LOCAL HAZARDS KNOWLEDGE AND RISK PERCEPTIONS OF STAKEHOLDERS IN SOUTHERN ILLINOIS WATERSHED PARTNERSHIPS

BY

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DISSERTATION

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ABSTRACT

During the past three decades, thousands of watershed groups or partnerships have emerged in the United States as federal and state agencies have fostered collaborative and participatory approaches to include local stakeholders in managing their watersheds. Many of these partnerships have failed to achieve their environmental potential due to lack of funds, poor management decisions, and ineffective leadership. However, ineffective management has also been tied to the limited capacity of local stakeholders to design holistic management schemes that address the multiplicity and complexity of watershed hazards and their effects and the interrelationships between health, social, and ecological uncertainties of watersheds. Looking into the roles of local hazards knowledge and risk perception can help understand how these two parameters influence collaborative watershed management and can provide watershed managers with insights on designing holistic management schemes that can address the complexities and health, social, and ecological uncertainties of watersheds. This study examined the relationship between local hazards knowledge and risk perception within the context of four Southern Illinois watersheds: the Cache, Kinkaid, Lower Ohio Bay, and Saline. A mixed methods approach—using secondary data analysis to assess watersheds' biophysical and socioeconomic vulnerability, semi-structured interviews, concept mapping, and surveys—was adopted to examine the relationship between: (a) the complexity of stakeholders' local hazards knowledge and integration of health, social, and ecological risk perceptions; and (b) stakeholders' awareness of the prevalence of and their levels of concerns about watershed hazards and their effects. Results of concept mapping of semi-structured interviews showed within and across watershed variations in the complexity of stakeholders' knowledge, both in terms of the nature and level of connections between multiple watershed hazards and their effects on ecological and human wellbeing. While participants predominantly articulated unidirectional relationships between direct effects of direct forces of change on ecosystem services and to a lesser extent on human wellbeing, fewer participants articulated bidirectional relationships between direct forces of environmental changes and ecosystem services. The local context seemed to play a significant role in molding the complexity of stakeholders' local knowledge. Participants of the Cache attained the highest complexity scores compared to those of the Saline, Kinkaid, and Lower-Ohio Bay. It is suggested that knowledge of the historical progression of environmental problems by the Cache participants might have led to elevated complexity compared their counterparts in the other three studied watersheds who did not discuss how environmental problems evolved and progressed in their watersheds. Finally, analysis of concept mapping showed that stakeholders' complexity of local hazards knowledge, organizational affiliation, tenure, and role in partnership were not strong indicators of the integration of health, social, and ecological concerns. On another note, survey results also showed within and across watershed variation in level of stakeholders' awareness of the prevalence of, and concerns about six watershed hazards (acid runoff, agricultural runoff, deforestation, erosion, flooding, and poor river drainage) and their effects on ecological and human wellbeing. The local context influenced local knowledge and risk perception. For instance, stakeholders of the Lower-Ohio Bay—a watershed technically assessed as having both low biophysical and socioeconomic vulnerability—had the lowest level of concerns as compared to their counterparts in the Cache—a watershed technically assessed as having both high biophysical and socioeconomic vulnerability—who had the highest levels of concerns. Despite variations in local hazards knowledge across watersheds, such variations were not congruent to results of the technical assessment of the four studied watersheds. For instance, despite the Cache being assessed as having both high biophysical and socioeconomic vulnerability, its participants held awareness of lower prevalence of watershed problems compared to stakeholders of the Saline watershed—technically assessed as having low biophysical and high socioeconomic vulnerability—who held awareness of a higher prevalence of watershed hazards and their effects. Finally, survey results showed that the relationship between local knowledge and risk perception is contextual, as awareness of the prevalence of hazards and their effects did not influence risk perceptions in all studied watersheds. For instance, in the Kinkaid watershed years of involvement in partnership rather than local knowledge was found to influence risk perception. The results of this study highlight the need to build the capacity of stakeholders to consider the complexity and multidimensional uncertainties of watersheds and to integrate both local and scientific knowledge while devising holistic watershed management schemes. Findings also reveal the need to understand factors underlying variations in local knowledge and risk perception across watersheds if considering collaborative management across several watersheds.

To

My husband Fouad and son Kareem Abd-El-Khalick

You are my inspiration and motivation.

I also dedicate this dissertation to my parents

Nada and Samir BouFajreldin

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Watersheds are complex dynamic social-ecological landscapes characterized with high degrees of uncertainty (Holling & Gunderson, 2002; Healey, 2001; McGinnis, 1999). In any given watershed, people regularly interact with each other and with their surrounding biophysical environment (Scheffer et al., 2002). Such interactions induce changes in watersheds that may vary across temporal and spatial scales (Westley et al., 2002). In other words, changes can be long or short-term and can be tied to a specific place or can spread across a watershed. Watershed changes often have the potential to exert effects on ecological and human wellbeing (Scheffer et al., 2002), and can therefore lead to health, social, and ecological uncertainties.

Failure to govern socio-ecological landscapes through conventional 'top-down' approaches has been ascribed to two main factors. First, conventional management typically depends on legal and technical approaches that only target specified environmental problems originating from known and identified sources. As such, these approaches often lack the procedural capacity to readily deal with the complexities and uncertainties of watersheds and environmental problems originating from unidentified sources and going beyond geographical and jurisdictional boundaries, such as non-point sources of pollution (Cortner & Moote, 1999; Hardy &Koontz, 2008; Moore & Koontz, 2003; Sabatier et al., 2005; Tarlock, 2000). Second, conventional approaches often lack political support and legitimacy among local watershed communities who may be skeptical about the role of science and technology in addressing environmental hazards and risks (Irwin et al., 1999; Sjöberg, 1999; 2001).

Deficiencies of conventional approaches in tackling the complexities and uncertainties of watersheds prompted federal and state agencies to make policy changes that foster collaborative approaches to watershed management (Hardy, 2010; Hardy & Koontz, 2008; Koehler & Koontz, 2008; Sabatier et al., 2005; Tarlock, 2000). In 1987, the federal government made amendments to the 1972 Clean Water Act to approve allocation of funds in support of community-based watershed management projects, in order to address non-point sources of pollution and complex environment problems (Hardy & Koontz, 2008; USEPA, 1996, 2002). Such policy changes resulted in the proliferation of thousands of watershed partnerships throughout the nation to manage water resources and improve water quality (Bonnell & Koontz, 2007; Sabatier et al., 2005).

The growing interest of federal and state agencies in collaborative watershed management is primarily attributed to the holistic, contextual, and integrative orientations of this form of governance. Considering 'watershed' as the unit of action, collaborative watershed management promotes management of both water resources and surrounding land in order to tackle local, multiple, and complex watershed hazards going beyond geographical and jurisdictional boundaries (Hardy, 2010; Hardy & Koontz, 2008; Michaels, 2001). In order to achieve the desired objectives, collaborative watershed management seeks through public-private partnerships to integrate the perspectives of both governmental and non-governmental stakeholders to effectively conserve watersheds and to promote both ecological and human wellbeing (Bidwell & Ryan, 2006; Conley & Moote, 2003; Corburn, 2003;Koehler & Koontz, 2008; Leach et al., 2002; Lubell, 2004; Margerum & Withall, 2004; Michaels, 2001; Ostrom, 1990; Rhodes, et al., 1999; Sabatier et al., 2005; Tarlock, 2000; Trachtenberg & Focht, 2005). Policy changes made by federal and state agencies have been a driving force of paradigmatic shifts in watershed management. These changes involved moving from conventional centralized approaches that are heavily ingrained into technical assessments of and legal solutions to specified watersheds hazards to decentralized participatory approaches that build on diverse stakeholder perspectives and concerns about watershed hazards.

Collaborative watershed management is particularly valued in rural watersheds where government institutions typically have limited capacities to deal with the complexities and uncertainties of watershed issues (Imperial & Hennessey, 2000). Collaboration between government agencies and local stakeholders is thought to enhance rural watershed governance by boosting financial, human, and technical resources, and by empowering local stakeholders to have a stake in identifying and solving watershed problems (Imperial & Hennessey, 2000; Wondolleck & Yaffee, 2000). However, despite consensus over the advantages of collaborative management, research shows that not all collaborative endeavors are successful in maintaining their sustainability and achieving their environmental potential, primarily due to inadequate funding, ineffective leadership, and poor designs of decision-making processes (Leach & Pelkey, 2001). While some barriers to success are known, the roots of the problem have not been fully explored. Ineffective management may also be associated with the limited capacity of governmental and non-governmental stakeholders to design holistic management and implementation schemes that account for the complexities and uncertainties of watersheds (Margerum & Hooper, 2001). In other words, given the complexity and uncertainty of watersheds as socio-ecological systems, delegation of management responsibilities to local stakeholders might not necessarily yield positive outcomes unless stakeholders acquire and retain a sophisticated holistic understanding of complexities and uncertainties of such systems. Moreover, watershed partnerships' capacity to achieve their environmental potential can be also limited by stakeholders' competing interpretations of and concerns about hazards in the surrounding environment (Lupton, 1999).

Delving to into the role of local knowledge and risk perception of watershed hazards provides a basis for investigating how these two constructs affect collaborative watershed management and the resiliency of watershed partnerships in the face of watershed risks and disasters. Current orientations in risk perception research do not account for paradigmatic shifts in watershed management and do not fully support the development of holistic hazards and risk management schemes catering to the complexities and uncertainties of socio-ecological landscapes, such as watersheds. According to Cutter (2003) and Renn (1998), most risk perception studies have primarily dealt with decontextualized and isolated risks. Moreover, many risk perception studies have resulted in vague or limited assessments of risk perception. As such, these studies do not properly inform watershed managers about strategies for devising holistic hazards and risk management schemes that account for the multiplicity of hazards and the interrelationships between hazards and health, social, and ecological risk perceptions. Therefore, exploring the relationship between local hazards knowledge and risk perception may reveal frameworks by which stakeholders view complex and uncertain socio-ecological systems, such as watersheds. Looking into the role of local knowledge and risk perception can aid in designing effective interventions to encourage stakeholders to think holistically about their watersheds in order to enhance the efficacy of their collaborative endeavors.

The overarching objective of this study was to explore the relationship between local hazards knowledge and risk perception of stakeholders of four watershed partnerships in four Southern Illinois watersheds: the Cache, Saline, Lower-Ohio Bay, and Kinkaid watersheds. Southern Illinois was selected as a research context in light of the region's rural nature, diverse topography, ecological systems, commercial and industrial activities, and adverse environmental and socioeconomic conditions compared to the rest of the State of Illinois.

Watershed partnership stakeholders often hold varied conceptual and perceptual representations of the interrelationships of multiple watershed hazards and their effects on ecological and human wellbeing, as well as varied perspectives and concerns about the prevalence of watershed hazards and their effects. Therefore, exploring the relationship between local hazards knowledge and risk perception was organized around two dimensions. The first dimension involved understanding the relationship between the complexity of local hazards knowledge and the nature of risk perception held by stakeholders belonging to a watershed partnership. The second dimension involved examining the relationship between stakeholders' awareness of the prevalence of multiple watershed hazards, and their nature and level of concern regarding these hazards. A mixed methods approach was adopted to examine the two abovementioned dimensions. Mixed methods served an *expansion* purpose, i.e. to "extend the breadth and range of inquiry by using different methods for different inquiry components" (Greene, Caracelli, & Graham, 1989, p. 259). In other words, expansion using both quantitative and qualitative methods allowed for exploring different aspects of the relationship between local hazards knowledge and risk perception and come up with relevant implications for collaborative watershed management.

