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Resilience Theory in Climate-Based Agriculture Development Projects: Useful Framework or Popular Buzzword?

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RESILIENCE THEORY IN CLIMATE-BASED AGRICULTURE DEVELOPMENT PROJECTS: USEFUL FRAMEWORK OR POPULAR BUZZWORD?

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We, the Graduate Committee of the above candidate for the Master of Science in Climate Science and Policy degree, hereby recommend the acceptance of the Master's Project.

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Abstract

International development organizations are increasingly attempting to improve the resilience of the communities they serve through their projects in these communities. However, these projects often fail to address key concepts from the resilience theory literature, calling into question their ability to effectively promote resilience. This thesis attempts to locate these gaps in understanding by analyzing proposal documents from projects intending to promote agricultural resilience to climate change. A content analysis approach was used to analyze 55 projects from three international development groups—the Global Environment Facility, the World Bank, and the United Nations Development Program—proposed or completed between 2006 and 2016. A list of 20 keywords was developed based on the resilience theory literature. Project documents were scanned for these keywords and weighted based on the document section in which they occurred and the depth of understanding apparent in their use. Overall, the projects were found to have far more superficial occurrences of these keywords than occurrences illustrating an understanding of the underlying resilience theory concepts. Further, the projects were not always successful in carrying through resilience concepts from their stated objectives to their methods of assessment and evaluation. This thesis suggests that resilience training and better methods of measuring the resilience of agroecosystems would allow international development groups to more effectively integrate and increase resilience in their projects.

Executive Summary

Global climate change is expected to have significant adverse effects on agricultural production and food security (IPCC 2014). Smallholder farmers in the Global South will be particularly vulnerable to these negative impacts (Morton 2007). Already, nearly one billion people are either hungry or undernourished (Tendall et al., 2015), and about two billion are considered food insecure as defined by the Food and Agriculture Organization, or FAO (Wheeler & von Braun, 2013). Food insecurity is currently highest in countries located in South Asia or sub-Saharan Africa (Wheeler & von Braun, 2013). These areas are also dominated by smallholder farmers, and are expected to bear some of the worst effects of climate change. While food security is not solely related to food production—food access has political components as well (Sen, 1982) —safeguarding agricultural systems from the effects of climate change will nonetheless be important.

In order for smallholders to continue to produce enough food despite the effects of climate change, agricultural systems will need to be able to function under more extreme and variable conditions. Resilient agricultural systems are seen as essential to achieving this goal and maintaining global food security. Resilience has a variety of definitions, but is generally understood to incorporate an ability to bounce back from external shocks or stresses, like those caused by climate change. International development groups, recognizing the importance of promoting resilient systems, have begun to increasingly incorporate resilience into projects (Barrett & Constas, 2014). However, they often do so without clearly referencing the theoretical literature on resilience thinking (Bahadur, Ibrahim, & Tanner, 2013; Barrett & Constas, 2014; Dixon & Stringer, 2015; Engle et al., 2014; Schipper & Langston, 2015; van Apeldoorn et al., 2011). The resilience theory literature, especially as it

relates to agroecosystems, is complex, with varying ideas on what it means for an agricultural system to be resilient, how to plan and achieve that resilience, and how to appropriately assess the resilience of the system (Cabell & Oelofse, 2012; Darnhofer et al., 2010b). Agroecosystems are complex social-ecological systems, affected by not only ecological factors but also by social, economic, and cultural factors (Darnhofer et al., 2010b).

If development projects are to effectively increase the resilience of these systems, all of these factors must be addressed. It is uncertain if current development projects are effectively promoting resilience as outlined in the literature or if they are merely incorporating a popular buzzword. This thesis addresses this question by analyzing 55 international development projects designed to increase agricultural resilience to climate change from three international development groups— the GEF, the World Bank, and the UNDP—to see how they understand and utilize the concept of resilience and the resilience theory literature. These three development organizations were chosen because of their global scope, large operating budgets, and public availability of detailed project documents. Chosen projects from all three organizations related to agriculture and climate change with a focus on increasing resilience.

The Global Environment Facility (GEF) has 183 member countries which make up the GEF Assembly. The GEF also encompasses 18 different agencies that work with stakeholders in the project areas to implement GEF-funded projects. These agencies include United Nations agencies, international development banks, and several non-governmental agencies (NGOs). GEF-funded projects are designed to aid developing countries in meeting the goals of five international environmental conventions. This thesis used the most descriptive document that could be found for each project, which varied depending on the implementing agency. These project documents ranged from around 50-250 pages in length. Twenty projects from GEF were used for this analysis.

The World Bank is made up of 189 member countries, or shareholders. The work of the World Bank falls under two main goals: reducing the occurrence of extreme poverty (a daily income of less than $1.90 per day); and increasing the income of each country's bottom 40%. The Program Documents were used for the analysis, as these were the most descriptive. These documents ranged from around 70-170 pages in length. Twenty-three projects from the World Bank were used for this analysis.

The United Nations Development Program (UNDP) leads the development efforts of the United Nations and works in nearly 170 countries. The work of the UNDP is based on supporting countries in meeting the Sustainable Development Goals. Within these broad goals, UNDP works within three main areas—sustainable development, democratic governance and peacebuilding, and climate and disaster resilience. Chosen proposals ranged from around 20 pages to 150 pages in length. A total of 12 projects from UNDP were used for this analysis.

Methodology

Based on the total 55 project documents from the past ten years, a content analysis was conducted to assess the level to which resilience is incorporated in project goals and evaluation methods. Content analysis is a flexible method of screening and analyzing large quantities of text data, such as project reports (Hsieh & Shannon, 2005). All of the chosen projects related to agriculture, climate change, and resilience in some way.

Twenty keywords were chosen for this content analysis based on a review of the literature, and in particular based on the behavior-based indicators of a resilient agroecosystem created by Cabell and Oelofse (2012). These twenty keywords were then divided into three main categories: system traits and measurement; stress to the system; and social characteristics of the system. Each project document was divided into four sections: project title; introduction; objectives; and assessment methods. These sections were chosen to help assess the depth of commitment to the resilience theory literature in the project documents. Keywords occurring in the assessment section were considered the most important occurrences, as this indicates the most follow through with the concepts. The document sections were searched for keyword occurrences using a pdf document reader. The number of occurrences in each section of each document was recorded, excluding occurrences that used the keyword in an unrelated way. Once the occurrences were located and tallied, each keyword occurrence was subjectively analyzed to determine whether the occurrence represented the organization's general awareness of the concept behind the keyword, or represented a deeper understanding of and commitment to addressing the keyword. Occurrences in the former category were marked as "aware," while those in the latter category were marked as "deep."

Results

The results show that projects as a whole have far more "aware" level occurrences of the keywords than "deep" level occurrences. However, it should be noted that no statistical tests have been run on the data, so differences should not be assumed to be statistically significant.

The World Bank had the fewest overall occurrences, but the most favorable ratio of "deep" occurrences to "aware" occurrences. While "aware" occurrences are important in that they show that the organizations are thinking about these keywords and beginning to include them in their projects, the "deep" occurrences were interpreted to indicate a more thorough understanding of the keywords and stronger efforts to address these concepts in the project.

Resilience keywords appear the most often in the objectives section and less often in the introduction and assessment sections. The UNDP had the most favorable ratio of occurrences in the assessment section to occurrences in the objectives section. While it is promising that organizations are including resilience concepts in their project objectives, this is unlikely to be effective if there is no clear method for assessing the success of these resilience objectives. Without balancing the occurrences in the objectives section with occurrences in the assessment section, the project will be unable to quantify any increases in system resilience that it is able to achieve.

The research presented here suggests that although international development groups claim to be striving for resilience, the projects they undertake often fall short of what the resilience theory literature would recommend. The analysis showed that projects tended to insufficiently carry resilience concepts from the introduction and objectives through the project assessment, and often incorporate more superficial references to the literature. Assessment documents from the World Bank and GEF's independent evaluation programs confirm that despite the goals of these organizations, resilience is not yet integrated in projects as effectively as they would like. The following policy recommendations would help improve the full incorporation of the resilience theory literature in international development projects.

Policy Recommendations

One method to address the issues outlined above is to use a set of indicators, which is one of the primary methods found in the resilience theory literature of assessing a system's resilience. Indicators are a set of observable system features that indicate enhanced resilience. Assessing resilience using this method is a key way to identify and address vulnerabilities. Having this kind of clear evaluation method would help development groups in measuring the results of their projects and making sure that the resilience concepts found in their objectives are carried through to the final evaluation.

In addition to incorporating resilience indicators into their projects, development groups could ensure better inclusion of resilience concepts by having project staff engage in resilience training.. The Stockholm Resilience Centre currently performs these kind of training sessions through their "Guidance for Resilience in the Anthropocene: Investments for Development" (GRAID) program ("GRAID" 2017). Currently, GRAID works as a "strategic knowledge partner" for three development organizations: The Rockefeller Foundation; the U.S. Agency for International Development (USAID); and the Swedish International Development Cooperation Agency (SIDA). Resilience training could be beneficial for other international development organizations as well, including the three included in this analysis, in order to enhance the integration and support of resilience into their development practice.

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Chapter 1: Introduction

Global climate change is expected to have significant adverse effects on agricultural production and food security (IPCC 2014). Smallholder farmers in the Global South will be particularly vulnerable to these negative impacts (Morton 2007). Cultivating resilient agricultural systems is seen as critical for smallholders to be able to withstand the effects of climate change and maintain agricultural productivity. International development groups, recognizing the importance of promoting resilient systems, have begun to increasingly incorporate resilience into projects (Barrett & Constas, 2014). However, they often do so without clearly referencing the theoretical literature on resilience thinking (Bahadur, Ibrahim, & Tanner, 2013; Barrett & Constas, 2014; Dixon & Stringer, 2015; Engle et al., 2014; Schipper & Langston, 2015; van Apeldoorn et al., 2011). For this reason, it is uncertain if these projects are effectively promoting resilience as outlined in the literature or if they are merely incorporating a popular buzzword. This thesis will address this question by analyzing international development projects designed to increase agricultural resilience to climate change, an important part of promoting global food security.

Altieri, Nicholls, Henao, and Lana (2015) argue that "farming is the human endeavor most vulnerable to the effects of climate change." Higher temperatures, especially in the tropics, may increasingly pass the threshold temperatures for critical plant processes, leading to crop failure (Porter & Semenov, 2005). Changing precipitation patterns will also significantly affect crop yields. Many regions are expected to get drier, increasing drought stress and water scarcity (IPCC 2014). Regions that receive more precipitation will be more likely to see less frequent but heavier rainfall, leading to potential flooding of fields.

Extreme weather events, including intense heat waves and heavy rainfall, will "very likely" become more frequent, according to the IPCC (IPCC 2014). Depending on the stage of development of the crops, these events can have severe effects on yield (Porter & Semenov, 2005). Extreme weather events can also damage agricultural infrastructure and harm livestock, causing long-term damage to farmers' livelihoods (Hoffmann 2011).

The impacts of changing climate on agriculture will have major implications for food security. Already, nearly one billion people are either hungry or undernourished (Tendall et al., 2015), and close to two billion are considered food insecure as defined by the Food and Agriculture Organization, or FAO (Wheeler & von Braun, 2013). Expected population increases will cause demand to increase an estimated 50 percent by 2030, further straining agricultural resources (Wheeler & von Braun, 2013). Smallholder farmers are essential to achieving global food security. Smallholders, who make up approximately 90 percent of farmers worldwide, are more often producing food in the areas where it is needed, thereby contributing to greater food accessibility (Horlings & Marsden, 2011). Food insecurity is currently highest in countries located in South Asia or sub-Saharan Africa (Wheeler & von Braun, 2013). These areas are also dominated by smallholder farmers, and are expected to bear some of the worst effects of climate change. While food security is not solely related to food production—food access has political components as well—safeguarding agricultural systems from the effects of climate change will nonetheless be important (Sen, 1982).

In order for smallholders to continue to produce enough food despite the effects of climate change, agricultural systems will need to be able to function under more extreme and variable conditions. Resilient agricultural systems are seen as essential to achieving this goal and maintaining global food security. Resilience has a variety of definitions, but is generally understood to incorporate an ability to bounce back from external shocks or stresses, like those caused by climate change. For an agroecosystem, this means that the system will still be able to provide a livelihood for the farmer while maintaining the health of the land (Cabell & Oelofse, 2012). According to Cabell and Oelofse (2012), assessing the resilience of a system can help find the system's vulnerabilities and motivate the creation of "a more sustainable future for people and the land."

