	Normalized Resilience total
Neighborhood roundtables	1.75758
Community organic gardens	1.87879
Urban infill with affordable housing (increase density)	1.24242
Cultural events	1.18182
Neighborhood newspapers	1.27273
neighborhood visions w/ municipal representative	1.93939
Building vision on sustainable future	2.72727
Online community forums	0.63636
Provide space and schedule “community” events	2.30303
Prohibit harmful pesticides and fertilizers	1.24242
Youth development programmes	1.42424
Community-supp. local energy prod.,business+services	1.72727
Bike to work campaigns	0.81818
Reduce taxation for producers for organic food	2.18182
Sustainability education	3.00000
Participatory governance (budgeting, planning..)	2.30303
Financial assistance program—bus. Improvement	1.21212
Beautification and urban restoration/revitalization	1.42424
Bio-regional planning	1.87879
Sustainability steering committee	2.45455
Taxation reduction for businesses creating employment	1.09091
Taxation reduces environmental pollution by locals	1.24242
Bike trails and walking paths	1.36364
Early Warning Systems (w/ Yearly Benchmark Summits)	2.45455
Multi-use zoning, urban infill, and mixed housing	2.09091
Community supported agriculture+manufacturing	2.48485
Wetland preservation and restoration	1.60606
High ease of business entry	1.96970
Small loan programmes for loan, sustainable business	2.63636
Provide adequate information to community	1.24242

## *Synergy Matrix- Resilience; Memory*

Measures	Memory		
	Economic	Social	Ecological
Neighborhood roundtables	2.00	3.00	0.00
Community organic gardens	1.00	3.00	1.00
Urban infill with affordable housing (increase density)	1.00	3.00	0.00
Cultural events	1.00	3.00	0.00
Neighborhood newspapers	1.00	1.00	0.00
neighborhood visions w/ municipal representative	1.00	1.00	1.00
Building vision on sustainable future	2.00	3.00	3.00
Online community forums	0.00	0.00	0.00
Provide space and schedule “community” events	2.00	2.00	1.00
Prohibit harmful pesticides and fertilizers	1.00	2.00	3.00
Youth development programmes	2.00	2.00	0.00
Community-suppl. local energy prod.,business+services	2.00	2.00	1.00
Bike to work campaigns	0.00	0.00	0.00
Reduce taxation for producers for organic food	3.00	2.00	3.00
Sustainability education	3.00	3.00	3.00
Participatory governance (budgeting, planning..)	3.00	3.00	3.00
Financial assistance program—bus. Improvement	0.00	0.00	0.00
Beautification and urban restoration/revitalization	1.00	2.00	0.00
Bio-regional planning	3.00	3.00	3.00
Sustainability steering committee	3.00	3.00	3.00
Taxation reduction for businesses creating employment	0.00	0.00	0.00
Taxation reduces environmental pollution by locals	0.00	0.00	1.00
Bike trails and walking paths	1.00	1.00	0.00
Early Warning Systems (w/ Yearly Benchmark Summits)	3.00	3.00	3.00
Multi-use zoning, urban infill, and mixed housing	2.00	3.00	1.00
Community supported agriculture+manufacturing	2.00	2.00	2.00
Wetland preservation and restoration	0.00	2.00	3.00
High ease of business entry	3.00	3.00	0.00
Small loan programmes for loan, sustainable business	2.00	2.00	3.00
Provide adequate information to community	2.00	2.00	2.00

## Ten Measures with highest total scores

Measures	Normalized total (#)
Support for local, organic	6.90657
Building vision on sustainable future	8.72727
Provide space and schedule "community" events	6.93182
Community-supp. local energy prod.,business+services	6.81961
Sustainability education	9.00000
Participatory governance (budgeting, planning..)	6.63636
Sustainability steering committee	8.45455
Early Warning Systems (w/ Yearly Benchmark Summits)	7.53788
Multi-use zoning, urban infill, and mixed housing	7.70202
Small loan programmes for loan, sustainable business	8.30303

## **7.4 Appendix IV**

### **List of Leverage Points according to Donella Meadows (1999)**

- 1) The power to transcend paradigms
- 2) The mindset or paradigm out of which the system- its goals, structure, rules, delays, parameters arises
- 3) The goals of the system
- 4) The power to add, change, evolve, or self-organize system structure
- 5) The rules of the system (such as incentives, punishments, constraints)
- 6) The structure of information flows (who does and does not have access to what kinds of information)
- 7) The gain around driving positive feedback loops
- 8) The strength of negative feedback loops, relative to the impacts they are trying to correct against
- 9) The lengths of delays, relative to the rate of system change
- 10) The structure the material stocks and flows (such as transport networks, population age structures)
- 11) The sizes of the buffers and other stabilizing stocks, relative to their flows
- 12) Constants, parameters, numbers (such as subsidies, taxes, standards)

## **7.5 Appendix V**

### **Leverage Points of Measures**

Sustainability Education: the goals the system (3); and information flow (6).

Create a Space for engagement: the power to self-organize (4); information flow (6); negative feedback loop (8); and length of delays (9).

Building vision on sustainable future: the goals of the system (3); the power to self-organize (4); rules of the system (5); and information flow (6).

Sustainability Steering Committee: the goals of the systems (3); the power to self-organize (4); and information flow (6).

Community-supported energy production, business and services: the goals of the system (3); and the power to self-organize (4).

Participatory Governance: the power to self-organize (4); information flows (6); and length of delays (9).

Early Warning Systems w/ Yearly Benchmark Summits: information flows (6); stop reinforcing process (7); the strength of negative feedback loops (8); length of delays (9); and numbers, constants, and parameters (12).

Multi-use zoning, urban infill, and mixed housing options: the power to self-organize (4); structure of material stocks and flows and nodes of intersection (10); and size of stocks relative to flows (11).

Small loan programs for local, sustainable development: the power to self-organize (4); stop reinforcing process (7); and numbers, constants, and parameters (12).

Support for local, organic food production: parameters power to self-organize (4); information flows (6); and numbers, constants, and parameters (12)