In addition to expansion, mixed methods also served a 'development' purpose. Development refers to "the use of results from one method to help develop or inform the other method, where development is broadly construed to include sampling and implementation, as well as measurement decisions" (Greene et al., 1989, p.259). Development was evident in all three phases comprising this study. Phase I was designed to delineate the watershed risk context by assessing the biophysical and socioeconomic vulnerabilities of the four selected Southern Illinois watersheds. Secondary data on water quality and flooding were used to assess biophysical vulnerability of the four selected watersheds. Also, county level socioeconomic vulnerability indices were used to assess the watersheds' socioeconomic vulnerability. Phase II of this study adopted both qualitative and quantitative methods to understand the nature of stakeholders' local hazards knowledge and risk perception, and their relationship concern. Using a conceptual approach, this phase sought to determine whether stakeholders with complex local hazards knowledge held integrated perceptions of risk. Semi-structured interviews were used to elicit stakeholders' perspectives on major watershed problems and their effects on ecosystem services and human wellbeing, and their concerns about water quality and watershed risks. Interview transcripts were transformed via a text extraction technique to mental modeling in accordance to the Millennium Ecosystem Framework. Generated concept maps were quantitatively scored to assess the complexity of stakeholders' local hazards knowledge. Phase III was based on the results of the prior two phases. Results of thematic analysis of Phase II were used to develop a cross-sectional survey. This quantitative assessment examined a conceptual framework delineating the relationship between the watershed risk context, stakeholders' awareness of the prevalence of multiple watershed hazards and their effects on ecological and human wellbeing, and risk perception (level of concern). Local hazards knowledge and risk perception composite scores were computed in order to examine the relationship of variables of the conceptual framework.

It is significant to note that there is considerable tension between generality and specificity in regards to comparative research of this nature. In this study, both local knowledge and risk perception are context specific and their relationship is expected to be influenced by the local context. Hence, generalizing the nature of and the relationship of these two parameters to watersheds beyond this study is indeed a challenging task (Greenwood & Levin, 2000).

The three phases of this study are further described in details in the chapters to follow. Chapter 2 presents a literature review on risk perception research related to the varied approaches to studying the relationship between knowledge and risk perception and highlights the need to expand risk perceptions to scaffold paradigmatic shifts in watershed management. This chapter concludes with a proposed conceptual framework designed to assess the relationship between knowledge and risk perception. Chapter 3 provides a description of the environmental and socioeconomic conditions of the four studied watersheds in the Southern Illinois region. It also describes the four partnerships that participated in this study. Chapter 4 presents the results of the examination of the relationship between the complexity of stakeholders' local hazards knowledge and risk perception. Chapter 5 presents the results of the quantitative assessment of the proposed conceptual framework. Finally, Chapter 6 concludes the study by collectively examining the results generated by Chapters 4 and 5 and includes both practical and theoretical implications for watershed management and policy. It highlights the need to build the capacity of watershed partnership stakeholders to holistically think about watershed hazards and their effects on both ecological and human wellbeing and their associated health, social, and ecological uncertainties. Moreover, Chapter 6 concludes with recommendations for future research on relationship between local hazards knowledge and risk perception and the effects of these two parameters on the efficacy of collaborative watershed management.

CHAPTER 2

LITERATURE REVIEW

Introduction

This chapter presents a critical review of the literature on local knowledge and risk perception research and calls for the need for expanding risk perception studies to inform the development of holistic and integrated hazards and risk management schemes, such as collaborative watershed management, which contextualize and account for interrelationships between multiple hazards. The chapter starts with an overview on the role of local knowledge and risk perception in collaborative natural resources management. Then, it presents a critical review of studies on the relationship between knowledge and risk perception. Finally, the chapter concludes with a discussion on the conceptual framework developed in this study to understand the relationship between local knowledge and risk perception.

Local Knowledge and Risk Perception: Central Elements of Collaborative Watershed Management

Before embarking on discussing the elemental roles of local knowledge and risk perception in collaborative natural resources management, it is wise to first clarify the commonalities and differences and define the two terms in order to avoid any misinterpretation. Indeed, analysis of the literature revealed that local knowledge and risk perception do share common grounds in terms of their underlying characteristics. First, both constructs are contextual. Similar to risk perception (Fitchen et al., 1987; Flint & Luloff, 2005; 2007), local knowledge is related to and emanates from a local or a regional socio-cultural and biophysical context (Antweiler, 1998). Both local knowledge and risk perception are influenced by proximity to natural features (Brody, Highfield, & Alson, 2004), individual observations and experiences with the surrounding environment, and are transmitted by local social groups through social and cultural venues (Berkes, 1999; Blaike et al., 1997; Davidson-Hunt & O'Flahtery, 2007; Davis & Wagner, 2003; Kasperson et al., 2003; Olsson & Folke, 2001; Sjöberg, 1999, 2001). Also, local knowledge and risk perception are dynamic and adaptive as they adjust to changes in a particular socio-ecological environment (Antweiler, 1998; MacGregor et al., 2007; Mozumder et al., 2008). However, despite their commonalities, local knowledge and risk perception are suggested to have distinct connotations. Local knowledge entails an understanding and an awareness of the complexities and the health, social, and ecological uncertainties of socio-ecological systems. It involves an understanding of the status and the mechanisms by which local natural and human made events induce changes in local socio-ecological systems. On the other hand, risk perception refers to the subjective assessment of risks and health, social, and/or ecological concerns (Sjöberg, 2004) associated with changes in socio-ecological systems.

Paradigmatic shifts in collaborative watershed management have bolstered the role of local knowledge and risk perception in management processes in order to holistically address watershed hazards and their effects on ecological and human wellbeing (Berkes & Folke, 2002; Botterill & Mazur, 2004; Flint & Luloff, 2005; 2007; Renn, 1998). Integration of local knowledge and risk perception into management processes allow technical experts and watershed managers to develop deeper insights into local ecological, social, and political contexts and their interrelationships (Born & Genskow, 2000; Cortner & Moote, 1999; Hardy, 2010; Hardy &Koontz, 2008; Kenny 1999; Moore & Koontz, 2003; Sabatier, Weible, & Ficker, 2005; Tarlock, 2000). Recent studies highlighted the complementary roles of both local and scientific knowledge for developing a comprehensive overview of a system's dynamics and proposing appropriate management plans, in addition to enhancing the scientific literacy of non-experts in understanding system dynamics (e.g. Beall et al., 2011). Local knowledge is found to complement scientific knowledge in management processes when science fails to quantitatively project uncertainties of socio-ecological systems, particularly at the local level (Berkes, 2007; Garcia-Quijano, 2009). Moreover, local knowledge provides clearer insight into the social dimensions of natural resources and hazards, aiding science to more powerfully assess risks (Corburn, 2002). Hence, the holistic orientation of local knowledge helps in predicting disasters associated with local hazards and ecological disturbances (Berkes, 2007), knowing that "disasters occur at the interface of society, technology, and environment" (Oliver-Smith, 1996, p. 303).

On another note, incorporating risk perceptions of stakeholders into management processes is thought to effectively tackle the uncertainties of watersheds (Renn, 1998). Considering risk perception along with technical assessments in risk management is suggested to provide a thorough outlook of concerns necessary to prioritize local hazards and their effects (Renn, 1998), by overcoming limitations inherent to only adopting technical risk assessments (Burton et al., 1978; Hewitt, 1983; Renn, 1992). Technical risk assessments are typically based on technical or statistical data and are designed to develop cause-effect predictions of isolated risks (Renn, 1992). They are often used to prioritize hazards and set standards for mitigating effects of known and unknown risks (Renn, 1992; Renn 1998). They are simplistic and rarely factor in the interactions of humans with their surrounding environment (Berkes, 1999; Renn, 1992), and cannot handle complex environmental issues not exhibiting immediate and measurable effects (Renn, 1998). Moreover, technical assessments often overlook people's knowledge and perceptions of risk (Bohneblust & Slovic, 1998). The latter point has resulted in management schemes that over-rely on technological solutions and overlook the technical deficiencies of or incompatibilities among beneficiaries or stakeholders in the design of technological solutions (Blaike et al., 1997). Therefore, incorporating risk perception into risk management can provide risk managers the flexibility to more properly handle the complexities of local environmental issues, particularly those bounded with high degrees of uncertainty.

Integration of both local knowledge and risk perception into collaborative watershed management minimizes skepticism about and opposition towards technical assessment of risk. Such skepticism is often generated by people's mistrust in the ability of science and technology to deal with risks (Sjöberg, 1999; 2001) and by their perceptions regarding government recreancy, or the failure of governments to live up to expectations and obligations (Freudenberg, 1996). Accordingly, integration of both local knowledge and risk perception is thought to enhance the efficacy of management schemes by diminishing conflicts created by schisms in risk perceptions between the experts and the public and by competing knowledge associated with divergent interpretations of the surrounding world (Lupton, 1999). Moreover, thorough consideration of the local context provides a basis to make informed decisions for developing integrated and holistic management schemes that address the complexities and uncertainties of watersheds. These schemes are suggested to reduce vulnerability and boost resiliency of communities against potential disasters more effectively than only relying on technical risk assessments (Berkes, 2007; Folke et al. 2005; Haque & Etkins, 2007). In other words, management schemes built on varied stakeholder perspectives and concerns can empower and build the capacity of watershed partnership stakeholders and communities to prevent and mitigate watershed risks and disasters (Berkes & Folke, 2002; Berkes, Kartez, & Wenger, 1993;

Corburn, 2003; Duffield et al., 1998; Flint & Luloff, 2005, 2007; Renn, 1998; Scholz & Stiftel, 2005; Wenger, 1978; Wondolleck & Yaffee, 2000).

Approaches to Understanding the Relationship between Knowledge and Risk Perception

The centrality of local knowledge and risk perception in collaborative natural resource management directs attention to both parameters as root causes of effective collaborative endeavors. Understanding the nature of local knowledge and risk perception and their variation across stakeholders and local contexts by synthesizing literature on local knowledge and risk perception can provide insights into ways to enhance the efficacy of collaborative management within the context of complex and uncertain socio-ecological systems, such as watersheds.

Studies on the relationship between knowledge and risk perception are well established and documented in the risk perception literature. By hypothesizing knowledge to mediate the relationship between hazards and perceptions of risk (Boholm, 1998), these studies expanded the scope of research to understand findings generated by psychometric studies that found variations in risk perception among laypeople and between lay and experts' perceptions of risk (Sjöberg, 1999; Slovic, 1992). Psychometric studies denote risk as a decontextualized objective hazard, threat, or danger (Renn, 1998) that can be assessed without accounting for social and cultural processes (Lupton, 1999). They primarily aim to examine the relationship between the attributes of a specified hazard to people's perceptions of, choices, and decisions regarding risk (Slovic, 1987; 1992). Psychometric studies pointed to the concurrence of experts' judgments of risk with findings of technical assessments and probabilities, as opposed to laypeople's judgments that were more driven by the dread of a hazard and uncertainty of risks (Slovic, 1987; 1992). In other words, laypeople's assessments of risks were influenced by their concerns about the *catastrophic* *potential* (Slovic, 1987, p. 283), controllability, fatality, voluntariness of a hazard, and the extent to which hazards affect people (Slovic, 1992), as well as their perceptions of the extent to which a hazard is “observable, exposed, and known to science” (Slovic, 1992, p. 123).

Studies examining the relationship between knowledge and risk perception largely focused on decontextualized and isolated risks, as observed by Cutter (2003), Johnson (1993), and Renn (1998). These studies fell under three main approaches, as identified by Johnson (1993): the factual approach, the heuristic approach, and the conceptual approach. The factual approach—the most popular—focused on assessing people’s comprehension of facts about hazards and its relationship to their level of tolerance to risk and concern. The cognitive heuristic approach looked at people’s reasoning mechanisms about hazards and their relationship to risk perception. Finally, the conceptual approach—used to a much lesser extent than the latter two approaches—examined people’s mental models about a hazard (Johnson, 1993). These approaches follow different methodologies and vary in terms of their scope and objectives. While factual and heuristic approaches focus on the relationship between knowledge of hazard facts and risk perception, and availability and affect heuristic, the conceptual approach examines the complexity of laypeople’s factual knowledge.

A description of the three abovementioned approaches is presented below. Such description is intended to acknowledge the presence of the three approaches to examining the relationship between knowledge and risk perception. Also, this description sets the stage for explaining the reason underlying the adoption of the conceptual approach in this study to evaluate the complexity of stakeholders’ local knowledge of hazards within socio-ecological systems such as watersheds.