International development groups as a whole are increasingly addressing the idea of resilience, including in development projects focused on agriculture (Bahadur, Ibrahim, & Tanner, 2013; Barrett & Constas, 2014; Dixon & Stringer, 2015; Engle et al., 2014; Schipper & Langston, 2015; van Apeldoorn et al., 2011). McGreavy (2016) points to the Rockefeller Foundation's focus on resilient cities, the National Oceanic and Atmospheric Administration (NOAA)'s work on coastal resilience networks, and the World Bank's climate resilience programs as a few large examples of the billions of dollars development groups are spending on efforts to enhance resilience. However, it is less clear how these groups are conceptualizing resilience (Dixon & Stringer, 2015). The resilience theory literature as it relates to agroecosystems is complex, with varying ideas on what it means for an agricultural system to be resilient, how to plan and achieve that resilience, and how to appropriately assess the resilience of the system (Cabell & Oelofse, 2012; Darnhofer et al., 2010b). Agroecosystems are complex social-ecological systems, affected by not only ecological factors but also by social, economic, and cultural factors (Darnhofer et al., 2010b). If development projects are to effectively increase the resilience of these systems, all of these factors must be addressed—resilience cannot simply be used as a buzzword. This thesis analyzes the extent to which three international development groups—the World Bank, the

GEF, and the UNDP—understand and utilize the concept of resilience and the resilience theory literature.

Chapter 2 of this study reviews the relevant resilience theory literature, first outlining the basics of resilience theory and then expanding on its applications for agroecosystems and in a development context. Chapter 3 describes the process used to choose international development groups and projects relating to climate resilient agricultural systems, as well as the qualitative content analysis process used to analyze the chosen projects. Chapter 4 outlines the results of that analysis and discusses where gaps are found. The final chapter concludes by providing policy recommendations for groups hoping to better operationalize the resilience theory literature.

Chapter 2: Literature Review

Agroecosystems are complex social-ecological systems, affected by not only environmental factors but also by social, economic, political, and cultural factors (Darnhofer et al., 2010b). If development projects are to effectively increase the resilience of these systems, all of these factors must be addressed. This analysis aims to assess the depths to which development projects have conceptualized and incorporated resilience and the resilience theory literature. This section presents the relevant literature on resilience and its applications for agroecosystems and development.

This review of the literature first outlines resilience theory, including the adaptive cycle of social-ecological systems, the concept of panarchy, and the various definitions of resilience that have evolved since its origin. It then delves more specifically into the literature as it relates to the resilience of agroecosystems. This chapter concludes by analyzing the literature on incorporating resilience into international development projects.

2.1 Resilience Theory

Resilience theory was first described in 1973 by C.S. Holling, who studied how populations function within ecological systems, particularly after some sort of ecological stress. Ecological research prior to Holling's work had been focused on system equilibrium, but Holling argued that a system may have multiple equilibria that it shifts between during stress. In studying predator-prey relationships and population models, Holling noticed that there were multiple stable states possible (Folke, 2006). This realization shifted ecological work from focusing solely around a single equilibrium to system unpredictability and more variable behaviors. Thus, from Holling's work, resilience is defined as a system's ability to cope with a stress or shock while preserving its existing function and organization—in other words, without shifting to a new equilibrium (Bahadur et al., 2013). This resilience perspective shifts the focus from attempting to isolate a system from change to attempting to build the capacity of a system to tolerate change; to quote Holling, "the relevant focus is not on constancy but on variability" (Folke, 2006).

Holling and his fellow researchers introduced work in 1995 that connected the organization and behavior of ecosystems with the organization and behavior of the people who live in and work with these ecosystems (Folke, 2006). This work stressed the inevitability of uncertainty and began to push environmental management techniques away from the simple "command-and-control" tactics that try to avoid system change. Holling argued that these tactics may provide the desired effect in the short term, but as they do not take all variables into account, they can leave systems more vulnerable to disturbances in the long run. Holling's discovery of multiple stable states also led to his work on adaptive ecosystem management and the idea of the adaptive cycle.

This section first outlines panarchy and the adaptive cycle, the building blocks of resilience theory. It then outlines different interpretations and definitions that have built on this work and adapted Holling's ideas outside of ecology.

2.1.1 Panarchy and the Adaptive Cycle

The adaptive cycle is a cycle of disturbance and recovery that systems go through as they respond to stresses. Panarchy is the idea that these cycles are nested, rather than hierarchically or linearly organized (Holling & Gunderson, 2002). Panarchy describes adaptive cycles as complexly linked both spatially and temporally, often in ways which may cause “cascading” events where failure of one level can affect a variety of other levels (van Apeldoorn et al., 2011). For example, a failure at the field level of an agricultural system could cause changes affecting the regional-scale agricultural system (van Apeldoorn et al., 2011).

The adaptive cycle, as defined by Holling and Gunderson (2002), has four main stages: exploitation, conservation, release, and reorganization. Exploitation and conservation are the front of the loop, while release and reorganization are the back of the loop (Figure 1). The first stage, r, is the “exploitation” stage, characterized by rapid growth and high resiliency (Holling & Gunderson, 2002). For example, this could be the growth of a forest, when resources are allocated toward the rapid growth of trees. The cycle then shifts to the second stage, K. K is the “conservation” stage, characterized by efficiency rather than growth and buildup of system resources. This buildup and the increased connectedness that occurs during the K stage leaves the system inflexible, with a high potential for and vulnerability to change (Holling & Gunderson, 2002). This would be when the forest is dominated by large, old-growth trees. There is no longer much room for growth.

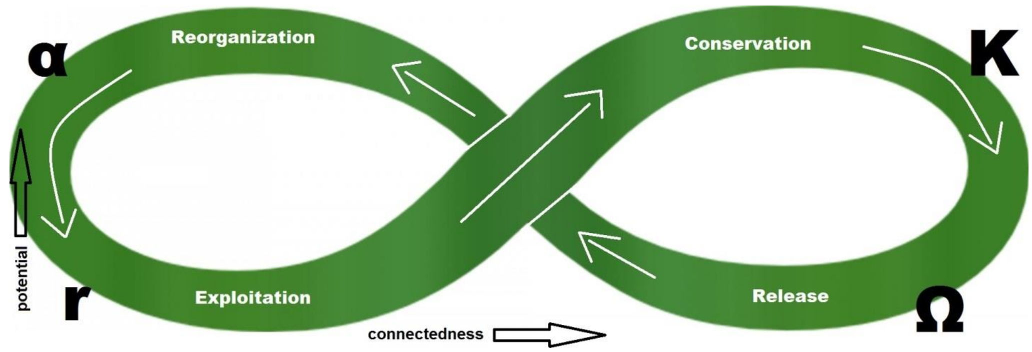

Figure 1. The adaptive cycle. Adapted from Holling & Gunderson, 2002.

A significant disturbance in the K stage will cause a release of the accrued resources and push the system into the third stage, Ω, the "release" stage. While the shift from r to K tends to be slow and gradual, the Ω stage is characterized by rapid change resulting from a system shock (Holling & Gunderson, 2002). An example would be a forest fire burning down the trees. In this stage, the resources that were previously stored in the trees would be released by the fire. After the disturbance, the system will move to α, the "reorganization" stage. Here, the system begins to rebuild, accumulating some basic resources again and likely reconfiguring into the same—or at least a similar—system. In the forest example, the resources that were released in the fire are now available in the soil for new growth. In some cases, if the disturbance was great enough or the system is unable to reorganize to its previous state, the system may become something new entirely. This is a shift from one state of equilibrium to another.

The adaptive cycle illustrates the degree to which change is an integral part of social-ecological systems. Thus, rather than defining resilience based on the ability to maintain a stable stasis, the natural cycle of change needs to be accounted for. The inevitability of changes to the system means that flexibility and adaptability are crucial to a resilient system. This is why definitions of resilience have evolved to incorporate cycles of change, as well as changes from one state of equilibrium to another. Resilient systems, including agroecosystems, are able to cope with sudden shocks and effectively reorganize. The next section explores how these concepts of resilience have evolved since Holling's 1973 work.

2.1.2 Evolving Concepts of Resilience

Since Holling's landmark ecological work, other researchers in various fields—anthropology, economics, environmental psychology, human geography, etc.—have applied the concept to their own work to challenge existing equilibrium-based theories (Folke, 2006). This led to work across disciplines on risk, vulnerability, uncertainty, and surprise. Different definitions of resilience have developed from work in these various disciplines. This section describes the evolution of these definitions.

Engineering Resilience

Because there was little field data collected at the time supporting Holling's multiple equilibrium theory, many ecologists continued to operate under the single equilibrium view. Resilience in this view—called engineering resilience—is defined as the amount of time it takes a system to return to its previous state after a disturbance (Folke, 2006). While this definition is still used in some instances, it is only applicable to smaller disturbances where the system does not end up far from the initial equilibrium. The more complex definitions argue that this steady-state definition does not apply to ecosystem behavior in an unstable state—this kind of behavior requires a definition that uses a perspective of complex adaptive systems rather than stable states (Folke, 2006). A complex adaptive systems perspective views systems as being dependent on organic processes and feedbacks that operate on different spatial and temporal scales.

Ecological Resilience and Social Resilience

From this perspective of complex adaptive systems and multiple states of equilibria came the ecological resilience and social resilience concepts, which go a step beyond the idea of engineering resilience. Ecological resilience and social resilience focus on buffer capability, which refers to the ability of a system to adjust to a shock without changing its function or structure (Darnhofer, 2013). These concepts relate more to "persistence" than the engineering resilience ideas of system recovery and consistency (Folke, 2006). They can be used in the context of an ecosystem absorbing a shock without changing its function or in the context of a social system or community absorbing a shock while maintaining its organization. However, the resilience of ecological systems and social systems cannot be effectively studied separately, as they are so dependent on one another (Folke, 2006). The next section explores social-ecological resilience, which combines the two into one interrelated system.

Social-Ecological Resilience

Social-ecological resilience incorporates concepts of recovery and persistence while also moving beyond these to a more adaptive idea of system resilience. This definition incorporates an additional three key aspects: the ability to self-organize; the ability to learn and adapt; and the ability to transform into an improved state.

The ability of the system to self-organize is described as crucial to how the system will emerge following a shock and has clear implications for social systems (Altieri et al., 2015; Cabell & Oelofse, 2012; Folke, 2006; Quinlan et al., 2015). In social-ecological systems, this means finding a sustainable balance between human regulation and ecological regulation. Socially, the farmers themselves need to be able to self-organize, as do the consumers. This can involve farmer cooperatives, local networks, and smaller governance structures, all of which enable relatively high degrees of farmer participation and self-organization (Cabell & Oelofse, 2012). A self-organized system will be more resilient than one that either is not organized or has a forced system of organization—for example, one dictated by a political body (Folke, 2006).

Also central to the social-ecological resilience concept, and strongly interrelated to networks, is the capacity to learn and adjust (Altieri et al., 2015; Cabell & Oelofse, 2012; Engle et al., 2014; Folke, 2006; Urruty, Tailliez-Lefebvre, & Huyghe, 2016; Quinlan et al., 2015). This relates to the concept of adaptive capacity, defined as the ability of a system to adjust by learning and developing, but without involving radical changes to the system's function or structure (Darnhofer, 2013). Cabell and Oelofse (2012) refer to this capacity as reflected and shared learning, meaning that stakeholders within the system are able to learn and adjust based both on past experiences and on information from each other. Local networks can provide a convenient method for this kind of knowledge sharing. By learning from the past or by sharing best practices, the system is able to adapt and be better prepared for future shocks, rather than simply reacting to them as they happen. For example, if climate change alters temperatures and causes a new pest to invade fields, an agricultural system will be more resilient if the farmers learn from this experience try something new, like introducing natural predators of that pest, rather than simply increasing pesticide use.

Social-ecological resilience also incorporates the concept of shifting forward to an improved state rather than merely bouncing back to the previous stable state (Engle et al., 2014; Cabell & Oelofse, 2012). For example, Engle et al. (2014) define resilience as “the potential to absorb and cope with impacts of climate shocks and extremes in the short term, and to learn, reorganize, and redevelop, preferable to an improved state, in the longer term.” This definition argues that in order for a system to be resilient, it must be able to not only cope with immediate stresses but also make itself less vulnerable to future stresses (Engle et al., 2014). This links to the third resilience capability, called transformative capability. This refers to the ability of a system to respond to shock by radically altering its system or function (Darnhofer, 2013). This is an evolution from Holling’s work—here, a shift from one state of equilibrium to another is seen as resilient, so long as the shift is beneficial in the long term. For example, consider a region economically based on agriculture that experiences a severe drought. Under the most basic resilience definition, the system would be resilient if it is able to recover from the drought and build back the agricultural systems that were previously in place. However, if more frequent droughts are expected under climate change, the system may be leaving itself vulnerable when more droughts occur. Under an adaptive resilience definition, the system would be resilient if the drought influenced some farmers to shift to alternate livelihoods. Having a more diversified economy would make the region more resilient to future droughts.

The next section takes these concepts of social-ecological system resilience and applies them to agroecosystems. It first discusses how agroecosystems fit into the adaptive cycle and then describes efforts to measure agroecosystem resilience, a key factor in assessing resilience.

2.2 Agroecosystem Resilience

Agroecosystems are complex social-ecological systems, integrating agronomic, ecological, environmental, social, economic, and cultural factors that vary across time and space. Ideally, all of these factors must be considered in attempting to create a resilient agroecosystem, as these factors all affect one another. However, its complexity makes it difficult to succinctly define what a resilient agricultural system looks like. Different circumstances may cause something that was considered resilient under certain conditions to undermine resiliency under others. Rather than attempting to directly define agroecosystem resilience, the literature focuses on different methods of measuring or assessing the resilience of a system. This section explores this literature, starting with applying the adaptive cycle to agroecosystems. It then analyzes measures of resilience that have been developed, including a discussion of behavior-based resilience indicators.

2.2.1 Agroecosystems and the Adaptive Cycle

Although agroecosystems are a classic example of a social-ecological system, it can often be difficult to apply the adaptive cycle and other classic resilience frameworks to agriculture. Although agriculture depends on ecological processes, the ecosystem is controlled by humans, while most social-ecological systems incorporate more fully “natural” ecosystems (van Apeldoorn et al., 2011). The human element is also present at a variety of levels, from the farmer to the policymakers to the consumers (Darnhofer et al., 2010). Because of the level of control that humans have over agroecosystems, the adaptive cycle may not always play out as smoothly as in the example of the forest above (van Apeldoorn et al., 2011).

Despite the challenges, the adaptive cycle can sometimes be applied. Darnhofer et al. (2010b) give the example of kiwifruit farming in New Zealand. The first exploitation (r) phase occurred when farmers first learned how to grow kiwifruit and markets for kiwifruit were emerging. Darnhofer et al. (2010b) then describe the conservation (K) phase as the point when kiwifruit were being heavily exported and grown under conventional methods with chemical pesticides and fertilizers. The release (Ω) phase occurred as a result of the kiwifruit being rejected from a key market due to chemical residues found on the skin of the fruit. In the reorganization (α) phase, the farmers shifted to a growing system of integrated management and organic production. Integrated management became a national standard for kiwifruit export. These changes in production led to the next exploitation phase (Darnhofer et al., 2010b).

This example illustrates some of the complexities that are inherent in agroecosystems. Multiple scales are relevant, from the individual farmers learning how to grow kiwifruit, to the national standards for export, to the international market demands. These different scales and stakeholders can make resilience theory difficult to operationalize for agroecosystems. The next section discusses the challenges of measuring resilience in agroecosystems and methods that have been developed to work around direct measurements.

2.2.2 Measuring Resilience of Agroecosystems

While defining the concept of resilience is relatively straightforward, it is virtually impossible to operationalize these definitions because they are complex, unobservable, and subjective. Measuring agroecosystem resilience requires subjective decisions about the boundaries of the agroecosystem and understanding how the smaller agroecosystem chosen is connected to many nested systems at many different levels. As Cabell and Oelofse (2012) say, “resilience defies measurement.”

For these reasons, some scholars have attempted to indirectly measure resilience by mathematically or conceptually modeling it (Fletcher, Miller, & Hilbert, 2006; Resilience Alliance 2010). These measurement systems all begin by attempting to bound the system and define the “resilience of what to what.” They give the example of a longleaf pine forest, a system that needs to maintain certain tree species in order to protect woodpecker habitat. The goal is then to measure the resilience of the longleaf pine forest to invasion of hardwood species. However, a second strain of the literature argues that agroecosystems are “too complex and variable in time and space” for this to be useful (Darnhofer et al., 2010a). This group argues that creating general rules or indicators will be more useful for a system as complex as a farming system. These are lists of system characteristics that help to enable the three resilience capabilities described by Darnhofer (2013): buffer capability, adaptive capability, and transformative capability.

Darnhofer (2013) agrees with Cabell & Oelofse, and others, that agroecosystems are too complex to apply specific rules or measurements of resilience. These authors instead advocate the use of a list of observable system features, called “indicators,” in order to evaluate the resilience of the system. The indicators do not address resilience to a specific stress or shock, but rather a more general resilience (Dixon & Stringer, 2015).

Cabell and Oelofse (2012) characterize a resilient agroecosystem as one that is able to provide food, clothing, and a livelihood for the farmers while maintaining and building the natural capital of the land. Agroecosystems are complex social-ecological systems, making it difficult to know which actions lead to enhanced resilience (Darnhofer, Fairweather, & Moller, 2010b). Agroecosystem resilience measures must therefore be fairly broad and applicable through time and space (Darnhofer et al., 2010b). To that end, Cabell and Oelofse (2012) developed a set of 13 behavior-based indicators that, when present in an agroecosystem, indicate enhanced resilience (Table 1). The absence of any one of these indicators suggests a vulnerability in the system (Cabell & Oelofse, 2012). Assessing resilience using this method is a key way to identify and address vulnerabilities. These behavior-based indicators are the clearest, most-developed tools to assess agroecosystem resilience available in the literature.

Table 1. Indicators for assessing agroecosystem resilience. From Cabell and Oelofse, 2012 with permission.

Indicator (sources)	Definition	Implications	What to look for
Socially self-organized (Levin 1999, Holling 2001, Milestad and Darnhofer 2003, Atwell et al. 2010, McKey et al. 2010)	The social components of the agroecosystem are able to form their own configuration based on their needs and desires	Systems that exhibit greater level of self-organization need fewer feedbacks introduced by managers and have greater intrinsic adaptive capacity	Farmers and consumers are able to organize into grassroots networks and institutions such as co-ops, farmer's markets, community sustainability associations, community gardens, and advisory networks
Ecologically self-regulated (Sundkvist et al. 2005, Ewell 1999, Jackson 2002, Swift et al. 2004, Jacke and Toensmeier 2005, Glover et al. 2010, McKey et al. 2010)	Ecological components self-regulate via stabilizing feedback mechanisms that send information back to the controlling elements	A greater degree of ecological self-regulation can reduce the amount of external inputs required to maintain a system, such as nutrients, water, and energy	Farms maintain plant cover and incorporate more perennials, provide habitat for predators and parasitoids, use ecosystem engineers, and align production with local ecological parameters
Appropriately connected (Axelrod and Cohen 1999, Holling 2001, Gunderson and Holling 2002, Picasso et al. 2011)	Connectedness describes the quantity and quality of relationships between system elements	High and weak connectedness imparts diversity and flexibility to the system; low and strong impart dependency and rigidity	Collaborating with multiple suppliers, outlets, and fellow farmers; crops planted in polycultures that encourage symbiosis and mutualism
Functional and response diversity (Altieri 1999, Ewell 1999, Berkes et al. 2003, Luck et al. 2003, Swift et al. 2004, Folke 2006, Jackson et al. 2007, Di Falco and Chavas 2008, Moonen and Barbieri 2008, Chapin et al. 2009, Darnhofer et al. 2010*b,* McIntyre 2009)	Functional diversity is the variety of ecosystem services that components provide to the system; response diversity is the range of responses of these components to environmental change	Diversity buffers against perturbations (insurance) and provides seeds of renewal following disturbance	Heterogeneity of features within the landscape and on the farm; diversity of inputs, outputs, income sources, markets, pest controls, etc.
Optimally redundant (Low et al. 2003, Sundkvist et al. 2005, Darnhofer et al. 2010*b,* Walker et al. 2010)	Critical components and relationships within the system are duplicated in case of failure	Also called response diversity; redundancy may decrease a system's efficiency, but it gives the system multiple back-ups, increases buffering capacity, and provides seeds of renewal following disturbance	Planting multiple varieties of crops rather than one, keeping equipment for various crops, getting nutrients from multiple sources, capturing water from multiple sources
Spatial and temporal heterogeneity (Alcorn and Toledo 1998, Devictor and Jiguet 2007, Di Falco and Chavas 2008)	Patchiness across the landscape and changes through time	Like diversity, spatial heterogeneity provides seeds of renewal following disturbance; through time, it allows patches to recover and restore nutrients	Patchiness on the farm and across the landscape, mosaic pattern of managed and unmanaged land, diverse cultivation practices, crop rotations
Exposed to disturbance (Gunderson and Holling 2002, Berkes et al. 2003, Folke 2006)	The system is exposed to discrete, low-level events that cause disruptions without pushing the system beyond a critical threshold	Such frequent, small-scale disturbances can increase system resilience and adaptability in the long term by promoting natural selection and novel configurations during the phase of renewal; described as "creative destruction"	Pest management that allows a certain controlled amount of invasion followed by selection of plants that fared well and exhibit signs of resistance
Coupled with local natural capital (Ewell 1999, Milestad and Darnhofer 2003, Robertson and Swinton 2005, Naylor 2009, Darnhofer et al. 2010*a,b,* van Apeldoorn et al. 2011)	The system functions as much as possible within the means of the bioregionally available natural resource base and ecosystem services	Responsible use of local resources encourages a system to live within its means; this creates an agroecosystem that recycles waste, relies on healthy soil, and conserves water	Builds (does not deplete) soil organic matter, recharges water, little need to import nutrients or export waste

Table 1 cont.

Reflective and shared learning (Berkes et al. 2003, Darnhofer et al. 2010*b,* Milestad et al. 2010, Shava et al. 2010)	Individuals and institutions learn from past experiences and present experimentation to anticipate change and create desirable futures	The more people and institutions can learn from the past and from each other, and share that knowledge, the more capable the system is of adaptation and transformation, in other words, more resilient	Extension and advisory services for farmers; collaboration between universities, research centers, and farmers; cooperation and knowledge sharing between farmers; record keeping; baseline knowledge about the state of the agroecosystem
Globally autonomous and locally interdependent (Milestad and Darnhofer 2003, Walker et al. 2010, van Apeldoorn et al. 2011)	The system has relative autonomy from exogenous (global) control and influences and exhibits a high level of cooperation between individuals and institutions at the more local level	A system cannot be entirely autonomous but it can strive to be less vulnerable to forces that are outside its control; local interdependence can facilitate this by encouraging collaboration and cooperation rather than competition.	Less reliance on commodity markets and reduced external inputs; more sales to local markets, reliance on local resources; existence of farmer co-ops, close relationships between producer and consumer, and shared resources such as equipment
Honors legacy (Gunderson and Holling 2002, Cumming et al. 2005, Shava et al. 2010, van Apeldoorn et al. 2011)	The current configuration and future trajectories of systems are influenced and informed by past conditions and experiences	Also known as path dependency, this relates to the biological and cultural memory embodied in a system and its components	Maintenance of heirloom seeds and engagement of elders, incorporation of traditional cultivation techniques with modern knowledge
Builds human capital (Buchmann 2009, Shava et al. 2010, McManus et al. 2012)	The system takes advantage of and builds "resources that can be mobilized through social relationships and membership in social networks" (Nahapiet and Ghoshal 1998:243)	Human capital includes: constructed (economic activity, technology, infrastructure), cultural (individual skills and abilities), social (social organizations, norms, formal and informal networks)	Investment in infrastructure and institutions for the education of children and adults, support for social events in farming communities, programs for preservation of local knowledge
Reasonably profitable	The segments of society involved in agriculture are able to make a livelihood from the work they do without relying too heavily on subsidies or secondary employment	Being reasonably profitable allows participants in the system to invest in the future; this adds buffering capacity, flexibility, and builds wealth that can be tapped into following release	Farmers and farm workers earn a livable wage; agriculture sector does not rely on distortionary subsidies

These behavior-based indicators each correspond to at least one of the phases in the adaptive cycle where they are most important. There is some significant overlap between some of the stages, as some indicators are vital at multiple stages of the adaptive cycle. Ecologically self-regulated; appropriately connected; high degree of spatial and temporal heterogeneity; responsibly coupled with local natural capital; and globally autonomous and locally interdependent are all categorized under the exploitation (r) stage. Each of these indicators are important for effective system growth. Ecologically self-regulated; appropriately connected; optimally redundant; high degree of spatial and temporal heterogeneity; globally autonomous and locally interdependent; and reasonably profitable are part of the conservation (K) stage, where the system is built up and highly interconnected. Optimally redundant; carefully exposed to disturbance; and honors legacy while investing in the future are part of the release (Ω) stage. The reorganization stage (α) includes socially self-organized; responsibly coupled with natural capital; reflected and shared learning; and honors legacy while investing in the future, all of which allow the system to effectively reorganize. High degree of functional and response diversity; and builds human capital should be present throughout the adaptive cycle to indicate resilience (Cabell & Oelofse, 2012).

Another alternative to direct modeling is to develop and measure surrogates for resilience. Surrogates include aspects of resilience that must be indirectly inferred, rather than observable system traits like indicators (Bennett, Cumming, & Peterson, 2005; Carpenter, Bennett, & Peterson, 2006). Surrogates are a more process-based approach to measuring resilience. Bennett et al. (2005) suggest analyzing the system in order to determine the stresses that different aspects of the system need to be resilient to. After that, it is important to identify the processes that affect these system aspects. From these aspects, stresses, and processes, a system model is created. The model is used to choose resilience surrogates. Bennett et al. (2005) suggest two kinds of surrogates: ones that measure the distance between the state of a system and a threshold or those that measure the rate of change in the threshold. The threshold point is where the system shifts to a new, less desirable state. However, thresholds can be difficult to measure or identify, making surrogates more challenging to operationalize than indicators.