The Factual Approach

This approach aims to understand the relationship between laypeople’s technical knowledge mostly about a specified decontextualized hazard and a single dimension of risk perception. Studies under this approach primarily addressed perceptions of health risks, and to a lesser extent, social and ecological risks.

Conceptualization and operationalization of knowledge and risk perception varied across factual studies depending on the scope and objectives of each study. Conceptualizations of hazards knowledge were not consistent and were limited to specific dimensions of hazards. In other words, extant articulations of knowledge were not tied to or were not inclusive of all hazards dimensions in terms of the nature, sources, effects, and control of hazards. For instance, in Baird’s study (1986), factual knowledge was conceptualized as knowledge of hazard effects on humans and hazard control measures. Knowledge was measured by two items relating to Environmental Protection Agency’s (EPA) death estimates from arsenic emitted from smelters, and the capacity of EPA’s proposed arsenic standards to control arsenic emissions into the air. Assessment of laypeople’s knowledge was inferred from the proportion of participants providing correct answers to technical questions. Risk perception was conceptualized as tolerance to social risks and was measured by a dichotomous variable grouping participants as less tolerant or more tolerant of smelter risks (Baird, 1986). Less tolerant participants were those encouraging arsenic control, which “might lead to smelter closure and the loss of jobs” (Baird, 1986, p. 427).

Bord & O’Connor (1990) adopted a more comprehensive approach to conceptualizing factual knowledge about food irradiation. Knowledge was defined by four items regarding the nature of hazard (traces of radiation and other unusual substances in food), source of hazard (food irradiation process), and effect of hazard on food (changes in food characteristics as a result of irradiation). A knowledge score was computed as the number of correct items. Risk perception was conceptualized in terms of acceptability/tolerance of risk (the extent to which a participant would try irradiated food at home, feel comfortable to serve irradiated foods to family members, and support legislation to ban irradiation of food). Also, in a study on risk perception on a hazardous waste site, Bord & O’Connor (1992) conceptualized knowledge in term of comprehension of facts about the level of danger of certain contextualized hazards (e.g. risk of drinking and bathing in water polluted by the hazardous site) compared to decontexualized day to day hazards (such as danger of smoking and driving). Knowledge was also defined in terms of self-reported level of knowledge about specific hazards, mainly benzene and tricholoethylene. As for risk perception, it was conceptualized as level of health concerns before and after the cleanup of hazardous sites.

More recent studies still followed a limited approach to conceptualizing knowledge and risk perception. For instance, Pagneux, Gísladóttir, & Jónsdóttir (2010) defined factual knowledge in terms of people’s awareness of the causes and attributes of local flood events (number of events and dates, as well as boundaries of historical floods). With the help of a rubric set by the researchers, people’s knowledge was measured by a composite score computed as the sum of the weighted sub-scores of the defined elements of knowledge about floods. As for risk perception, conceptualization did not designate the dimensions of risk perception explored, whether health, social, and/or ecological. Items were designed to ask participants about the importance of flood risks in their neighborhood and the extent to which participants worried about flood risks. These two items were measured using a five point Likert Scale. A third item was also used to measure risk perception and related to whether or not participants would relocate due to flood risks. This item was a dichotomous variable measured as yes or no (Pagneux, Gı́sladȯttir, & Jȯnsdȯttir, 2010).

Factual studies typically used survey methodology to collect data on people's factual knowledge and risk perceptions of specific decontextualized hazards. Yet, some studies followed a mixed method approach to understand the relationship between knowledge and risk perception. For instance, Golding, Krimsky, and Plough (1992) applied an experimental approach to understand the relationship between factual knowledge and perceptions of radon risks (defined as level of concern). In their study, the researchers aimed to compare technical and narrative communication formats in regards to their relationship with risk perception of radon. Six focus groups were first interviewed to elicit their views on radon issues. Elicited views were then used to write a narrative about radon, which included a story on hypothetical situations about individuals making decisions about radon problems. The material for the technical text was derived from the EPA's Citizens' Guide to Radon. Both narrative and technical formats included information about "the source and nature of radon, radon testing, health effects of radon, and mitigation" (p. 30). Baseline and follow-up telephone surveys were conducted to understand the effect of the narrative versus technical articles on radon on people's knowledge and perceptions of risk (level of concern about radon). The two groups were then compared to a control group (that was not exposed to any of the formats) in order to understand the differences.

Factual knowledge studies within the context of risk resulted in mixed results regarding the relationship between knowledge and risk perception (Johnson, 1993). For instance, Baird (1986) did not find factual knowledge to be positively associated with tolerance of smelter pollution. Bord and O'Connor (1990) found a positive correlation between factual knowledge about food irradiation and health concerns. Golding et al. (1992) did not find a correlation between factual knowledge about radon as a chemical and associated levels of concern. Rather, these latter levels were influenced by contextual social and regulatory factors; trust in mitigation measures, and media coverage of environmental problems perceived of more significance than radon (Golding et al., 1992). Pagneux, Gísladóttir, & Jónsdóttir (2010) did not find a correlation between factual knowledge about the causes and attributes of flood and levels of worry and concern. Rather, risk perception was more tied to personal experiences with flooding events (Pagneux, Gísladóttir, & Jónsdóttir, 2010).

The Heuristics Approach

A heuristic is “any reasoning device that helps us think quickly and efficiently” (Winter & Koger, 2004, p. 170). The heuristics approach, hence, considers people’s judgment and estimation of risks to be tied to the mechanisms by which they assimilate their surrounding environment (Tversky & Kahneman, 1974). Studies under this approach primarily focused on understanding the influence of affect and availability heuristics on risk perception of both decontextualized and contextualized hazards. Affect heuristic refers to people’s dependence on feelings in assessing the extent to which a stimulus is “good” or “bad” (Slovic et al., 2004). Availability heuristic refers to the “situation in which people assess the frequency of a class or the probability of an event by the ease with which instances or occurrences can be brought to mind” (Tversky & Kahneman, 1974, p. 1127). According to Tversky and Kahneman (1974), availability heuristics can be loaded with several forms of biases. For the purpose of this study, discussion only pertained to certain biases, including *retrievability of instances, imaginability, and illusory correlation* (Tversky & Kahneman, 1974, p. 1127-1128). *Retrievability of instances* refers to the condition when people recall information about the occurrence of a class (in this case the potential health, social, or ecological effects of a hazard) if this class is familiar and significant to them (Tversky & Kahneman, 1974). *Imaginability* refers to the condition where people retrieve the occurrence of a risk based on the extent to which dangers can be easily envisioned (Tversky & Kahneman, 1974). Thus, if risks associated with a hazard are easily predicted, then the perceived probability of these risks coming to fruition might be easily retrieved and articulated. Finally, the *illusory-correlation effect* states that a "judgment of how frequently two events co-occur could be based on the strength of the associative bond between them. When an association is strong, one is likely to conclude that the events have been frequently paired. Consequently, strong associates will be judged to have occurred together frequently" (Tversky & Kahneman, 1974, p. 1128).

Experimental (e.g. Finucane et al., 2000; Keller et al., 2006) and quasi-experimental (e.g. Siegrist & Gutscher, 2006) designs were adopted to understand the effect of availability and affect heuristic on risk perception. In both cases, survey methodology was used to collect data about the studied variables by using both open-ended (e.g. Siegrist & Gutscher, 2006) and close-ended questionnaires (e.g. Peters, Burraston, & Mertz, 2004). Studies showed that people depended on availability and affect heuristic—both influencing people's perception of risk—to oversimplify and navigate complex and uncertain environmental issues (Peters, Burraston, & Mertz, 2004; Slovic et al., 2004). For instance, in an experiment on psychology students at the University of Western Australia, Finucane et al. (2000) found that affect heuristic significantly influenced the relationship between perceived risks and risk benefits. Negative feelings towards a hazard diminished perceived benefits of a hazard, consequently amplifying participants' risk perceptions. On the other hand, positive feelings increased people's perceptions of the benefits of a hazard, and therefore, decreased their risk perception. Finucane et al. (2000) also showed that the relationship between affect, perceived risks, and perceived benefits was manipulated by time pressure and technical information. Time pressure was found to increase the correlation between affect, perceived risks, and perceived benefits. Participants designated to the time pressure group did not have the opportunity to analytically think about the list of studied decontextualized hazards. The correlation between perceived risks and perceived benefits of hazards seemed to be higher among participants in the time pressure group, compared to their counterparts who belonged to the no time group and who were given the time to deliberate the studied hazards. On another note, Keller, Siegrist, and Gutscher (2006) found that prior exposure to and experiences with a hazard may elevate perception of risk of people exposed to that hazard.

Further research showed that affect and availability heuristics are not separate entities, but rather go in conjunction to each other. Siegrist and Gutscher (2008) found that people with prior exposure to and experience with flood events exhibited more negative feelings (such as fear, uncertainty, insecurity, and hopelessness) and higher perceptions of risks than their counterparts who were not exposed to flooding events and who put more emphasis on the destructive potential of floods. Both availability heuristic and affect heuristic led to adopting precautionary measures among those affected by flooding due to their elevated risk perceptions, as compared to their counterparts (Siegrist & Gutscher, 2008).

Heuristic studies generated mixed results in regards to the relationship between technical knowledge and risk perception. Finucane et al. (2000) showed that providing participants with technical information about the benefits of a hazard induced positive feelings among participants towards the studied hazards, resulting in decreased perceptions of risks towards these hazards. On the other hand, other studies showed that judgments towards hazards and the quality of decision making in risk management do not necessarily match the quality of knowledge held by laypeople (Arvai, Gregory, & Zaksek, 2008). For example, Zaksek and Arvai (2004) found that while laypeople held accurate technical information about wildfires, their technical knowledge did not aid in setting proper wildfire management schemes. Explanations of this observation were provided by prior risk perception studies (Arvai, Gregory, & Zaksek, 2008). Incompatibility between the quality of laypeople's technical knowledge, risk perceptions, and decisions has been associated with the way hazard information is presented to laypeople (Fischhoff & MacGregor, 1980), and the dependence of people on affect and availability heuristics to navigate complex environmental issues (Arvai & Zaksek, 2004).

The Conceptual Approach

Studies under this approach assessed people's knowledge of both specified decontextualized and contextualized hazards. Unlike studies under the factual and heuristic approaches, studies under the conceptual approach assessed the complexity of laypeople's technical knowledge using expert mental models as a benchmark (Johnson, 1993; Leiserowitz, 2006; Taylor-Gooby & Zinn, 2006). In other words, assessment of knowledge was based on the extent to which laypeople's mental models coincided with those of experts (e.g. Bostrom et al., 1992; Jungermann et al., 1988; Lave & Lave, 1991; Maharik & Fischhoff, 1992; Wagner, 2007). Mental models are incomplete, simplified, and dynamic "cognitive representations of external reality" that can undergo changes over time through further experience and learning (Jones et al., 2011, p. 2). These models can show how people think about cause-effect relationships within complex and dynamic systems (Doyle & Ford, 1998; Jones et al., 2011; Moray, 2004).

Similar to factual studies, conceptualization of hazards knowledge varied across conceptual studies. For instance, Lave and Lave (1991) asked participants in flooded communities about causes, effects, and mitigation of floods. Jungermann et al. (1988)

conceptualized knowledge in terms of the effects of a medication on human health. Atman et al. (1994) conceptualized knowledge about radon in terms of the sources, health effects, and control of radon. More recent studies also differed in their conceptualization of hazard knowledge. For instance, technical knowledge was defined as laypeople's comprehension of the causes, ecological effects, and control of flashfloods and landslides (Wagner, 2007).