This section has outlined the literature on resilience in agroecosystems, and how it is measured or assessed. The next section moves to the literature on how resilience is understood and used in the development community.

2.3 Incorporating Resilience in International Development Projects

The concept of resilience is increasingly understood to be an important one by the development community. Several papers exist in the literature attempting to consolidate resilience theory into concrete, useful concepts for international development groups (Barrett & Constas, 2014; Bahadur et al., 2013; Dixon & Stringer, 2015; Engle et al., 2014; Hoffmann 2011). Much of this literature relates either to general resilience or resilience to climate change, rather than resilience of an agroecosystem.

This section will first address the challenges development resilience faces from vague definitions. It will then discuss the difference in priorities between the general resilience literature and the development literature. Finally, it will analyze different resilience measurement techniques employed in development literature.

2.3.1 Resilience, Vulnerability, and Adaptive Capacity

The vaguely-defined connections between the concepts of resilience, vulnerability, and adaptive capacity are seen as a major challenge for translating resilience theory to development work (Bahadur et al., 2013; Engle et al., 2014). The IPCC defines vulnerability as “the propensity or predisposition to be adversely affected” (IPCC 2014). Resilience is often presented as vulnerability’s opposite, though both are more complex than that. For example, Dixon and Stringer (2015) argue that a system can be both resilient and vulnerable, depending on the shocks. They give the example of a farm near a river, which may be resilient to drought but vulnerable to flooding. Dixon and Stringer (2015) also state that the resilience application frameworks they analyzed disregard much of the resilience theory literature by treating these two concepts as opposites. Engle et al. (2014) argue that resilience is a more useful framework for climate change related development than vulnerability, as the magnitude of risk from climate change is uncertain in many regions.

2.3.2 Shifting Priorities

International development projects are often undertaken with the primary goal of improving livelihoods. To that end, much of the focus when discussing resilience is on the well-being of individuals, rather than on ecological well-being. A report from the Global Environment Facility (GEF), for example, suggests that one of the primary values of understanding resilience of a system is that it "will help people to make intentional changes (or system interventions) with a stronger chance of reaching their sustainability goals" (O'Connell et al., 2016). The GEF report also acknowledges the challenges with operationalizing resilience thinking for a development context: "Applying resilience concepts to individual projects poses many challenges. We need consistent approaches to define, assess and report resilience at different scales."

There is support for this primary focus on social resilience over ecological resilience in the literature as well. Barrett and Constas (2014) begin to create a theory of resilience for development applications by pointing out that development is inherently different from previous applications and thus needs its own definition of resilience. While social-ecological resilience is focused on the system as a whole, development is focused on the wellbeing of the individual people within the system. These authors argue that in order to apply the existing resilience theory to development, it must be effectively combined with the economics literature. For example, development resilience relates to the economics literature on poverty traps in the similar frameworks used (Barrett and Constas, 2014).

To that end, the authors define development resilience as "the capacity over time of a person, household or other aggregate unit to avoid poverty in the face of various stressors and in the wake of myriad shocks" (Barrett & Constas, 2014). This definition focuses entirely on the human element of the system, rather than on the system as a whole.

Dixon and Stringer (2015) disagree with this focus somewhat. These authors argue that resilience is explicitly different from poverty reduction. While both goals are important, a project could increase climate resilience without having any effect on poverty levels, and vice versa. They refer back to the point that resilience is not always a positive trait, as would be the case in a resilient system that leaves the inhabitants of the system in perpetual poverty. Because of this, they suggest continued focus on this issue to develop frameworks linking the two more effectively, as well as ensuring the enhanced capacity for positive transformative changes in the systems (Dixon & Stringer, 2015). They argue that resilience frameworks need to be clear about who will benefit from the more resilient system and who will not.

Some of the literature also argues that as the theory of resilience has adapted from its ecological roots, there has been limited engagement with certain social issues that are important in social-ecological systems and in development. These issues include areas of power and politics (Bahadur et al., 2013; Barrett & Constas, 2014; Dixon & Stringer, 2015). Barrett and Constas (2014) point out the often-overlooked importance of power dynamics, ranking it equally as important as factors like the ecology or agronomy of the system. Dixon & Stringer (2015), who analyze frameworks that allow for practical application of resilience theory (including Cabell & Oelofse's), suggest that these frameworks do not consider the importance of politics as much as they should.

2.3.3 Measurements of Resilience

Measuring development resilience has the same challenges that measuring agroecosystem resilience does. Indicators can again be a way to overcome these challenges. Engle et al. (2014) support the use of indicators in assessing resilience, similar to Cabell and Oelofse (2012). However, Engle et al. (2014) seek to address the challenge of climate change more broadly, rather than the specific system being challenged (e.g. agroecosystems). As climate change has such a wide variety of consequences, one indicator set would not be able to address every aspect of climate change. Therefore, rather than creating a single set of indicators themselves, as Cabell and Oelofse did, they instead put forth a guide for development groups to create their own set of indicators, depending on the circumstances. They focus their guide on five broad categories: governance and security; natural resource systems; social systems; economic systems; and built environment/infrastructure. Engle et al. (2014) suggest that development groups create multiple indicators in each category along different spatial and temporal scales. For example, a group directing a project focused on resilience to drought could have *government incentives for crop diversity* as one of their resilience indicators in the "governance and security" category. Dixon and Stringer (2015) agree that multiple sets of indicators are needed to apply to a wide variety of circumstances. To go with Cabell and Oelofse's (2012) agroecosystem indicators, they suggest that sets of climate-related resilience indicators be created for urban systems, a variety of geographies, and a variety of scales.

In assessing their indicators, Engle et al. (2014) use a hybrid framework, created with both quantitative and qualitative resilience assessment concepts. Barrett and Constas (2014), who focus heavily on the human aspect of the system, support this type of framework, arguing that in order to measure development resilience effectively, we need to develop both qualitative and quantitative measurements for human well-being. This involves also quantifying the natural resource base that supports human well-being (Barrett & Constas, 2014). One could then measure the resilience of the individual, household, or community based on the probability of that unit falling into poverty. For the quantitative measures, Engle et al. (2014) suggest a set of indicators, which they say are helpful because they are transparent, easy to understand, and easy to compare. However, they also point out that indicators do not take feedbacks and system interactions into account, and can be biased by the priorities of the person creating the indicators. Adding qualitative assessments can help to overcome some of these limitations. Engle et al. (2014) suggest using case studies and interviews with relevant experts and stakeholders.

Bahadur et al. (2013) also focus broadly on resilience to climate change. The authors create a list of what they call characteristics of resilience—functionally the same as indicators. The characteristics that the authors consider common to resilient systems are: high diversity; effective governance and institutions; acceptance of uncertainty and change; non-equilibrium system dynamics; community involvement and inclusion of local knowledge; preparedness and planning; high degree of equity; social capital, values, and structures; learning; and adoption of a cross-scalar perspective (Bahadur et al., 2013). These characteristics of resilience overlap somewhat with Cabell & Oelofse's (2012) behavior-based indicators, though the characteristics are more general. For example, Bahadur et al.'s (2013) "high diversity" corresponds to Cabell and Oelofse's (2012) "functional and response diversity." Bahadur et al. (2013) define effective governance and structures as flexible formal and informal institutions that are equitable and work in their individual setting. Acceptance of uncertainty and change relates to the idea that excessive stability of the system can undermine resilience, and corresponds to Cabell and Oelofse's (2012) "exposure to disturbance."

Non-equilibrium system dynamics refers to the concept that a system returning to the same equilibrium over and over may just leave it vulnerable to the same shocks. This goes with the idea of a system being able to shift forward to a new, preferable state (Bahadur et al., 2013). Community involvement and inclusion of local knowledge are common themes throughout resilience theory literature, and corresponds to a variety of Cabell and Oelofse's (2012) indicators, including socially self-organized, reflective and shared learning, and honors legacy. Preparedness and planning also relates to the reflective and shared learning indicator, as it speaks to the idea of learning from past experiences and using them to prepare for future occurrences. High degree of equity brings in the ideas of power dynamics, something that Barrett and Constas (2014) and Dixon and Stringer (2015) described as often overlooked in these types of frameworks.

The social capital, values, and structures characteristic speaks to the idea of cooperation, and how community coordination can enhance equity, access to resources, and resilience. This correlates with Cabell and Oelofse's ideas of local interdependency and the ability to socially self-organize. The learning characteristic is another one that is prevalent throughout the literature, and corresponds with the reflective and shared learning indicator. Finally, adoption of a cross-scalar perspective addresses the interconnectedness of systems and the need to view the system from multiple levels. This relates to the idea of panarchy, where there are multiple nested cycles occurring at a variety of spatial and temporal scales.

While indicators and characteristics are present throughout much of the literature, there remains a fair amount of debate between using a broader set of indicators and using surrogates as measurements of resilience (Bahadur et al., 2013; Barrett & Constas, 2014). Without a standardized choice for measurements, it becomes even more difficult for development groups to slog through the large amount of literature and operationalize it.

This chapter has reviewed the literature on resilience theory, resilience of agroecosystems, and resilience as it relates to international development. The next chapter outlines the methodology used to analyze how the concept of resilience is being used in international development projects, and how that compares with the way resilience is presented in the literature. The concepts described within this literature review are used to create a list of keywords which are used in analyzing the chosen project documents. These keywords draw heavily on the behavior-based indicators put forth by Cabell and Oelofse (2012).

Chapter 3: Methodology

In order to gauge the level at which international development projects are conceptualizing and operationalizing resilience theory, this thesis will analyze projects implemented by three international development groups: the Global Environment Facility (GEF), the World Bank, and the United Nations Development Program (UNDP). These three development organizations were chosen because of their global scope, large operating budgets, and public availability of detailed project documents. Only projects with detailed documentation available could be used for this analysis. All of the chosen projects related to agriculture, climate change, and resilience in some way.

Based on documents from the past ten years, a content analysis was used to assess the level to which resilience is incorporated in project goals and evaluation methods. This chapter first describes the three organizations that were chosen and the chronological scope of the chosen projects. It then outlines the content analysis method and the steps that were used to choose keywords, divide the project documents into sections, and weight the keyword occurrences.

3.1 Choosing Projects and Documents

3.1.1 GEF

The Global Environment Facility (GEF) has 183 member countries which make up the GEF Assembly. Some of these countries are donors who contribute to projects while others are project recipients. The GEF is governed by a Council made up of representatives from 32 member countries—16 from developing countries, 14 from developed countries, and two from “economies in transition” (“Organization,” 2016). The Council members are appointed by the member countries and rotate every few years. The Council is responsible for developing operational policies and approving project proposals. As approved by the Council, the GEF has an annual corporate budget of approximately $26 million.

The GEF also encompasses 18 different agencies that work with stakeholders in the project areas to implement GEF-funded projects. These agencies include United Nations groups, international development banks, and several non-governmental agencies (NGOs). Because the GEF encompasses so many different agencies, it does not have an organizational culture in the way that the other two organizations do. GEF-funded projects are designed to aid developing countries in meeting the goals of five international environmental conventions: the Convention on Biological Diversity; the United Nations Framework Convention on Climate Change; the Stockholm Convention on Persistent Organic Pollutants; the UN Convention to Combat Desertification; and the Minamata Convention on Mercury. GEF divides the goals of these conventions into their work in seven “focal areas:” biodiversity; chemicals and waste; climate change; international waters; land degradation; ozone layer depletion; and persistent organic pollutants.

Included in this analysis are projects within the focal area of climate change or those with multiple focal areas including climate change. From these focal areas, agricultural sector projects were chosen with a focus on resilience. This thesis used the most descriptive document that could be found for each project, which varied depending on the implementing agency. These project documents ranged from around 50-250 pages in length. 20 projects from GEF were used for this analysis.

GEF program effectiveness is assessed by the Independent Evaluation Office (IEO). The IEO evaluates the impact that GEF projects have across the board, generally focusing on certain focal areas or project themes.

3.1.2 World Bank

The World Bank is made up of 189 member countries, or shareholders. The World Bank is led by a Board of Governors, made up of one Governor and one Alternate Governor from each of the member countries. The Governors delegate the general operations to a Board of Directors, which consists of 25 executive directors ("Organization" 2017). Five of these are appointed by the five largest shareholders, while the remaining 20 are elected by the Governors. The Board of Directors is responsible for choosing the President of the World Bank, who is responsible for the day-to-day leadership. The World Bank Group has an annual capital budget of around $185 million.

The work of the World Bank falls under two main goals: reducing the occurrence of extreme poverty (a daily income of less than $1.90 per day); and increasing the income of each country's bottom 40%. Within these broad goals, the Bank works in a variety of "themes," which fall into various categories: economic management; environmental and natural resources management; financial and private sector development; human development; public sector governance; rule of law; rural development; social development, gender, and inclusion; social protection and risk management; trade and integration; and urban development.

Projects chosen for this thesis were under the theme climate change, which is part of the environmental and natural resources management category. This was further limited to projects within the agriculture, fishing, and forestry sector. The Program Documents were used for the analysis, as these were the most descriptive. These documents ranged from around 70-170 pages in length. Twenty-three projects from the World Bank were used for this analysis.

The effectiveness of World Bank projects is assessed by the World Bank Independent Evaluation Group (IEG). The IEG, which reports to the Board of Directors, aims to "promote a stronger internal culture for results, accountability, and learning" ("About IEG" 2016).

3.1.3 UNDP

The United Nations Development Program (UNDP) leads the development efforts of the United Nations. UNDP is led by an executive office and administrator in New York City, but is then divided into 5 regional bureaus: Africa; Asia and the Pacific; Arab States; Europe and the Commonwealth of Independent States; and Latin America and the Caribbean ("2017 Organisational Chart" 2017). These bureaus are further subdivided into nearly 170 country offices. UNDP operates with a four-year budget of $24.3 billion from 2014-2017, eight percent of which is dedicated to management activities.

The work of the UNDP is based on supporting countries in meeting the Sustainable Development Goals, which were created to follow the Millennium Development Goals. The Sustainable Development Goals, or Global Goals, include a broad range of tactics to improve global wellbeing: no poverty; zero hunger; good health and well-being; quality education; gender equality; clean water and sanitation; affordable and clean energy; decent work and economic growth; industry, innovation, and infrastructure; reduced inequalities; sustainable cities and communities; responsible consumption and production; climate action; life below water; life on land; peace, justice, and strong institutions; and partnerships for the goals ("Sustainable Development Goals" 2017). Within these broad goals, UNDP works within three main areas—sustainable development, democratic governance and peacebuilding, and climate and disaster resilience.

Projects for this thesis were chosen from the climate and disaster resilience section. This was further narrowed to projects that related to agriculture. Chosen proposals ranged from around 20 pages to 150 pages in length. A total of 12 projects from UNDP were used for this analysis.

Effectiveness of UNDP work is assessed by the UNDP Independent Evaluation Office (IEO). The IEO reports to the UNDP Executive Office.

3.1.4 Chronological Scope

For consistency, projects were chosen that were registered or approved in the past decade, between 2006 and 2016. This time period provides a relatively broad number of projects during the time in which resilience has become an increasingly popular topic within the literature and within the development community.

3.2 Content Analysis

The chosen projects were screened for consideration of resilience using a qualitative content analysis method. Content analysis is a flexible method of screening and analyzing large quantities of text data, such as project reports (Hsieh & Shannon, 2005). A series of keywords were developed from the resilience theory literature that would indicate resilience is being addressed in the project. The project documents were divided into their relevant document sections, as described below in Section 3.2.2. Document sections were then scanned in a PDF reader to identify the presence and location of keywords. Each keyword occurrence was then evaluated and weighted based on the context, as outlined in Section 3.2.3.

3.2.1 Developing Keywords

Twenty keywords were chosen for this content analysis based on a review of the literature, and in particular based on the behavior-based indicators of a resilient agroecosystem created by Cabell and Oelofse (2012). These twenty keywords were then divided into three main categories: system traits and measurement; stress to the system; and social characteristics of the system (Table 2). Included in Table 2 is the root that was used to search the project documents for occurrences of the keyword. For example, for the keyword resilience, the root "resilien" was used so that occurrences of resilience, resilient, or resiliency would be found.

Table 2. Resilience- related keywords chosen for content analysis.

System traits and measurement	Resilience	Resilien
	Indicator	Indicator
	Diversity	Divers
	Redundant	Redundan
	Heterogeneous	Heterogen
	Interdependent	Interdependen
Stress to the system	Vulnerability	Vulnerab
	Disturbance	Disturbance
	Shock	Shock
	Recovery	Recover
	Coping	Coping
	Adaptive	Adapt
	Transformative	Transform
Social Characteristics of the System	Learning	Learning
	Network	Network
	Legacy	Legacy
	Profit	Profit
	Income	Income
	Livelihood	Livelihood
	Self-organize	Self-Organize, self organize

3.2.2 Dividing Documents by Section

Each project document was divided into four sections: project title; introduction; objectives; and assessment methods. These sections were chosen to help assess the depth of commitment to the resilience theory literature in the project documents. Words that occurred in the title of the project indicate a strong interest, but do not give any sense of the depth of understanding of the keyword or how well the concept is carried throughout the project document. Keywords that occurred in the introduction of the project document were considered more superficial nods to the literature, as this section is merely background material and does not show the goals of the project. Keywords occurring in the objectives section of the documents were considered more important than those in the introduction, as this section describes exactly what the project intends to address and how it intends to improve system resilience. Keywords occurring in the assessment section were considered the most important occurrences, as this indicates the most follow through with the concepts. This section addresses how the success of the project will be evaluated. If a keyword occurs in the introduction and objectives sections, but not in the assessment, this suggests that while the organization is interested in addressing the concept, there is no method to evaluate how successful their interventions in that area were.

The goal in dividing the documents by section was to be able to compare number of occurrences between document sections. However, because the document sections were different lengths, the number of occurrences could not be directly compared. Instead, the number of keyword occurrences in each section was compared with the total number of words in each section, which was found using a word processor. Keyword occurrences are therefore expressed as a ratio so that the numbers may be more meaningfully compared.

3.2.3 Locating and Weighting Keyword Occurrences

The document sections were searched for keyword occurrences using a pdf document reader. The number of occurrences in each section of each document was recorded, excluding occurrences that used the keyword in an unrelated way (for example, mentioning a non-*profit* organization rather than the *profits* of smallholder farmers) and occurrences that were part of citations or footnotes. Once the occurrences were located and tallied, each keyword occurrence was subjectively analyzed to determine whether the occurrence represented the organization’s general awareness of the concept behind the keyword, or represented a deeper understanding of and commitment to addressing the keyword. Occurrences in the former category were marked as “aware,” while those in the latter category were marked as “deep.” For example, if the document mentioned the *diversity* of the project area, this was categorized as “aware,” as it suggests that the organization is aware that diversity is relevant to the project and its goals. If the document mentioned plans to increase the *diversity*, gaps in protections of *diversity*, or the importance of *diversity* in promoting resilience, this was categorized as “deep,” as this suggests the organization realizes the importance of the concept for the project and is taking clear steps to understand and address the concept. This distinction is somewhat subjective, but serves to separate those occurrences of the keywords that really show an understanding of the importance of the underlying concept. Projects containing “deep” level keywords throughout the project documents showed a deeper, more complex understanding of resilience theory.

This chapter has outlined the methodology used to analyze the chosen 55 projects. The next chapter will present the results of this analysis, first by combining results across all 55 projects and then by comparing results across organizations.

Chapter 4: Results and Discussion

4.1 Resilience Analysis across Organizations

A total of 55 project documents were analyzed. The number of occurrences of each keyword in various sections of the project document is displayed below in Table 3. Corresponding tables split up by organization can be found in Appendix A.

Table 3. Keyword Occurrences for 55 Project Documents

	Title	Introduction		Objectives		Assessment		Total
Keyword	#	#aware	#deep	#aware	#deep	#aware	#deep	#
Resilience	19	394	95	690	555	191	52	1996
Indicator	0	32	1	265	40	257	49	644
Diversity	4	519	257	805	310	97	34	2026
Redundant	0	0	1	3	1	0	0	5
Heterogeneous	0	0	2	1	0	0	0	3
Interdependent	0	1	3	1	0	0	1	6
Vulnerability	4	445	88	608	149	107	32	1433
Disturbance	0	4	2	1	0	1	0	8
Shock	0	35	25	18	30	3	3	114
Recovery	4	50	32	192	60	78	26	442
Coping	0	4	13	17	10	5	0	49
Adaptive	10	531	209	1161	509	271	141	2832
Transformative	0	26	17	14	8	0	1	66
Learning	0	27	8	144	45	40	26	290
Network	0	20	13	74	66	42	25	240
Legacy	0	2	0	1	0	0	0	3
Profit	0	9	4	16	5	4	9	47
Income	0	126	62	159	76	29	21	473
Livelihood	3	223	110	415	195	71	58	1075
Self-Organize	0	0	0	0	0	0	0	0

The only keywords appearing in project titles were resilience, diversity, vulnerability, recovery, adaptive, and livelihood. The keywords that appeared most frequently overall were resilience, diversity, vulnerability, adaptive, and livelihood—a nearly identical list. While resilience was the keyword that occurred the most often in the project titles, diversity and adaptive both occurred more often throughout the entire document. The high occurrence of resilience is not a surprise, as projects were specifically chosen that focus on resilience. The only keyword that did not occur at all was self-organize, though redundant, heterogeneous, interdependent, disturbance, and legacy also occurred very infrequently.

Because of the differences in document and document section length, the quantities on the y axes of the following figures are ratios, not absolute numbers, and are primarily useful for comparison (discussed in detail in Section 3.2.2). Figure 2, below, compares the ratio of "aware" level occurrences versus the total number of "deep" level occurrences, across all keywords and document sections.

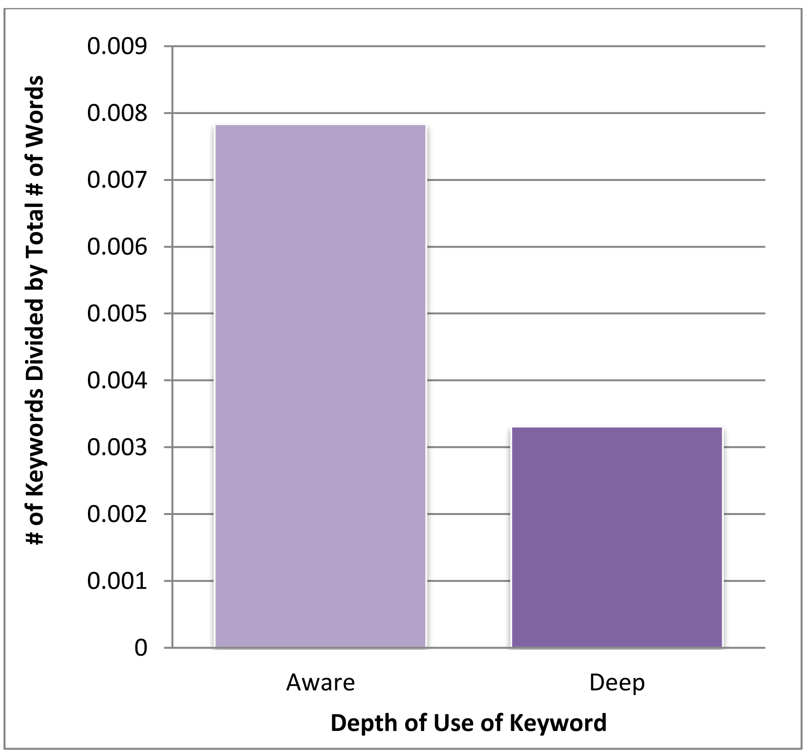

Figure 2. Ratio of "aware" versus "deep" occurrences of resilience keywords across all project documents and sections

As Figure 2 illustrates, the projects as a whole have far more "aware" level occurrences of the keywords than "deep" level occurrences. However, it should be noted that no statistical tests have been run on the data, so differences should not be assumed to be statistically significant. Figure 3, below, combines the "aware" and "deep" level occurrences. This figure shows the ratio of keywords in each document section. The section bars are further divided into the three categories of keyword: System Traits and Measurement, Stress to the System, and Social Characteristics of the System.