Operationalization of knowledge also varied across studies. For instance, Jungermann et al. (1998) operationalized knowledge about drugs along two dimensions. The first dimension was *(declarative) conceptual knowledge* which referred to "important components and their properties" (Jungermann et al., 1988, p. 151). The second dimension was *(procedural) simulation knowledge* referring to "functional relations among the concepts" (Jungermann et al., 1988, p. 151). Hence, conceptual knowledge included themes grouped under specific concepts, such as a drug's main effects, symptoms of contraindication, and side effects. On the other hand, simulation knowledge related to relationships between identified elements of conceptual knowledge (Jungermann et al., 1988). Subsequent conceptual studies developed mental models along the two dimensions proposed by Jungermann et al. (1988). These studies involved constructing an influence diagram (an expert mental model); usually developed by a panel of experts (e.g. Lave & Lave, 1991), and/or in accordance to scientific information about a specified hazard (e.g. Maharik & Fischhoff, 1992; Zaksek & Arvai, 2004).

Data collection procedures used to elicit and assess laypeople's knowledge about a hazard typically involved conducting open-ended interviews with non-experts (e.g. Bostrom et al., 1992; Bostrom et al., 1994; Lave & Lave, 1991; Maharik & Fischhoff, 1992; Zaksek & Arvai, 2004). Open-ended interviews allowed participants to freely express their ideas about the nature, source(s), and effects of hazards, particularly on human wellbeing, in order to control for the influence of experts' views on respondents (e.g. Bostrom et al., 1992; Zaksek & Arvai, 2004). Some studies also used other methods to elicit people's perspectives. For instance, Bostrom et al. (1992) used photographs to elicit respondents' views on radon. These photographs entailed images of a lung, "a frozen food section in a grocery store, and a person dusting a book shelf" (p. 90). Respondents were then asked to sort and describe these photographs based on how these photos related to radon. Respondents' views were later integrated into the analysis of participants' knowledge structure about this particular hazard. Zaksek & Arvai (2004) conducted open-ended interviews with both technical experts and other stakeholders to elicit their views on wildfire management. This latter approach was adopted to compare across experts and non-experts' perspectives and concerns (Zaksek & Arvai, 2004).

Assessment of knowledge typically involved comparing laypeople's mental models to those of experts using different analytical methods. Lave and Lave (1991) elicited laypeople's conceptual understanding of floods and protective and mitigation measures from open-ended interviews. Only concepts conveyed voluntarily by participants were considered for analysis. Knowledge was then assessed by the proportion of participants who reported a concept included in the influence diagram. Others assessed knowledge based on four criteria: completeness, concurrence, accuracy, and specificity (e.g. Bostrom et al., 1992; Maharik & Fischhoff, 1992). Completeness is the "proportion of concepts in the expert model mentioned by a respondent" (Maharik & Fischhoff, 1992, p. 389). Concurrence is the "percentage of respondents' concepts that were in the expert model" (Maharik & Fischhoff, 1992, p. 389). Accuracy is the "product of completeness and concurrence, resulting in higher scores for respondents who not only said right things, but also said many of them" (Maharik & Fischhoff, 1992, p. 389). Specificity referred to the level of detail of people's knowledge. It was defined as "a respondent's ratio of specific concepts to general concepts, divided by the comparable ratio for the expert model. A ratio larger than '1' means that a respondent had a higher proportion of specific concepts than did expert models" (Maharik & Fischhoff, 1992, p. 389).

Conceptual studies revealed variations between laypeople's and experts' levels of knowledge. Lave and Lave (1991) showed that laypeople knew less than experts about floods and protective and mitigation measures. Bostrom et al. (1992) revealed that knowledge of laypeople and experts about radon varied in terms of the three dimensions previously identified: completeness, accuracy, and specificity of knowledge. Laypeople provided less complete, accurate, and detailed information about radon in terms of exposure processes, the effect mechanisms of radon on people, and risk management of radon (Bostrom et al., 1992). More recent studies still supported the distinction in knowledge about a specified hazard between experts and laypeople. For instance, Zaksek & Arvai (2004) found that non-experts held a less inclusive understanding of wildfires than technical experts. Unlike experts, non-experts did not address issues related to environmental benefits of wildfires. Their mental models only reflected knowledge about environmental (e.g. air pollution, water pollution, etc.) and quality of life risks (e.g. health effects, economic effects, such as job opportunities, etc.) (Zaksek & Arvai, 2004).

Expanding Risk Perception Research to Foster Paradigmatic Shifts in Watershed Management

Factual, conceptual, and heuristic studies loosely defined the term 'lay knowledge,' but generally referred to it as people's comprehension of facts, mostly, about a specified decontextualized hazard (Johnson, 1993). There were apparent differences in the conceptualization and operationalization of 'lay knowledge' among studies within and across the three approaches, as previously discussed. Similar to lay knowledge, risk perception lacked definitional rigor and was defined differently across various studies. Whereas some studies defined risk perception in terms of level of acceptance or tolerance of a hazard, others referred to it as level of worry or concern. Also, most risk perception studies dealt with a single dimension of risk (health, social, or ecological), while other studies exhibited vague assessments of risk perceptions and did not designate the dimension of risk perception explored (e.g. Pagneux, Gíssladóttir, & Jónsdóttir, 2010).

Despite differences in their methodologies and conceptualizations and operationalizations of knowledge and risk perception, factual, heuristic, and conceptual studies commonly followed an *information deficit model,* as suggested by Karjalainen and Habeck (2004). In other words, these studies highlighted conceptual and perceptual gaps between experts and laypeople regarding a specified hazard (Irwin et al., 1999; Lupton, 1999; Sjöberg, 1999; Tversky & Kahneman, 1974). Experts considered the public fatalistic, not well educated, subjective, emotional, and irrational (Sjöberg, 1999), and associated people's irrationality in estimating risk with the quality of the source of knowledge (Lupton, 1999; Tversky & Kahneman, 1974). Hence, these studies presented lay knowledge as 'inferior' (Johnson, 1993). Such conclusions have disempowered and disenfranchised people to have a stake in hazards and risk management (Cvetkovich & Earle, 1992). Generalizations about the quality of laypeople's knowledge and risk judgments generated by studies under the factual, heuristic, and conceptual approaches and the resultant suggestions for risk communication and management schemes have been contested in the literature. To date, there has been a scholarly transition defying common misconceptions generated by prior risk perception studies about people's knowledge of environmental issues (Irwin et al., 1999). This transition contextualizes hazards and asserts that people are not ignorant, but rather hold contextual hazard knowledge that is complementary to scientific knowledge (Irwin et al., 1999).

Prior risk perception studies focused on factual knowledge which neither represented the nature of nor revealed variations in knowledge and risk perceptions held by people (Johnson, 1993). They did not account for the dynamic nature and heterogeneity of knowledge and the role that personal factors and local social and environmental contexts play in the development of local hazards knowledge and risk perception (Johnson, 1993; Fitchen et al., 1987; Flint & Luloff, 2005, 2007; Irwin, 2001; Irwin et al., 1999). According to Johnson (1993, p. 196 - 197):

> Facts are … less definitive than often assumed. People who jointly see something should never be wholly confident that the group observed reality. Simultaneous delusion, implicit or explicit social pressure to conform, and cognitive biases that are general (heuristic) or situational…may affect the observation.

Also, these studies commonly assumed laypeople to be passive learners, where as studies show they are not (Karjalainen & Habeck, 2004). Individuals tend to contextualize and reinterpret scientific knowledge and concerns in ways that adhere to their personal experiences and observations that often result from social action and interaction with their local environment (Irwin, 2001; Irwin et al., 1999; Karjalainen & Habeck, 2004). For instance, a study conducted in Jarrow, England revealed factors underlying people's knowledge about a chemical plant in the community (Irwin et al., 1999). Knowledge about chemical pollution was shaped by locals' memories of accidents (an explosion) caused by the plant, and their daily observations of, experiences with, and proximity to the chemical site (Irwin et al., 1999). Reinterpretation of knowledge by local people was also shaped by the historical context of their locale in relation to the chemical plant and their mistrust in technical information about the pollution generated by the plant (Irwin et al., 1999). Personal experience with a hazard often creates skepticism among local people towards the validity of technical information and the ability of science to address environmental issues, and make them more tied to their personal observations and experiences (Karjalainen & Habeck, 2004). Nevertheless, acknowledging the existence of contextualized knowledge helps in diminishing conceptual and perceptual schisms and skepticism between experts and laypeople through highlighting the complementary roles of both local and scientific knowledge (Beall et al., 2011).

Paradigmatic shifts in watershed management—and hazard and natural resource management in general—from ‘top-down’ to ‘bottom-up’ approaches to engage local stakeholders in management require expanding risk perception research to reflect on the complexities and uncertainties of watersheds as local socio-ecological systems. Contextualizing hazards knowledge and risk perception provides a better understanding of variations in knowledge and perceptions (Johnson, 1993; Olson & Folke, 2001) brought into the management process by partnership stakeholders representing various social groups. Given the complexities and uncertainties of watersheds as socio-ecological systems, it is recommended that risk perception studies expand their conceptualization of knowledge of watershed hazards to account for the multiplicity and interrelatedness of these hazards and their effects on ecological and human wellbeing. It is also suggested that these studies account for the multidimensionality of risk perception (Flint & Haynes, 2006) in order to address uncertainties bounding such complex socio-ecological systems. The multiplicity and interrelatedness of hazards within such systems are suggested to result in multiple and interrelated health, social, or ecological uncertainties. Thus, expanding articulations of knowledge and risk perception to include health, social, and ecological dimensions and their relationship enhances the efficacy of collaborative endeavors by promoting holistic schemes that address the multiplicity and interrelatedness of hazards and uncertainties within complex systems.

Conceptual Framework

This study aimed to examine a conceptual framework delineating the relationship between local knowledge and risk perception within the context of collaborative watershed management. Selecting watershed management as a context to understand the relationship between local knowledge and risk perception was tied to several factors. First, watershed partnership stakeholders belong to and act in a particular complex and uncertain socio-ecological system, in this case a watershed, which allows for exploring the complexity of their local knowledge and nature of risk perception. Second, partnership stakeholders often represent varied regions of their watersheds and often have varied backgrounds, in terms of their socioeconomic and characteristics, organizational affiliation, and tenure and role in partnerships. Such variations allow for examining variations in local knowledge and risk perception. Third, watershed partnerships provide a rich context for understanding how variations in levels and nature of local knowledge and risk perception and their relationship influence the efficacy of collective action among stakeholders acting within a complex socio-ecological system, such as a watershed.

Prior studies focused on elements underlying the success and sustainability of watershed partnerships. In their review of the empirical literature, Leach and Pelkey (2001) identified several determinants of watershed partnership success, which involved funding, interpersonal relationships and trust, active involvement of state and federal agencies, consensus-based decision making, and stakeholders' adequate scientific understanding of watershed issues. In addition, several theoretical frameworks have been developed in order to understand the efficacy of watershed partnerships. These frameworks include: the institutional rational choice, social capital, and advocacy coalition framework (Sabatier et al., 2005b). The institutional rational choice framework delineates interactions among stakeholders within the context of institutional limitations (Sabatier et al., 2005b). This framework also assumes that interactions are constrained by stakeholders' limited capacity to comprehend scientific information about environmental conditions within their watershed (Sabatier et al., 2005b). The social capital framework looks at how trust, reciprocity, and social networks among stakeholders influence the efficacy of watershed partnerships. Finally, the advocacy coalition framework assumes that the success of watershed partnerships is constrained by the heterogeneity of stakeholders' interests, knowledge, beliefs, and values (Sabatier et al., 2005b). The latter framework also highlights that the source of information influences the extent to which a stakeholder is willing to change his beliefs. In other words, stakeholders obtaining their information from their social group are highly unlikely to change their beliefs compared to those obtaining information from stakeholders not belonging to the same social group. Of these three frameworks illustrated above, the advocacy coalition framework seems to be closest to considering that stakeholders hold contextual knowledge and concerns that can be influenced by their personal observation and experience, beliefs, environmental and institutional contexts. Yet, continued exploration is needed to explicitly incorporate and understand local knowledge, risk perception, and their relationship.