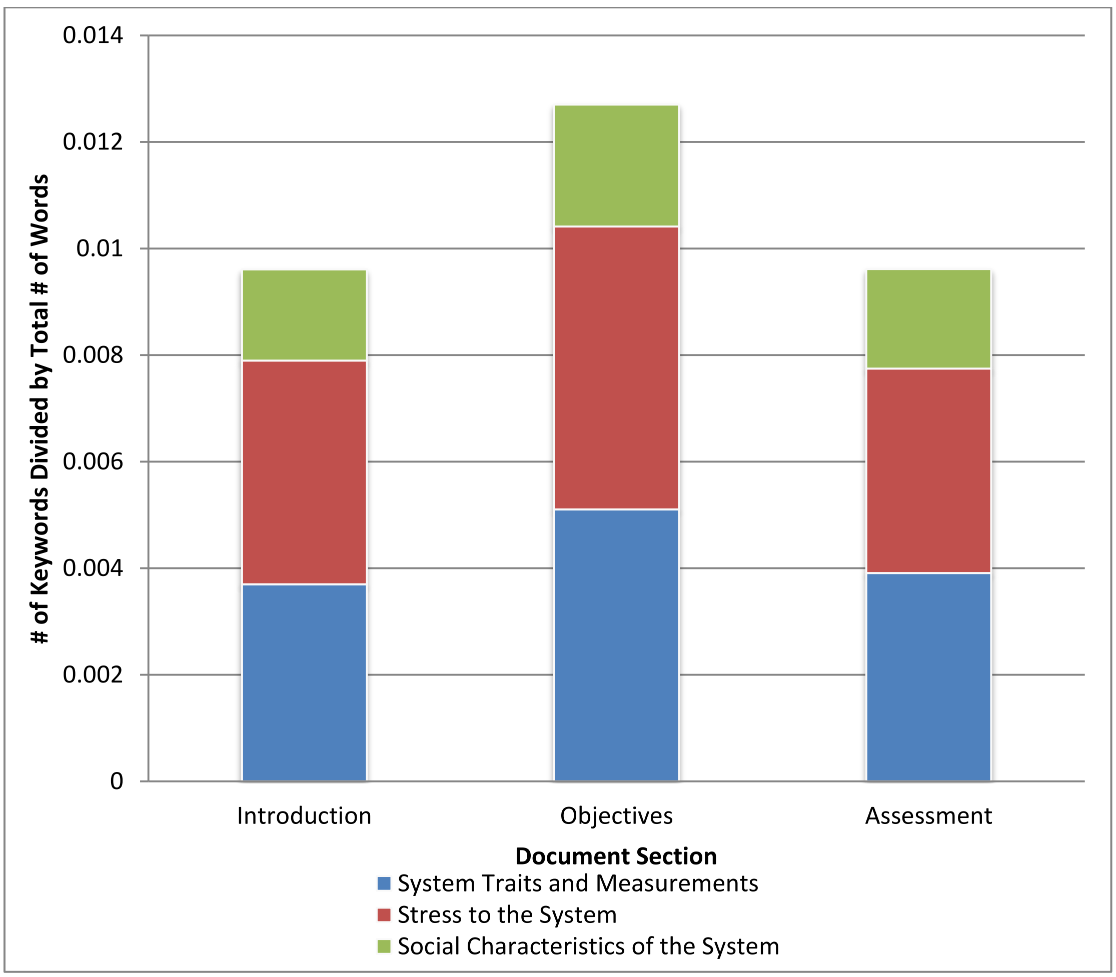

Figure 3. *Ratio of occurrences of keywords in all project documents by document section and keyword category*

This figure illustrates the disparity in keyword occurrence between the different document sections. Keywords appear the most often in the objectives section and less in the introduction and assessment sections, which show very similar numbers. The figure also shows the disparity between the occurrences of the different keyword categories. Keywords in the "Social Characteristics of the System" category appear less often than the other two categories across all document sections.

Figure 4 also shows occurrences split across document sections and keyword category, but also divides the occurrences into the "aware" versus "deep" designations. The "deep" designations are illustrated with the darker colored bars and are indicated by a "D" in the legend. The "aware" designations are illustrated with the lighter colored bars and are indicated by an "A" in the legend.

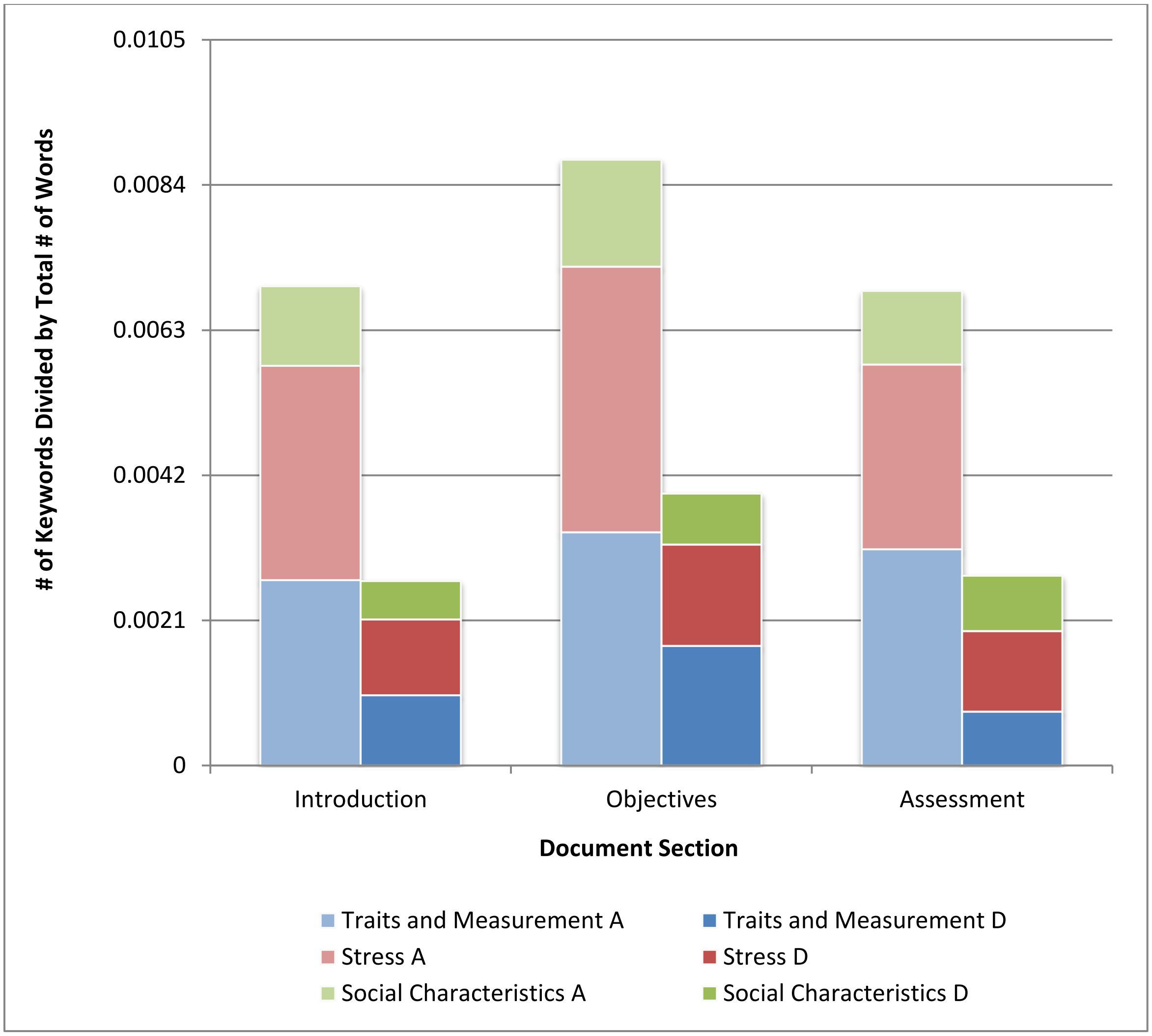

Figure 4. *Ratio of occurrences of keywords across all projects by document section, keyword category, and keyword quality designation*

This figure shows that the disparity between the numbers of "aware" versus "deep" occurrences persists across each document section. It also shows that the ratios of keyword categories are relatively consistent between the "aware" bars and the "deep" bars. The next section will break down these results by organization, providing a method of comparison across the three different organizations used for this analysis.

4.2 Comparisons Between Organizations

Figure 5 below illustrates the ratio of "aware" and "deep" occurrences for all of the project documents from the different organizations. The difference in number of documents and document length is again accounted for by dividing the number of keywords by the total number of words.

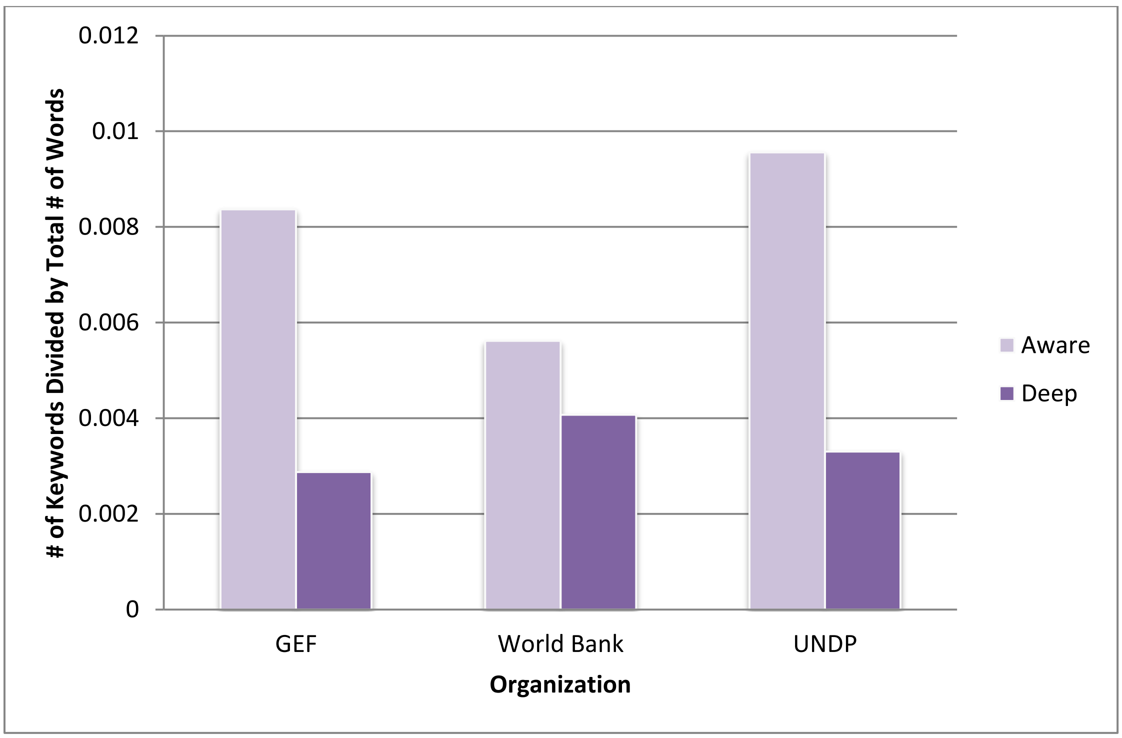

Figure 5. Ratio of occurrences of keywords across all projects by organization and keyword quality designation

All of the organizations show a more frequent occurrence of keywords at the "aware" level than at the "deep" level, as seen with the overall data. However, though the GEF and UNDP both have a greater overall ratio of keyword occurrences, they have far higher proportions of "aware" keywords to "deep" keywords than the World Bank. Figure 6, below, shows the ratio of keyword occurrences of each organization divided by keyword category.

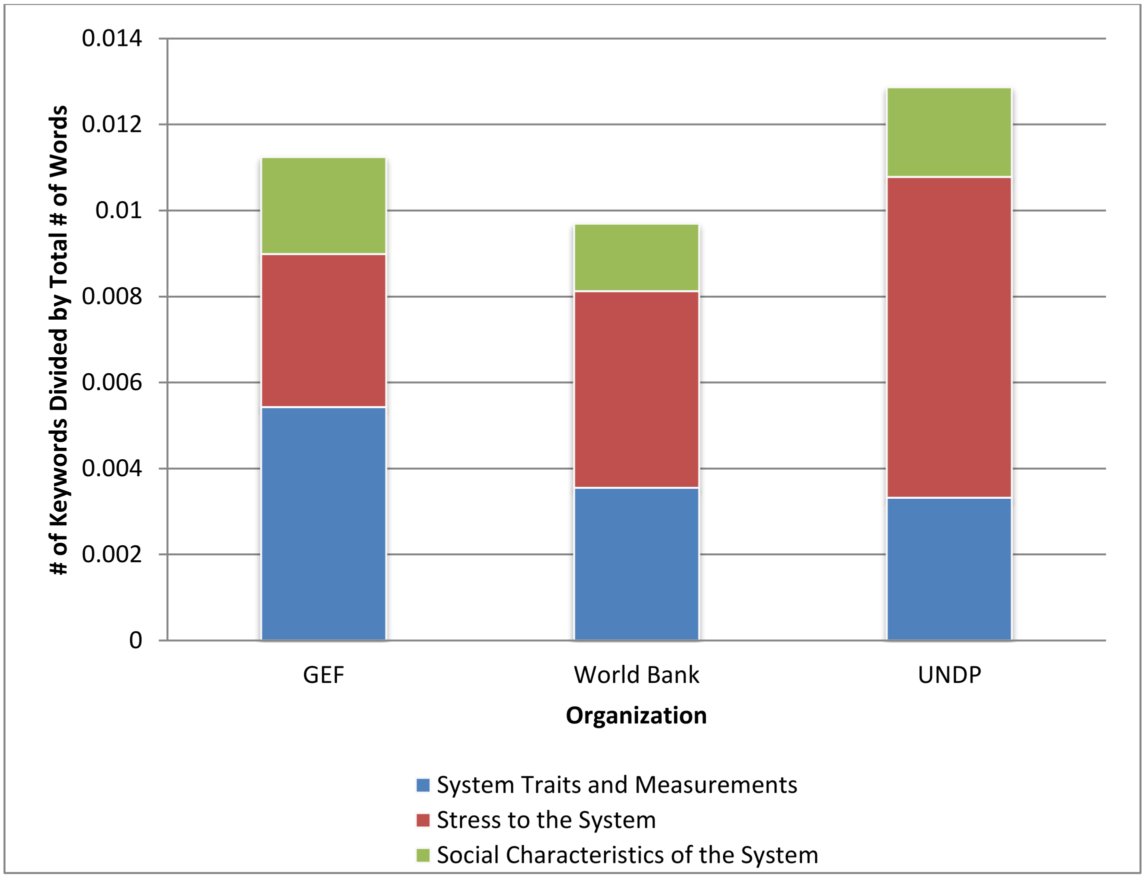

Figure 6. Ratio of occurrences of keywords across all projects by organization and keyword category

The combined data from all organizations showed that keywords in the "Social Characteristics of the System" category were least represented. This figure shows that this is true for all three of the organizations used in the analysis. GEF has the highest occurrences of "System Traits and Measurements" keywords, while the World Bank and GEF have the highest occurrences of "Stress to the System" keywords. Figure 7, below, combines the keyword categories and shows the differences in occurrences between document sections.