Based on the review of the literature, a conceptual framework is adopted in this study to expand the understanding of the relationship between local hazards knowledge and risk perception. This study considers watershed partnership stakeholders (both governmental and non-governmental) to hold contextual knowledge and risk perceptions of watershed hazards. For the purpose of this study, local hazards knowledge is interpreted as stakeholders' understanding and awareness of the prevalence and interrelatedness of multiple local hazards and their effects on ecological and human wellbeing in their watershed. Risk perception is interpreted as the extent to which watershed partnership stakeholders are concerned about social, health, and/or ecological risks associated with multiple and/or interrelated hazards in their watersheds.

The conceptual framework in this study highlights the complex relationship between local hazards knowledge and risk perception. In addition to the local context, stakeholders' socio-demographic and institutional backgrounds, activeness in, and satisfaction with the performance of their partnership are suggested to influence the relationship between local hazards knowledge and risk perception. Such factors are assumed to underlie variations in local knowledge and risk perception among watershed partnership stakeholders, hence influence the relationship between the two parameters. Further discussion of these factors is presented below.

Watershed hazards and their effects on ecological and human wellbeing may vary across temporal and spatial scales (Westley et al., 2002). As such, regions within a watershed may experience aspects of change differently. Watershed partnership stakeholders often represent varied social groups and regions in their watersheds. However, stakeholders interact differently within their complex local socio-ecological environments. Diversity of stakeholders' socio-demographic characteristics and interactions with their local environment generates varied personal observations of and experiences with hazards; hence varied perspectives and concerns about watershed hazards. In other words, the risk context plays a significant role in shaping stakeholders' local knowledge and risk perception (Blaike et al., 1997; Flint & Luloff, 2005). The risk context is delineated as the setting in which the biophysical elements, hazards, and the social, economic, and political processes in a community interact to determine community vulnerability to hazards, risks, and disasters (Flint & Luloff, 2007; Tobin & Montz, 1997). In this study, the watershed risk context refers to the biophysical and social vulnerabilities existing within the boundaries of a watershed. Such delineation of the watershed risk context was in accordance to the *hazards of place* framework developed and adopted in further research by Cutter and Solecki (1989) and Cutter, Mitchell, and Scott (2000). The model is a midrange framework which assumes vulnerability to be not equally distributed in a locale and to be a function of interactions between local biophysical and social contexts. This model combines two modes of research; research hypothesizing vulnerability a function of the attributes of a hazard and that hypothesizing vulnerability a function of the social, political, and cultural fabric within a locale (Cutter et al., 2000). In this study, adoption of the *hazards of place* model intersects with the definition of watersheds as being socio-ecological landscapes and the assumption that regions within a watershed experience biophysical and socioeconomic vulnerability differently.

In addition to the watershed risk context, stakeholders' local hazards knowledge is expected to influence risk perception. Stakeholders hold diverse models representing their awareness of multiple and/or interrelated watersheds hazards and their effects on ecological and human wellbeing. This knowledge is suggested to influence stakeholder's nature of concern. The notion that local knowledge and risk perception are influenced by the local context suggests that hazards knowledge of stakeholders belonging to and acting in such systems is complex, and their risk perceptions are multifaceted and even integrated. In other words, stakeholders holding complex views about watershed hazards are expected to hold integrated perceptions of risks. The term *integrated risk perception* was originally developed by Wolburg (2001) to refer to a model delineating factors influencing people's control of fear and danger from a risk, such as perceived threat, severity, susceptibility, outcomes, benefits, costs, response and self-efficacy. In this study, the term *integrated risk perception* is not used in accordance to Wolburg's (2001) interpretation, but rather refers to the extent to which individuals are concerned about and correlate the social, health, and ecological risks associated with multiple and/or interrelated hazards in complex ecosystems, such as watersheds.

The level of complexity of local knowledge (Olson & Folke, 2001; Ghimire at al., 2004) and the level of integration of risk perception are expected to vary across stakeholders belonging to the same watershed partnership due to differences in their tenure and role in partnership and organizational affiliations. Stakeholders often represent varied regions within their watersheds, and accordingly have varied observations and experiences with environmental problems. During management processes, stakeholders bring in and share their experiences with other stakeholders. Hence, the longer stakeholders are involved in their partnerships, the more their interactions with their peers. Interactions with other stakeholders might change and add to stakeholders' knowledge base as local knowledge is known to be cumulative (Blaike et al., 1997; Davidson-Hunt & O'Flahtery, 2007; Davis & Wagner, 2003). Also, members of watershed partnerships are expected to have more complex knowledge of watershed problems as they are heavily ingrained into knowing more about these problems, as compared to non-active partnership members.

The complexity of local hazards knowledge may also vary across organizational affiliation. Local stakeholders are expected to hold more complex knowledge than technical experts. Technical experts may or may not be residents of their watersheds. Daily experiences of non-resident technical experts with environmental issues may be limited, thus impacting the complexity of their local knowledge. Also, as local stakeholders interact with experts in their partnerships, the complexity of their knowledge might change (Sabatier et al., 2005b). Local knowledge is dynamic and blending of local and scientific knowledge generated by technical experts might lead to more elaborate knowledge of environmental issues on the part of local stakeholders. In all cases, variations in the complexity of local hazards knowledge may lead to variations in the level of integration of health, social, and ecological concerns.

Besides their differences in the nature of their risk perceptions, stakeholders are also hypothesized to differ by their level of concern about watershed hazards and their effects (Corburn, 2003). Level of concern is suggested to be cumulative and reflective of stakeholders' awareness of the multiplicity and prevalence of hazards within a watershed. In other words, stakeholders expressing higher prevalence of multiple watershed hazards are expected to have higher levels of health, social, and ecological concerns than those expressing lower prevalence of fewer or multiple hazards. Other factors suggested to be positively correlated with level of concern are educational level and age (Brody et al., 2005), and years of residence in watershed (Flint & Luloff, 2007). Studies reveal that younger and more educated populations often have higher levels of concerns (Brody et al., 2005). Also, it is expected that as years of residence in watershed increase, stakeholders become more aware of the multiplicity and prevalence of watershed problems and their effects, and therefore have higher levels of concern.

In addition to the latter factors, level of concern is expected to be influenced by stakeholders' activeness in their partnerships and levels of satisfaction with their partnership's performance in dealing with watershed hazards and their effects. Often, stakeholders' level of activeness in their watershed partnerships varies. Lubell et al. (2002) found that the severity of watershed problems is positively associated with the activeness of stakeholders and the emergence of watershed partnerships. However, stakeholders' satisfaction in the performance of watershed partnerships is found to mediate the relationship between the local context and stakeholders' activeness in partnership. Research shows a positive correlation between stakeholders' activeness in and satisfaction with the performance of their partnership in dealing with watershed risks (Samuelson et al., 2005). It is expected that stakeholders who perceive their partnership capable of addressing watershed hazards and their effects, and are therefore satisfied with their partnership, to be more engaged with their partnership. The effects of stakeholder engagement in partnerships might have twofold effects on levels of concerns. More stakeholder engagement can either lead to lower level of concern, because stakeholders are satisfied with their partnership involvement (Peters et al., 1997). On the other hand, stakeholder engagement might lead to higher levels of concern because interaction with other stakeholders might lead to higher perceptions of risks. Watershed partnerships are considered “risk amplification stations” (Renn et al., 1992). Accordingly, interaction of stakeholders within those groups might highlight hazards threatening watersheds, hence lead to an increased perception of risk (Renn et al., 1992).

Understanding variations in local hazards knowledge and risk perception and their relationship can be better understood by comparing these parameters across local contexts. As both local knowledge and risk perception are contextual, it is expected that stakeholders belonging to partnerships in watersheds that are both biophysically and socioeconomically vulnerable to have more complex local knowledge, more integrated risk perceptions, and higher levels of concerns than those stakeholders belonging to partnerships in watersheds with both lower biophysical and socioeconomic vulnerability. Contexts with high biophysical vulnerability may have multiple and interrelated hazards and effects on ecological and human wellbeing. Also, those contexts with high socioeconomic vulnerability may not have the social fabric necessary to build resiliency against multiple and complex environmental hazards and their effects. As stakeholders interact with their biophysical environment, they may become more aware of the multiplicity and complexity of watershed hazards and their effects on ecological and human wellbeing, leading to more complex knowledge and integration of risk perception. Also, stakeholders through their interactions with the social environment may become more aware of the inadequacies of social and institutional contexts for dealing with watershed problems, which may possibly influence communities’ and watershed partnerships’ capacity to build resilience against potential watershed risks and disasters (Adger, 2000). Increased awareness of social vulnerability (Satterfield, Mertz, & Slovic, 2004) and the inability of watershed partnerships or communities to solve multiple and complex watershed issues might elevate levels of concerns and might add to the complexity of local knowledge, thus leading to more integration of risks. As such, increased awareness of biophysical and social vulnerability may lead to increased complexity of local knowledge and levels and integration of concerns, given the complexity of biophysical and social issues within these watersheds.

Research Questions

In light of the presented conceptual framework, four research questions guided this study:

(a) What is the nature of local hazards knowledge and risk perception of watershed partnerships stakeholders?

(b) Does the nature and level of stakeholders’ concerns vary within partnerships and across watersheds?

(c) Do stakeholders with complex local hazards knowledge hold integrated perceptions of risk?

(d) To what extent does local hazards knowledge influence risk perception within the context of particular watersheds?

Exploration of the four stated research questions was conducted within the context of four rural Southern Illinois watersheds. Unlike the rest of the State of Illinois, Southern Illinois contains a wide array of risk contexts that allowed for a comparative analysis of local hazards knowledge, risk perception, and their relationship across these contexts. Further description of the four studied watersheds is presented in the next chapter.

CHAPTER 3

THE RESEARCH CONTEXT

The Southern Illinois Regional Context

This study is framed within the context of Southern Illinois. Southern Illinois is mostly rural and is characterized by its diverse topography, ecological systems, and commercial and industrial activities (Flint et al., 2008). Southern Illinois has been historically suffering from adverse environmental, social, and economic developmental disparities relative to the rest of the state of Illinois (Flint et al., 2008). These three characteristics of Southern Illinois are ingredients for a rich research context for a study of watershed partnerships and local perspectives and concern. They add to the complexity of the region's watersheds and their corresponding risks and provide a base for understanding variations in the relationship between local hazards knowledge and risk perception across varied rural watershed risk contexts existing within the same region.

In this study, Southern Illinois is defined as the 16 southernmost counties delineated by the Delta Regional Authority (DRA) to constitute the region, including Alexander, Franklin, Gallatin, Hamilton, Hardin, Jackson, Johnson, Massac, Perry, Pope, Pulaski, Randolph, Saline, Union, White, and Williamson counties. The 16 southernmost counties of Southern Illinois fall within the boundaries of six 8-digit HUC watersheds, as delineated by the Illinois Environmental Protection Agency. Out of these six watersheds, four—the Big Muddy, Cache, Lower-Ohio Bay, and Saline—were selected as research areas based on the existence of partnerships within these watersheds and the consent of these partnerships to participate in this study. In the Big Muddy watershed, the only partnership operates at the level of the 12-digit HUC Kinkaid watershed.

This led to further limiting the research area to the Kinkaid rather than the Big Muddy watershed (see Figure 3.1).

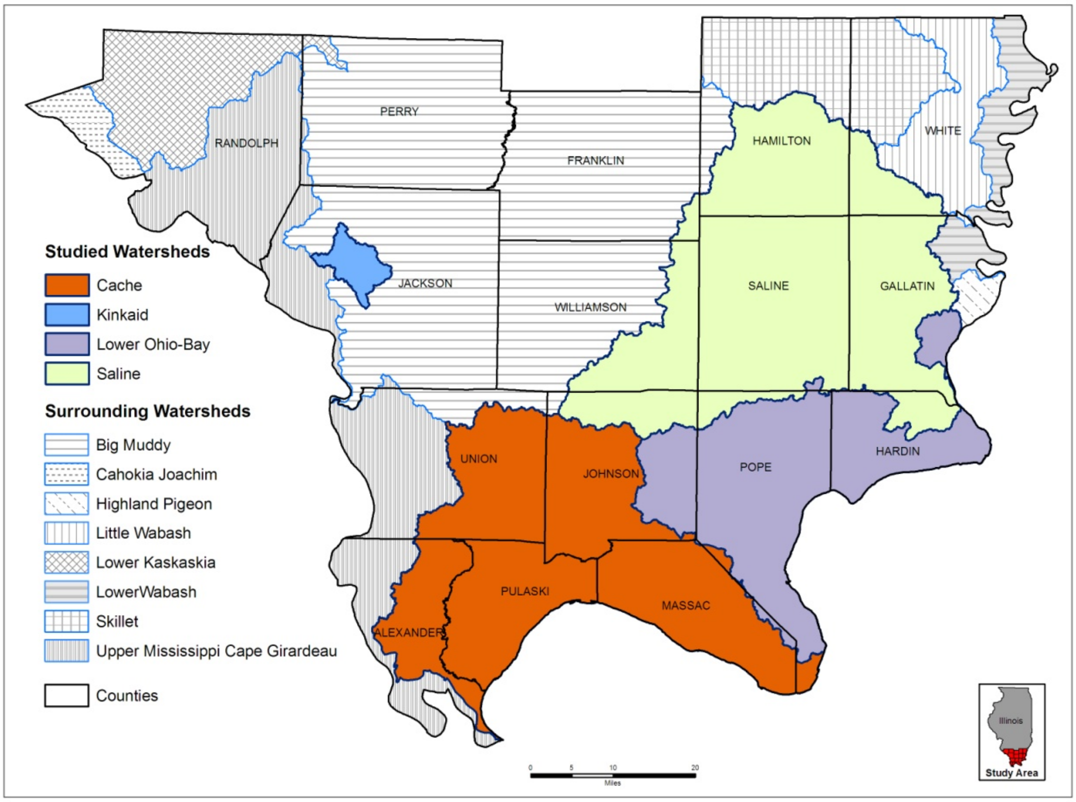


Figure 3.1. The Four Selected Watersheds in Southern Illinois

The four selected watersheds vary in terms of their biophysical and socioeconomic conditions; hence their vulnerability to environmental hazards. Each watershed contains a watershed partnership developed to mitigate environmental risks and hazards, minimize vulnerability, and promote ecological and human wellbeing. These partnerships are the Cache Joint Venture Partnership in the Cache watershed, the Saline Basin Partnership, the Shawnee Ecosystem Partnership in the Lower-Ohio Bay watershed, and the Kinkaid Watershed Partnership.

This chapter delineates the physical, environmental, and socioeconomic characteristics of the four selected watersheds. It also describes the structure and activities of partnerships within these watersheds. Description of these partnerships sets the stage for understanding the characteristics of respondents in this study and for understanding variations in local hazards knowledge and risk perception among these respondents.

Watersheds: Physical Attributes

Kinkaid

The Kinkaid watershed is the smallest of the studied watersheds. Its area is estimated at 40.2 square miles. The boundaries of this watershed are only confined to Jackson County. The watershed is the home of an artificial lake with a size of 2,350 acres and located 5 miles north of Murphysboro. The lake was built in 1972 after the Crissenberry Dam was installed. The lake normally stores 78,500 acre-feet of water, and provides recreational and water supply services for neighboring areas, such as Murphysboro. Four creeks drain into the lake: the Kinkaid, Little Kinkaid, Spring, and Johnson (IDNR, 2005; Kinney, 2004).

The Kinkaid watershed is characterized by slopes with gradients ranging between 20 to 40 %, particularly in the upstream areas of the Kinkaid Lake. The Kinkaid watershed is predominantly forested particularly in the area downstream of the lake (Kinney, 2004). Agricultural practices dominate upstream from Kinkaid Lake.

Lower-Ohio Bay

The Lower Ohio-Bay watershed has an estimated area of 598.3 square miles. It covers most of Pope and Hardin Counties, and part of Johnson and Massac Counties. The watershed contains approximately 1,168 miles of streams and rivers. The largest streams in the watershed are the Bay Creek, Lusk Creek, Big Grand Pierre Creek, and Big Creek (IDNR, 2002). In addition to streams, the Lower Ohio Bay watershed has 23 large lakes, totaling a surface area of 1,490 acres (IDNR, 2002). Most of the watershed is forested and hilly. The Lower Ohio Bay watershed is dominated by forest land cover (IL RDSS, 2011).

Saline Basin

The Saline Basin is estimated to have an area of 1,177.3 square miles. The watershed is partly hilly and covers most of Saline and Gallatin Counties, as well as parts of Franklin, Hamilton, White, Williamson, Johnson, Pope, and Hardin Counties. The Saline River is the main river in the watershed (75.5 miles) and is a tributary of the Ohio River. The watershed also contains a large lake, Lake of Egypt, with an area of 2,300 acres (NRCS, 2008).

The Saline watershed is characterized by being mainly agricultural, while forested land constitutes a smaller portion of the watershed's landscape (IL RDSS, 2011; NRCS, 2008). In addition to agriculture, other commercial and industrial activities are present in the watershed, including coal mining and manufacturing. Coal mining occurs largely in Saline County, and Gallatin and Williamson Counties to a lesser extent (NRCS, 2008).

Cache River Watershed

The Cache watershed has an area of 963.2 square miles. It covers Alexander, Johnson, Massac, Pope, Pulaski, and Union counties. The watershed lies at the confluence of the Mississippi and the Ohio rivers (Kraft et al., 2004). Four tributaries feed into the Cache River: Big Creek, Cypress Creek, Limekiln Slough, and Ketchel Slough (Demissie, Soong, & Camacho, 1990). The major river in the watershed is the Cache River (110 miles), which begins around

Cobden (Union County) and ends in the Mississippi River in Alexander County (IDNR, 1997a). The Cache watershed is characterized by its upland hills and flat slopes in the valley (IDNR, 1997a).

The Cache watershed is recognized as a worldwide ecologically valuable area by the United Nations Ramsar Convention (Kraft et al., 2004). The Ramsar Convention “is an intergovernmental treaty that embodies the commitments of its member countries to maintain the ecological character of their Wetlands of International Importance and to plan for the ‘wise use’, or sustainable use, of all of the wetlands in their territories” (Ramsar, 2010, p.1). The Cache watershed is the home of valuable wetlands as the watershed falls within four significant ecological regions: the Coastal Plain, the Interior Low Plateau, the Ozark Plateaus, and the Central Lowlands. Such a mixture of eco-regions results in unique and rare wildlife habitat and biodiversity (IDNR, 1997b; Kraft et al. 2004).

The Cache watershed has historically undergone major alterations, particularly due to deforestation and diversion of river flow. Economic development in the 19th century was an incentive for timber industries in the area to drain the river and wetland waters to meet the demands for timber, construction, and railroad (Kraft et al., 2004). Accordingly, in 1916, the Post Creek Cutoff was installed to drain around 60% of the Cache River and wetlands into the Ohio River, thus dividing the Cache River and the watershed into what is known today as the Lower Cache and the Upper Cache (Sierra Club, 2011). The Post Creek Cutoff was originally built to be 30 feet wide and 10 feet deep. However, across the years, the Post Creek Cutoff became wider (200 feet) and deeper (64 feet) due to an increase in the flow of waters caused by the loss of the meanders of the Upper Cache River (Sierra Club, 2011).

Draining the river and wetlands has also provided the opportunity for agricultural expansion in the area. To date, agricultural land occupies most of the landscape of the Cache watershed and is primarily located in the drained wetlands. Forests dominate the northern part of the watershed, and are mostly located within the boundaries of the Shawnee National Forest (IDNR, 1997a).

Watersheds: Environmental Conditions

The four studied watersheds in Southern Illinois vary by the type, sources, and severity of environmental problems. Erosion is a common problem to all four watersheds. In the Kinkaid watershed, erosion is naturally caused by steep slopes and human activities, primarily agricultural activities in the area. Streambank and lake-bank erosion are other forms of erosion in the Kinkaid watershed (IDNR, 2004). A 2004 IDNR assessment revealed that around 36% of the sediments in the Kinkaid Lake originate from gullies and 3% originate from streambanks. In the Saline watershed, streambank, gully, and soil erosion from agricultural land are also commonly found. In the Cache watershed, soil erosion and streambank erosion are mainly caused by deforestation, the Post Creek Cutoff, and agricultural practices (Beaulieu et al., 1998). As the Post Creek Cutoff became wider and deeper, the velocity of water flow increased leading to increased erosion rates (Sierra Club, 2011). Sedimentation has been of major concern particularly in the Lower Cache River Basin (IDNR, 1997a).

Flooding is a problem in Southern Illinois, particularly in counties belonging to the Cache and Saline watersheds, as both watersheds contain floodplains for the Ohio River. In the Cache watershed, the loss of wetlands, which act as buffer zones for floods, has increased the intensity of floods. Also, the widened and deepened Post Creek Cutoff has provided a drain for the elevated Ohio River waters to backflow into the Cache watershed, causing more flooding in the watershed. In the Saline watershed, flooding is primarily caused by the flat topography and poor water drainage.

Flooding data obtained from the SHELDUS database at the Hazards and Vulnerability Research Institute at the University of South Carolina show that over the course of 10 years (1998—2008), Alexander County had eight floods and Massac County had five floods. In the Saline watershed, Saline County had six floods and White County had 11 floods. In addition to flooding, deforestation and alteration in the flow of the Cache River has inflicted other serious effects. Deforestation and the post creek cutoff have led to habitat fragmentation, which has particularly influenced bird reproduction in the area (Sierra Club, 2011). As for the Saline Basin, acid runoff from abandoned coal mines has been a major concern (IL EPA, 2011).

Regarding water quality, a few ambient water quality parameters exceeded the Illinois Environmental Protection Agency (IL EPA) water quality standards for general use. In Table 3.1, the reported figures are yearly medians of monthly readings for each of the ambient water quality parameters (% DO, pH, nitrates, phosphates, turbidity, total suspended solids, and fecal coliform). These figures neither account for seasonal variations nor are they sensitive to outlier readings generated from specific monitoring sites (Boyer & Briceňo, 2005; Christian et al., 1991). The pH levels of all four watersheds fell within the IL EPA standards (6.5—9.0). However, phosphorous levels in the Saline and Cache watersheds exceeded the Illinois EPA standards (> 0.05 milligrams per liter). An IDNR assessment report indicates that phosphorous levels in the Kinkaid watershed also exceeded the IL EPA standard of 0.05 milligrams per liter, particularly in the upstream area where agriculture is prevalent (Kinney, 2004). Elevated levels of phosphorous, particularly the Saline and Cache, are primarily attributed to nutrient runoff from agricultural lands surrounding water bodies in these watersheds (IDNR, no date).

Regarding fecal coliform, levels are below the IL EPA water quality standards in each of the Cache, Kinkaid, and Saline watersheds (< 200/100 milliliters) (see Table 3.1).

Table3.1

Water Quality Data of the Four Studied Watersheds

	Watersheds✓				
Water Quality	Kinkaid	Lower-Ohio Bay	Saline	Cache	**ILEPA† Standards**
DO (% saturation)	-	81.3	85.0	90.0	
pH	7.2	7.2	7.7	7.7	**6.5—9.0**
Nitrates (milligram/L)	-	0.44	1.32	5.81	**-**
Phosphorus (milligram/L)	-	0.04	0.06	0.36	**0.05 mg/ L**
Turbidity (NTU)	7.9	15.0	3.3	16.5	**-**
Total Suspended Solids	-	7.0	18.0	26.0	**-**
Fecal Coliform (count/milliliter)	4.35	N/A	110	28	**200/100 ml**

† Source: Environmental Protection Agency (2009). Water Quality Standards—Title 35: Environmental Protection, Subtitle C: Pollution, Chapter 1: Pollution Control Board, Part 302.

✓ Water quality data for the Lower-Ohio Bay, Saline, and Cache watersheds were obtained from the Illinois Environmental Protection Agency for the year 2005. Water quality data for the Kinkaid watershed was obtained from the Kinkaid Reed's Conservancy District for the year 2008.