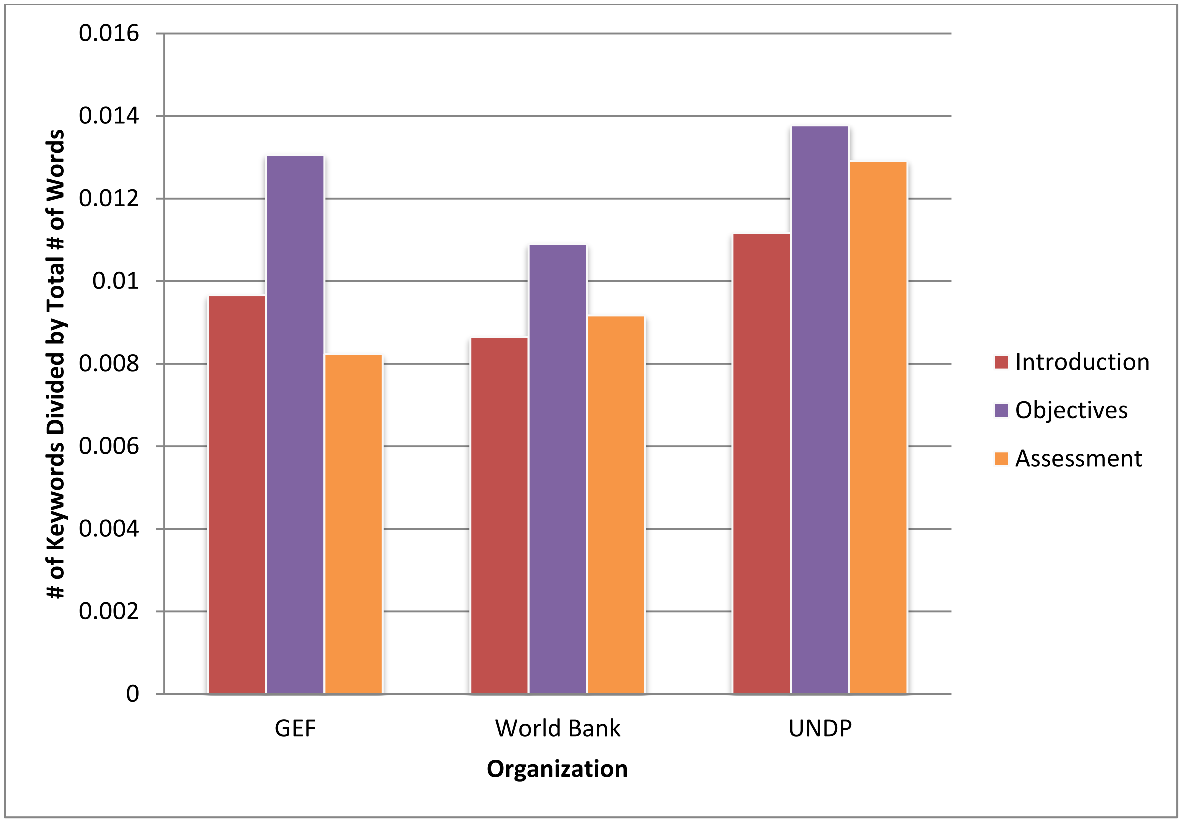

Figure 7. Ratio of occurrences of keywords by organization and document section

The combined data for all organizations showed the highest ratio of occurrences of keywords in the objectives section. This is also true for each of three of the organizations individually. However, there are some distinctions in the comparisons between the introduction and assessment sections. The World Bank results are similar to the overall results, showing very similar ratio of occurrences in the introduction and assessment. The UNDP shows a more favorable ratio, with higher occurrences in the more relevant assessment section. The GEF, on the other hand, shows the opposite ratio, suggesting a need to focus more on making sure the relevant resilience theory is reflected throughout the entire document. Figure 8 further divides the data shown in Figure 7 by splitting the document sections into “aware” and “deep” designations. “Aware” designations are represented by the lighter colored bars and an “A” in the legend, while “deep” designations are darker colors and have a “D” in the legend.

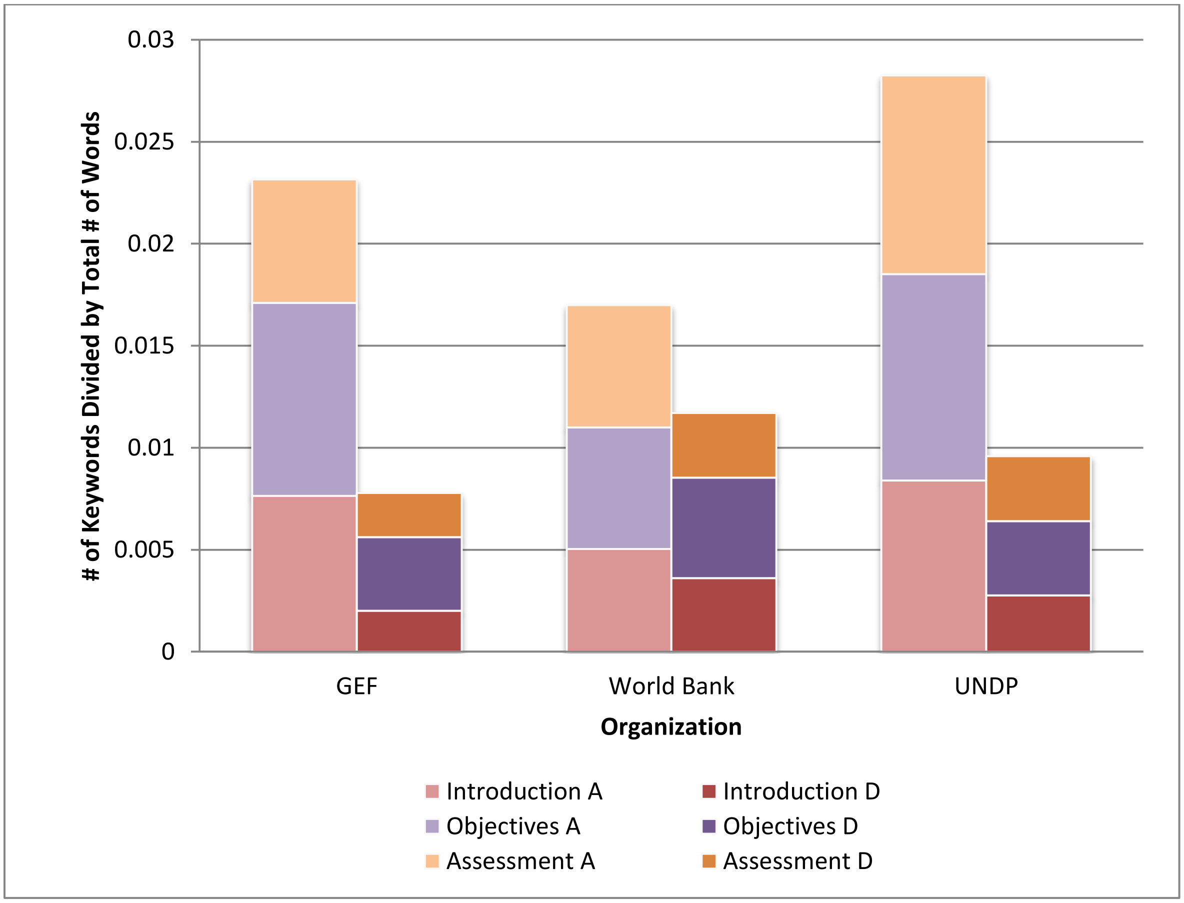

Figure 8. Ratio of occurrences of keywords across all projects by organization, document section, and keyword quality designation ("A" for "aware," "D" for "deep")

This figure shows that while UNDP has a fairly even ratio of “deep” occurrences among the sections, GEF and World Bank both have relatively fewer “deep” occurrences in the assessment section.

4.3 Discussion

4.3.1 Keyword Quality Designation

The first trend that stands out from analyzing the combined organizational data is the large difference between the "aware" level occurrences and the "deep" level keywords. This trend is mirrored in the data comparing the organizations, although the World Bank is doing far better in this regard than GEF and UNDP. While "aware" occurrences are important in that they show that the organizations are thinking about these keywords and beginning to include them in their projects, the "deep" occurrences were interpreted to indicate a more thorough understanding of the keywords and stronger efforts to address these concepts in the project. This disparity shows one of the key areas where organizations can work to improve their resilience-building efforts.

The results across document sections also imply that project designs have room for improvement. The overall data show that the objectives section had the most keyword occurrences. However, these occurrences do not carry over to the assessment section at the same rate. While it is promising that organizations are including resilience concepts in their project objectives, this is unlikely to be effective if there is no clear method for assessing the success of these resilience objectives. Without balancing the occurrences in the objectives section with occurrences in the assessment section, the project will be unable to quantify any increases in system resilience that it is able to achieve. The UNDP was most effective in this area, as Figure 7 shows that assessment section occurrences were nearly as high as objectives section occurrences.

The overall results also showed a similar ratio of “aware” to “deep” occurrences between the sections. As the introduction contains the least important material for building resilience, this section can have lower keyword occurrences, and more “aware” level occurrences would be expected. While fewer “deep” occurrences in the introduction is not as important, the ratio of “deep” to “aware” occurrences should ideally be higher for the objectives and assessment sections. A deeper understanding of the concepts is vital to ensuring that the project objectives will actually succeed in increasing system resilience and in ensuring an effective assessment method.

4.3.2 Keyword Categories

The data show that keywords from the “Social Characteristics of the System” category were underrepresented compared with the “System Traits and Measurements” and “Stress to the System” categories. While there is no right ratio that organizations should be aiming for, a relatively even mix across the categories would suggest a robust understanding of the resilience theory literature. Each of these keyword categories is important to achieving overall system resilience, so a lopsided focus will be less likely to achieve the desired results. A heavy focus on ecological resiliency could be at the expense of the humans living in the system, for example. The larger proportions of the “System Traits and Measurement” and “Stress to the System” categories could be due to the very high number of occurrences of a few of the words in the higher categories—resilience, diversity, vulnerability, and adaptive all occurred far more often than the majority of the keywords, and were in these two categories. The only high-occurring keyword in the “social” category was livelihood, and even these numbers were low compared with the other four. Regardless, a well-rounded understanding of resilience is something that organizations can continue to work towards in future projects.

One reason to have a fairly even mix of keywords from the different sections is that these sections correspond to different activities with different outcomes. For example, "System Traits and Measurements" could be addressed by creating a set of indicators to measure the resilience of the system. For example, the project might assess the number of crop varieties planted on the basis that planting multiple crop varieties would achieve a more heterogeneous system with built-in redundancies. Organizations could address "Stress to the System" by promoting local cultivars that are less vulnerable to shocks, enabling farmers to better adapt and cope. An activity in the "Social Characteristics of the System" section could be increasing market access for smallholder farmers, enabling greater incomes and improved livelihoods. All three types of activities are needed to truly increase the resilience of the system. Having multiple varieties of crops is not helpful to farmers if all of the varieties are highly susceptible to drought, for example. More resilient cultivars will not be adopted if there is no market available for farmers to sell these varieties. Including a mix of keywords and activities from each category helps to promote total system resilience.

In addition to the uneven occurrence of keyword categories, issues emerge looking at the occurrence of individual keywords. While not every keyword has to appear in every project for the project to successfully promote resilience, there are some general trends across the projects that show gaps in understanding. The biggest example of this is the keyword "self-organize," which does not show up at all in any of the 55 projects. As outlined in the literature review, the ability of a system to self-organize is one of three key components of resilient social-ecological systems. While organizations could be indirectly addressing this concept through building networks and promoting fair, transparent governance structures, the fact that not a single project addresses this directly is a sign that organizations need to consider how to more effectively operationalize this aspect of the resilience theory literature.