Watersheds: Socioeconomic Conditions

Southern Illinois is characterized by a higher poverty rate (18.0%) compared to the rest of the state (12.4%), due to higher unemployment rates, lower educational attainment, and slower economic development (Flint et al., 2008). In 2005, the average unemployment rate in the Southern Illinois was 6.2% and was higher than the state's average (5.7%). Unfortunately, the national economic downturn took its toll on the unemployment rate in Southern Illinois. The latest unemployment statistics shows that in July 2011, the average unemployment rate in Southern Illinois was comparable to that of the State of Illinois and reached to 10.0%.

As is generally the case, educational attainment is related to socioeconomic challenges (Cutter, 2003). In 2010, only around 14.2% of the surveyed population in Southern Illinois held a bachelor's degree, compared to 29.8% in the rest of the state (US Census Bureau, 2011). Also, Southern Illinois is characterized by a higher rate of high school dropout, compared to the rest of the state. Only 81.2% of the surveyed population in Southern Illinois held a high school diploma, compared to 85.7% in the rest of the State of Illinois. The median household income in the region is $36,093 and is considerably lower than that of the state of Illinois ($55,222).

Table 3.2

Socioeconomic Indicators for the Southern Illinois Region

County	Unemployment Rate[1] (%) (not seasonally adjusted)	Poverty Rate [2] (%)	Median Household Income[2] ($)	Educational Attainment (%)[2]	
				High School Diploma	Bachelor's Degree or higher
Alexander	13.6	24.1	28,983	76.8	9.8
Franklin	11.9	18.3	33,711	83.7	13.4
Gallatin	9.0	17.6	33,954	79.1	9.7
Hamilton	8.4	11.4	34,014	78.7	10.0
Hardin	10.9	17.0	32,083	77.4	10.3
Jackson	8.1	29.6	29,493	88.8	35.2
Johnson	10.3	13.9	45,934	78.7	14.1
Massac	10.6	15.0	38,237	83.2	13.3
Perry	10.8	13.5	39,031	80.9	12.1
Pope	10.2	16.0	39,153	85.4	9.2
Pulaski	11.0	28.1	28,775	76.4	10.0
Randolph	8.1	12.5	43,395	78.9	11.9
Saline	9.6	18.7	33,341	81.7	14.7
Union	11.0	22.3	38,028	76.5	17.9
White	7.8	13.8	40,070	85.8	14.7
Williamson	8.7	16.5	39,286	87.6	20.7
Region	**10.0**	**18.0**	**36,093**	**81.2**	**14.2**
Illinois	**10.0**	**12.4**	**55,222**	**85.7**	**29.8**

Source: 1. Bureau of Labor Statistics, Local Area Unemployment Statistics (LAUS, 2011); 2. 2005-2009 American Community Survey 5-Year Estimates, US Census Bureau (2011). This data is used instead of the 2009 1-year estimate as the 2005-2009 is more comprehensive and includes information on all counties, and provides a trend of conditions across the five years; - Not Available.

Not seasonally adjusted means that the computation of the figures did not account for seasonal events, such as opening and closing of schools, holidays, etc.

With such socioeconomic characteristics (and many others not described in this chapter, such as housing and other aspects of the built environment), many counties in Southern Illinois are classified as socioeconomically vulnerable to environmental hazards, as shown by a study conducted by Cutter (2003). Socioeconomic vulnerability indices for the 16 southernmost counties in Southern Illinois reveal that seven Southern Illinois counties have a high socioeconomic vulnerability status compared to all counties in the State of Illinois. Seven counties (Alexander, Franklin, Hamilton, Jackson, Pulaski, Saline, and Union,) rank among the top 20% of the counties in Illinois with high socioeconomic vulnerability indices. On the other hand, seven other counties in Southern Illinois (Hardin, Gallatin, Massac, Perry, Pope, White, and Williamson) have medium-high vulnerability, and Johnson has a low socioeconomic vulnerability, as compared to all counties in Illinois. Given, the socioeconomic characteristics of Southern Illinois, the socioeconomic conditions of watersheds in the region are expected to reflect those of the Southern Illinois Counties.

Watershed Partnerships in the Four Studied Watersheds

Each of the four selected watersheds in Southern Illinois has one partnership. Thus, four watershed partnerships participated in this study; the Cache River Wetlands Joint Venture Partnership, Saline Basin Partnership, Kinkaid Watershed Partnership, and the Shawnee Ecosystem Partnership (SEP) in the Lower Ohio Bay watershed. The four partnerships varied by their size, type, and stakeholder composition and characteristics, government involvement, and type, level, and scale of activity.

Descriptions of the four participating partnerships, presented below, are based on results of semi-structured interviews conducted with partnership coordinators/presidents. Partnership coordinators were asked about: (1) when, how, and why their watershed partnership was developed, (2) major partnership activities and projects, (3) sources of and procedures for partnership funding, (4) involvement of partnership stakeholders in planning and decision making, (5) major challenges facing their partnerships, (6) background of partnerships' stakeholders, and (7) their strategies for encouraging and maintaining stakeholder participation. The interview protocol is presented in Appendix A. Additional information about the four participating partnerships was supplemented by documents about these partnerships (either provided by the partnership coordinators or obtained from internet sources).

In this study, the typology set forth by Moore and Koontz (2003) was adopted to better describe the characteristics of the four participating watershed partnerships. This typology is primarily based on the types of stakeholders involved in partnerships. Hence, partnerships can be citizen-based, agency-based, or mixed (Moore & Koontz, 2003). Whereas citizen-based groups are mostly comprised of local citizens, agency-based groups mostly include governmental representatives, and mixed-based groups contain equal representation of citizen and government representatives. According to this typology, the four participating watershed partnerships are either mixed or citizen-based. Further description of these partnerships is presented below.

The Cache Joint Venture Partnership (Cache partnership)

The Cache partnership is a mixed public-private partnership developed in 1991 to restore and preserve the biological diversity and wetlands of the Cache watershed. Its core partners include three federal/state agencies, the US Fish and Wildlife Service (USFWS), Natural Resource Conservation Service (NRCS), and Illinois Department of Natural Resources (IDNR), and two non-governmental organizations, The Nature Conservancy (TNC) and Ducks Unlimited (DU) (see Table 3.3).

Table 3.3

Core Partners of the Cache Joint Venture Partnership

Partners	Type of Organization/Agency	Mission	Scale of Activities
USFWS	Federal	Conserving fish, wildlife, plants, and their habitats	Federal
NRCS	Federal	Conserving natural resources on private land	Federal
IDNR	State	Conserving natural, recreational, and cultural resources in private lands, raising public awareness and enhancing public's knowledge of the significance of these resources.	State of Illinois
TNC	Non-governmental	Protection of ecologically valuable land and water for future generations	International
DU	Non-governmental	Conserving wetlands and waterfowls (i.e. birds living on freshwater lakes and streams).	North America

As stated by the partnership coordinator, CJVP was originally called for by The Nature Conservancy (TNC) in order to conserve the biological diversity of the Cache watershed; a designated Ramsar site of international ecological significance. For TNC, the necessity to partner with governmental agencies and non-governmental organizations was based on ecological and jurisdictional grounds. Historically, the Cache River was divided into the Lower and Upper Cache, due to major river alterations caused by the post creek cutoff. The two designations for the Cache Watershed also reflect the jurisdictional boundaries of the federal and state agencies. The Lower Cache falls within the US Fish and Wildlife Service jurisdictions, and the Upper Cache falls within the 'purchase boundaries' of IDNR. Moreover, partnering with NRCS—the agency collaborating with private landowners in the upland areas (i.e. the Upper Cache) for preserving natural resources—has been deemed essential to cover private lands within the management process. Finally, Ducks Unlimited is involved in the partnership as they have been already involved in restoring and conserving wildlife and their habitat in the Cache Watershed.

The partnership has a full time coordinator—appointed and funded by the government agencies—who manages the activities among those partners. Both the private and public partners have equal leadership roles in the partnership, as both have a stake in planning and decision making. However, the partnership has been keen to extend its collaborations to other private stakeholders to execute the planned projects. These stakeholders are identified by the partnership and belong to various sectors: county/city agencies, business/land owners, other non-governmental agencies, the media, and academic institutions. Identified stakeholders are neither partners nor members of the partnership. Some of these stakeholders are engaged in partnership discussions, but do not have any significant input apart from providing feedback on and supervising partnership activities. However, the Cache partnership's outreach activities are intended to raise public awareness and increase access to information on partnership activities, ensure proper planning and execution of partnership projects, and advocate the legitimacy of partnership activities in the watershed. The latter point constitutes a major challenge to this partnership, as some local stakeholders are skeptical about scientific information provided and management activities conducted by the partnership.

The Saline Basin, Shawnee Ecosystem, and Kinkaid Watershed Partnerships

The Saline, Kinkaid, and Shawnee partnerships are citizen-based groups formed under the Conservation 2000 (C2000) Program. This program was initially a six-year $100 million initiative launched in 1999. Further amendments to the Public Act 95-0139 extended the C2000 Program till the year 2021. The C2000 program aims to support projects of IDNR, Illinois Department of Agriculture, and IL EPA. It engages local communities and public and private landowners, through ecosystem partnerships throughout the state, in preserving and protecting natural resources in the State of Illinois. In other words, this initiative encourages and empowers local communities and landowners to incorporate varied perspectives and interests while devising their holistic ecosystem management ventures (IDNR, 2011).

The Saline, Kinkaid, and the Shawnee partnerships primarily consist of private stakeholders (such as landowners, business owners, and representatives of farmer bureaus and soil and water conservation districts) representing different areas of their watersheds. These partnerships also have state representatives from the Illinois Department of Natural Resources (IDNR), Illinois Environmental Protection Agency (IL EPA), and Illinois Department of Agriculture (ILDA), who impart technical contributions to partnerships' activities. While private stakeholders have a leading role in prioritizing watershed problems, and devising management schemes, state agencies representatives have a supplementary technical role in developing those schemes.

In all three partnerships, state agencies have had an 'encourager' role (Koontz et al., 2004). These agencies have been catalysts for formulating and encouraging these partnerships; conforming to the directions of the C2000 Program. Representatives of state agencies have reached out to and provided watershed residents with financial incentives to devise watershed partnerships. The three state agencies have provided residents the freedom to self-organize and choose representatives or partners for their partnerships. Also, they have authorized partnerships to technically assess, prioritize, and devise schemes to manage watershed problem, and have provided these partnerships with needed administrative, technical, and financial assistance. The three state agencies mentioned above do not interfere directly in the activities of Saline, Kinkaid, and Shawnee partnerships. However, these partnerships are required to submit their management schemes to state agencies for funding. State agencies have the power to impose alterations to the partnerships' proposed budgets, often leading to modifications of and restrictions to the scope of partnerships' activities.

The Saline, Kinkaid, and Shawnee partnerships vary in their scope and scale of activities. The Shawnee partnership primarily works on erosion control through initiating a reforestation project in the Lower-Ohio Bay watershed. The Saline partnership primarily works on mitigating acid runoff from coal mines, technically assessing problems in a sub-watershed, and creating a management plan for these problems in order to obtain funds from the Illinois Environmental Protection Agency (IL EPA). Finally, KWP mainly works on stabilizing lakeshore erosion and mitigating agricultural runoff into the Kinkaid Lake, which is the only water supplier to areas within and near the Kinkaid sub-watershed.

Institutional changes and the economic downturn in the State of Illinois undermined the capacity of state agencies to support partnership activities across the state, and the Saline, Kinkaid, and Shawnee partnerships are no exceptions. The lack of availability of state funds constitutes a major challenge to these three partnerships. Financial challenges have taken their toll on the level of activity of watershed partnerships, as stated by the coordinator of one of the four partnerships:

> I: What kind of activities is the partnership involved with right now?
>
> P: None that I know of….No, because IDNR said they have no money, so we haven't gone through the—we haven't solicited any projects to be funded. One thing about our group—we don't meet just to have meetings. If there's a project we need to work on we'll address it, but we don't—
>
> I: Waste your time with meetings.
>
> P: Yeah, because that's a very important thing when we first started. We said if we've got things we need to do we'll work as hard as we have to to get it done, but we're not just gonna meet to say we're—'cause I think IDNR suggested that partnerships meet six or eight times a year. I think that was when we first started, and that was decided—and maybe we did meet earlier the first year, then we decided that wasn't of any real value.