"Indicator" is another keyword that could be utilized more effectively. While "indicator" appears fairly often, and is used as a measurement of relevant concepts (diversity, for example), the projects as a whole have not incorporated indicators of resilience itself. While measuring aspects of resilience, like diversity and network building, is important and effective, a project that aims to increase system resilience would be more effective if it included an indicator set for measuring resilience itself. Without a method of assessing overall system resilience, it will be difficult for organizations to measure progress in increasing that resilience. Including a set of indicators specifically for resilience is a key next step for these organizations to better build resilient social-ecological systems.

4.3.3 Differences in Organizational Evaluations

A 2011 evaluation report by the GEF Independent Evaluation Office (IEO) found that while resilience concepts were being increasingly integrated into projects, several challenges limited "mainstreaming" of resilience (Romboli, Talafré, & Nielsen, 2011). The report references a lack of clear systems for operationalizing resilience concepts, as well as a lack of sufficient incentives to incorporate resilience. The report also points out a certain level of silo-ing between the different funds managed by the GEF, limiting the possibility for effective collaborative co-financing. In the report, the IEO recommended providing clear incentives for integrating resilience into projects across all of the GEF focal areas. Potential incentives include clear tools for operationalizing resilience concepts, as well as a screening process at the project approval stage that emphasizes the importance of resilience (Romboli et al., 2011).

The GEF Independent Evaluation Office has a strong focus on the monitoring and evaluation of projects. Despite having this focus, the GEF analysis showed the lowest keyword occurrence ratio of assessment section to the other sections. This could be because the IEO has not combined their efforts to enhance integration of resilience concepts with their efforts to improve monitoring and evaluation. It could also be the case that GEF has not undertaken all of the recommendations that the IEO has provided regarding the importance of quality monitoring and evaluation.

A 2014 report from the World Bank Independent Evaluation Group found that in projects funded by the World Bank's Climate Investment Funds, projects have struggled to incorporate sufficient stakeholder engagement to be able to develop strong, effective networks (ICF International, 2014). In addition, although resilience concepts were regularly referenced, the report found that these concepts did not always continue through the project implementation. Projects were also not as effective as helping vulnerable groups as the World Bank would hope. The report states, "...early designs for climate information services and water management and agriculture resilience projects did not assure that the needs of vulnerable communities and households would be met" (ICF International, 2014). The projects have been insufficient in supporting local participation and learning, instead relying too heavily on improving infrastructure. This focus on infrastructure and the physical aspects of the system could be one reason behind the lesser occurrences of the keywords in the "Social Characteristics of the System" category.

The report also analyzed the Pilot Program for Climate Resilience (PPCR), one of the programs funded through the Climate Investment Funds. The goal of this pilot program is to fully integrate resilience concepts into development projects. The authors describe the PPCR as perhaps “the most problematic of the CIF efforts, mainly because we have limited experience in measuring progress in increasing resilience, let alone in achieving that progress” (ICF International, 2014). This assertion supports this thesis’s finding that resilience concepts are insufficiently addressed in the assessment section of project proposals, as well as the finding that resilience is not being effectively measured or assessed. Creating and using a set of indicators is one way that these projects could begin to measure the resilience of the targeted systems, as well as the progress they make in improving resilience.

One recommendation from the report was that the Bank recognize that when attempting to implement a transformational system change, it may take a long time for benefits to become apparent (ICF International, 2014). In order to create a more resilient system, transformational change is sometimes required. If the focus on near-term benefits is too strong, there may be few incentives to invest in more effective but longer projects. The report also recommends capacity building at the national level for more effective evaluation of resilience-building progress. This is necessary as there is no evaluation system in place for the Climate Investment Funds beyond the 2014 report, leaving minimal opportunities for learning and improving resilience projects. The report found an overall lack of focus on learning, even in the pilot programs that are supposed to be designed for learning. It recommends greater focus on information sharing and promoting lessons learned.

While the UNDP's Independent Evaluation Office (IEO) has performed many evaluations of individual projects, as well as certain thematic areas, no evaluation was found that assessed UNDP's overall effectiveness in addressing climate resilience. Despite this, UNDP does well with overall number of occurrences as well as occurrences in the assessment section, suggesting that UNDP is incorporating resilience theory concepts throughout the projects. This could be an effect of an organizational culture that is more focused on full integration of resilience, differences in funding, or different priorities from individuals within the organizations. Further research could investigate the potential causes behind the differences between the three organizations.

Chapter 5: Policy Recommendations

The idea of system resilience has been increasingly incorporated in projects by international development groups. Resilience is seen by these groups as a desirable trait that various systems should strive for, particularly in the face of climate change. Agroecosystems are at a particular risk from climate change and are essential for maintaining global food security. The increases in climate variability and extreme events that will occur under climate change threaten smallholder food production, and by extension the lives of those who depend on that food. Increasing the resilience of these agricultural systems to climate change and extreme weather events is seen as a key way to mitigate the negative effects and ensure the systems will continue to be able to produce enough food.

However, the research presented here suggests that although international development groups claim to be striving for resilience, the projects they undertake often fall short of what the resilience theory literature would recommend. Resilience theory is broad, complex, and admittedly difficult to operationalize from a development standpoint. Despite the inherent challenges, fully understanding and incorporating key aspects of the resilience theory literature is essential if these groups are to succeed in increasing the resilience of the targeted systems. This section provides policy recommendations that would help to improve the full incorporation of the resilience theory literature in international development projects.

5.1 Create a Set of Indicators to Assess System Resilience

The project analysis showed that projects tended to mention the keywords less often in the section describing project assessment than in the introduction and objectives sections. Including mentions of the keywords in these first two sections is promising, as it shows that these groups have an understanding of the importance of the various aspects of resilience theory. However, having a resilience-focused objective is not as effective if there is no clear system in place to measure its success. Without this element, it will be impossible for groups to assess the effectiveness of the actions undertaken with the goal of increasing resilience.

One method to address this is to use a set of indicators, which are one of the primary methods found in the resilience theory literature of assessing a system's resilience. Groups could use a set of indicators from the literature that suits their needs, like the one created by Cabell and Oelofse (2012) for an agroecosystem. Alternately, and perhaps even more effective, these groups could create their own sets of indicators to suit the needs of different situations. These indicator sets should be created with input from the resilience theory literature and resilience theory experts, and could be tailored to suit the different circumstances surrounding each system and project. Engle et al.'s (2014) suggestions for creating indicators that cover various spatial and temporal scales, as well as their hybrid framework of qualitative and quantitative assessment, would be excellent systems for development groups to adopt. Bahadur et al.'s (2013) method of using resilience characteristics to assess a system's resilience would also be effective. These methods would provide international development groups with a clear, effective way of assessing the resilience of the targeted systems both before and after completion of the project. Having a point of comparison would allow groups to see which of their projects' actions were most or least effective, and which aspects of resilience are most improved versus those that seem to have been overlooked.

Additionally, the results showed consistent use of many of the chosen keywords, others were noticeably absent from most or all of the projects. While the absence of a particular keyword doesn't necessarily indicate an incomplete understanding of resilience, as the organization may be using a different synonym or focusing on other aspects within the same category of keyword, in some cases it may be cause for more concern. One key example of this is the lack of instances of they keyword "self-organize" in the projects. Altieri et al. (2015), Folke (2006), Quinlan et al. (2015), and Cabell and Oelofse (2012) all include references to the ability of a system to self-organize in their core definitions of resilience.

Incorporating a set of indicators would enable development groups to identify the key aspects of resilience that are specific to the systems they are targeting. Having this understanding would allow international development groups to prioritize their objectives in line with the literature, making their projects more inclusive of the wide body of literature and more effective in increasing resilience overall. A concrete list of system traits, like the kind included in a set of indicators, will help groups to ensure that all of the important aspects of resilience are covered by their projects.

5.2 Incorporate Resilience Training Sessions at Development Organizations

In addition to incorporating resilience indicators into their projects, development groups could ensure better inclusion of resilience concepts by having resilience trainings. The

Stockholm Resilience Centre currently performs these kind of training sessions through their "Guidance for Resilience in the Anthropocene: Investments for Development" (GRAID) program ("GRAID" 2017). GRAID, funded by the Swedish International Development Cooperation Agency (SIDA), focuses on removing barriers to operationalizing resilience theory for development applications. This particular program focuses on projects in the Sahel, Horn of Africa, South Asia, and Southeast Asia, but could be expanded or applied to other global locations.

Currently, GRAID works as a "strategic knowledge partner" for three development organizations: The Rockefeller Foundation; the U.S. Agency for International Development (USAID); and the Swedish International Development Cooperation Agency (SIDA). These three organizations have formed a Global Resilience Partnership (GRP), focused on better incorporating resilience into development projects. GRAID has three main goals: providing support and building capacity for GRP; developing clear, operational methods for mainstreaming resilience in development projects; and using experiences from GRP's projects on the ground to create a resilience framework ("GRAID" 2017). GRAID works with GRP to accomplish these goals in part by providing resilience trainings to help these organizations effectively incorporate resilience theory. These kinds of resilience trainings could be vastly beneficial for other international development organizations as well, including the three included in this analysis.

5.3 Conclusions

With agroecosystems so at risk under changing climate conditions, international development groups are increasingly seeing resilience as a way to protect these essential systems from the worst effects of global climate change. While recognizing the value of system resilience is an important first step, these goals cannot be realized without a full understanding and incorporation of the resilience theory literature in development projects. This thesis has illustrated the areas where current projects are falling short in operationalizing the resilience theory literature. By implementing these policy recommendations, groups will be able to move towards a more complete use of resilience theory in their projects, thereby enabling them to more effectively enhance the resilience of these valuable systems.

Appendix A: Organizational Level Data

Table 1. Keyword Occurrences for 20 GEF Projects

	Title	Introduction		Objectives		Assessment	
Keyword	#	#aware	#deep	#aware	#deep	#aware	#deep
Resilience	8	149	14	374	197	66	18
Indicator	0	18	0	124	26	120	36
Diversity	3	503	154	652	280	69	22
Redundant	0	0	0	3	0	0	0
Heterogeneous	0	0	2	1	0	0	0
Interdependent	0	0	0	0	0	0	0
Vulnerability	2	146	29	373	86	14	8
Disturbance	0	3	2	0	0	0	0
Shock	0	4	0	4	2	0	0
Recovery	0	9	0	12	2	2	0
Coping	0	0	2	1	5	0	0
Adaptive	3	204	57	525	218	75	29
Transformative	0	14	10	9	5	0	1
Learning	0	6	4	53	24	9	6
Network	0	14	10	35	27	27	13
Legacy	0	1	0	1	0	0	0
Profit	0	8	2	12	3	3	1
Income	0	105	19	118	22	21	6
Livelihood	2	134	41	294	92	44	21
Self-Organize	0	0	0	0	0	0	0

Table 2. Keyword Occurrences for 23 World Bank Projects

	Title	Introduction		Objectives		Assessment	
Keyword	#	#aware	#deep	#aware	#deep	#aware	#deep
Resilience	6	160	34	72	254	70	19
Indicator	0	10	1	107	13	72	10
Diversity	1	6	97	116	7	16	8
Redundant	0	0	0	0	0	0	0
Heterogeneous	0	0	0	0	0	0	0
Interdependent	0	0	2	1	0	0	0
Vulnerability	0	141	12	70	4	46	6
Disturbance	0	1	0	0	0	0	0
Shock	0	23	22	9	25	3	3
Recovery	2	15	21	21	17	14	8
Coping	0	1	5	12	5	5	0
Adaptive	6	188	112	238	154	110	71
Transformative	0	7	5	4	2	0	0
Learning	0	8	1	69	7	17	11
Network	0	3	1	4	15	4	4
Legacy	0	0	0	0	0	0	0
Profit	0	1	2	1	2	1	8
Income	0	9	41	12	46	3	12
Livelihood	1	5	58	22	75	2	32
Self-Organize	0	0	0	0	0	0	0

Table 3. Keyword Occurrences for 12 UNDP Projects

	Title	Introduction		Objectives		Assessment	
Keyword	#	#aware	#deep	#aware	#deep	#aware	#deep
Resilience	5	85	47	244	104	55	15
Indicator	0	4	0	34	1	65	3
Diversity	0	10	6	37	23	12	4
Redundant	0	0	1	0	1	0	0
Heterogeneous	0	0	0	0	0	0	0
Interdependent	0	1	1	0	0	0	1
Vulnerability	2	158	47	165	59	47	18
Disturbance	0	0	0	1	0	1	0
Shock	0	8	3	5	3	0	0
Recovery	2	26	11	159	41	62	18
Coping	0	3	6	4	0	0	0
Adaptive	1	139	40	398	137	86	41
Transformative	0	5	2	1	1	0	0
Learning	0	13	3	22	14	14	9
Network	0	3	2	35	24	11	8
Legacy	0	1	0	0	0	0	0
Profit	0	0	0	3	0	0	0
Income	0	12	2	29	8	5	3
Livelihood	0	84	11	99	28	25	5
Self-Organize	0	0	0	0	0	0	0

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