Also, financial challenges have limited the role of state agencies in some of these partnerships. For instance, despite IDNR's elimination of Kinkaid partnership's funding for financial and institutional reasons, this partnership has moved forward with its activities. Regardless, its board members meet frequently to discuss watershed problems and have been trying to seek other sources of funding. Such financial and institutional changes have transformed IDNR's role from 'encourager' to 'follower' (Koontz et al., 2004), limiting the activities of IDNR to provision of technical and administrative expertise upon request. The above presented descriptions of the four participating watershed partnerships show variations in their structure and activities. A table summarizing the attributes of these partnerships is presented below (see Table 3.4).

Table 3.4

Attributes of Participating Southern Illinois Watershed Partnerships

	Partnership			
Attributes	Cache	Shawnee	Saline	Kinkaid
Watershed	Cache	Lower Ohio-Bay	Saline	Kinkaid
Watershed Scale	8-digit HUC	8-digit HUC	8-digit HUC	12-digit HUC
Type of partnership	Mixed	Citizen-based	Citizen-based	Citizen-based
Date Initiated	1991	1999	1999	1999
Number of stakeholders[1]	5 partners (219 total including other private stakeholders)	16	89	82
Organizational affiliation of partners	Federal and state agencies, and NGOs	Landowners and state agencies	Landowners, business owners, and state agencies	Landowners, business owners, NGOs, and federal and state agencies
Role of government	Leader	Encourager	Encourager	Encourager→Follower

1. Number of stakeholders obtained from the partnerships' contact list of stakeholders.

Table 3.4 (Continued)

	Partnership			
Attributes	Cache	Shawnee	Saline	Kinkaid
Partnership's activities	Technical assessments, restoration and protection of wetlands and biological diversity	Erosion control, reforestation	Working with industries to control acid runoff, Assessment of watershed environmental conditions	Developing watershed management plan, restoring and protecting the Kinkaid Lake – primarily lake bank stabilization and controlling agricultural runoff
Level of activity	Very active	Minimally active	Active	Active

CHAPTER 4

LOCAL HAZARDS KNOWLEDGE AND RISK PERCEPTION: IMPROVING THE EFFICACY OF COLLABORATIVE WATERSHED MANAGEMENT

Introduction

Watersheds are dynamic landscapes where social-ecological interactions take place (Healey, 2001; McGinnis, 1999). Interactions among these two dimensions are complex and bounded with high degrees of uncertainty (Healey, 2001). Governance of such landscapes through conventional approaches that typically adhere to legal and technical assessments of and solutions to specified environmental issues have often failed (Hardy, 2010; Koehler & Koontz, 2008), as they overlook the complexities and uncertainties embedded in these landscapes (Healey, 2001). Deficiencies of traditional approaches have contributed to the emergence of collaborative watershed management (CWM) due to its holistic, contextual, and integrative orientations. CWM is thought to effectively address local, multiple, and complex environmental hazards going beyond geographical and jurisdictional boundaries through schemes founded on diverse perspectives of local stakeholders and technical experts (Irwin, 2001; Hardy, 2010; Koehler & Koontz, 2008; Michaels, 2001; Sabatier, Weible, & Ficker, 2005; Tarlock, 2000).

Local knowledge and risk perception are central pillars of collaborative natural resources management approaches (Berkes & Folke, 2002; Botterill & Mazur, 2004; Flint & Luloff, 2005; 2007; Renn, 1998). Both parameters can provide technical experts and watershed managers with a profound understanding of interweaving local ecological, social, and political contexts (Born & Genskow, 2001; Cortner & Moote, 1999; Hardy, 2010; Hardy &Koontz, 2008; Kenny 1999; Moore & Koontz, 2003; Sabatier, Weible, & Ficker, 2005; Tarlock, 2000). Thorough consideration of the local context provides a basis to make informed decisions for developing holistic management schemes that address the complexities of watersheds. Also, incorporating risk perceptions of stakeholders into management processes is thought to effectively tackle the uncertainties of watersheds (Renn, 1998). Hence, integrating both local knowledge and risk perception into watershed management can empower and build the capacity of watershed partnership stakeholders and communities to prevent and mitigate watershed risks and disasters (Berkes & Folke, 2002; Berke, Kartez, & Wenger, 1993; Corburn, 2003; Duffield et al., 1998; Flint & Luloff, 2005, 2007; Renn, 1998; Scholz & Stiftel, 2005; Wondolleck & Yaffee, 2000). In this study, local hazards knowledge refers to stakeholders' knowledge of hazards and their effects on ecological and human wellbeing in their watershed (Chapter 2).

Delegation of watershed management responsibilities to local stakeholders puts stakeholders at the center of the management process. It is suggested that the efficacy of management processes (Healey, 2001) and the resiliency of watershed partnerships and communities in the face of watershed risks and disasters, especially in rural contexts, is strengthened if stakeholders acquire and retain a sophisticated holistic understanding of watersheds as socio-ecological systems and hold integrated perceptions of risk. Unraveling the nature of and the relationship between local hazards knowledge and perceptions of watershed risks among those involved in watershed partnerships is a crucial undertaking. It is a starting point to gain insight into the mechanisms by which these two constructs influence the sustainability and resiliency of partnerships and communities in watersheds. The term "integrated risk perception" was originally developed by Wolburg (2001) to refer to a model delineating factors influencing people's control of fear and danger from a risk, such as perceived threat, severity, susceptibility, outcomes, benefits, costs, response and self efficacy. In this study, the term 'integrated risk perception' is not used in accordance to Wolburg's (2001) interpretation, but rather refers to the extent to which individuals are concerned about and correlate the social, health, and ecological risks associated with multiple and/or interrelated hazards in complex ecosystems, such as watersheds.

This study examined mental models of watershed partnership stakeholders in Southern Illinois in order to delineate the nature of their local hazards knowledge and risk perception. Specifically, it examined whether stakeholders with complex local hazards knowledge held integrated perceptions of risk. It was conducted within the context of rural Southern Illinois; a region characterized by diverse socio-ecological landscapes, and environmental and socioeconomic disparities compared to the rest of the State of Illinois. These regional characteristics provided a rich context to examine within partnership and across watershed variations in the levels of complexity of local hazards knowledge and integration of the three dimensions of risk perception, stated above. Generalization of the nature of and the relationship between local knowledge and risk perception to watersheds beyond this study is challenging as both parameters are deeply rooted in the local context (Greenwood & Levin, 2000). In other words, as local knowledge and risk perception are context-specific, the nature of these parameters and their relationship is also expected to be contextual and tied to conditions inherent to each of the studied watersheds.

Literature Review

In collaborative watershed management, diverse governmental and non-governmental stakeholders work together through partnerships (Bidwell & Ryan, 2006; Leach, Pelkey, &Sabatier, 2002) to prevent and mitigate watershed hazards and risks and to protect ecological and human wellbeing. These stakeholders come from all walks of life and are likely to hold divergent and conflicting views, goals, and interests regarding uses of water resources (Cronin & Ostergren, 2007), as well as varied concerns about hazards (Irwin, 2001). Thus in many watershed management contexts, both local and scientific knowledge are brought into the management process (Irwin, 2001). Through interactions among partnership stakeholders, local and scientific knowledge about watershed hazards blend and varied reinterpretations of scientific knowledge and perceptions of risk among partnership stakeholders materialize (Irwin, 2001; Olsson & Folke, 2001; Sjöberg, 1999, 2001). Diverse reinterpretation of scientific knowledge and risk perceptions are expected in light of stakeholders' varied personal experience and observation, understandings, practices, values, beliefs, and identity (Greider & Garkovich, 1994; Renn, 1992; Schwandt, 2000), institutional and local environmental contexts (Blaike et al., 1997), diversity in resource use and interests of social groups (Duffield et al., 1998), and proximity to natural features (Brody, Highfield, & Alson, 2004).

Prior risk perception research focusing on the relationship between lay knowledge and concerns aimed to devise 'top-down' risk communication strategies that alleviate conceptual and perceptual gaps between laypeople and experts regarding a specified hazard (Bord & O'Connor, 1990, 1992; Bostrom, Fischhoff, & Morgan, 1992; Cvetkovich & Earle, 1992; Maharik & Fischhoff, 1992). These studies largely looked at perceptions of decontextualized and isolated hazards and risks in relationship to factual knowledge, as observed by Cutter (2003), Johnson (1993), and Renn (1998). Three approaches to studying lay knowledge and risk perception were identified by Johnson (1993); the factual approach, the cognitive heuristic approach, and the conceptual approach. The factual approach—the most popular—focused on assessing people's comprehension of facts about hazards and its relationship to their level of concern. The cognitive heuristic approach looked at people's reasoning mechanisms about hazards and their relationship to risk perception. Finally, the conceptual approach—used to a much lesser extent than the latter two approaches—examined people's mental models about a hazard (Johnson, 1993).

Studies under the factual, heuristic, and conceptual approaches loosely defined the term 'lay knowledge,' but generally referred to it as people's comprehension of facts about a specified hazard (Johnson, 1993). Studies under these approaches typically assessed 'lay knowledge' using expert knowledge as a benchmark while following different methodologies. Studies of the factual and heuristic approach assessed knowledge based on the number of "correct answers to factual questions" (Johnson, 1993, p.189). On the other hand, studies under the conceptual approach compared mental models of laypeople to those of experts. In these studies, assessment of knowledge was based on the extent to which lay mental models coincided with those of experts (e.g. Bostrom et al., 1992; Jungermann et al., 1988; Lave & Lave, 1991; Maharik & Fischhoff, 1992).

Findings obtained from studies under the factual approach revealed mixed results regarding the relationship between lay knowledge and level of concern (Johnson, 1993). For instance, Bord and O'Connor (1990) found a positive correlation between factual knowledge about food irradiation and health concerns. However, Baird (1986) did not find factual knowledge to be positively associated with concerns about smelter pollution. Also, Golding et al. (1992) did not find a positive correlation between factual knowledge about radon as a chemical and associated levels of concern. Rather, these latter levels were influenced by contextual social and regulatory factors, such as devaluing of homes and the absence of governmental regulations (Golding et al., 1992). In comparison, studies under the conceptual approach did not touch upon the relationship between knowledge and risk perception (Johnson, 1993). Instead, these studies analyzed and compared people's conceptual understanding about the sources and effects of a specified hazard to those of experts (Johnson, 1993; Leiserowitz, 2006; Taylor-Gooby & Zinn, 2006). Yet, findings obtained from both factual and conceptual studies consistently pointed to people's misconceptions about hazards and irrationality in estimating risks (Lupton, 1999; Sjöberg, 1999; Tversky & Kahneman, 1974), thus disempowering and disenfranchising people from having a stake in hazards and risk management (Cvetkovich & Earle, 1992).

Skepticism about non-expert or laypeople knowledge about hazards conveyed by extant risk perception research has been challenged in the local knowledge literature. Contextualization of hazard knowledge—an approach overlooked by most risk perception research—has made significant contributions to natural resources and hazards management, both in urban and rural settings (e.g. Huntington, 2000; Yli-Pelkonen & Kohl, 2005). Knowledge of the local context is found to complement scientific knowledge in management processes when science fails to quantitatively project uncertainties of socio-ecological systems, particularly at the local level (Berkes, 2007; Garcia-Quijano, 2009). Local knowledge provides clearer insight into the social dimensions of natural resources and hazards, aiding science to more powerfully assess risks (Corburn, 2002). Local knowledge also helps in predicting disasters associated with local hazards and ecological disturbances (Berkes, 2007), as "disasters occur at the interface of society, technology, and environment" (Oliver-Smith, 1996, p.303). Thus, integration of local and scientific knowledge into natural resources and hazards management helps reduce vulnerability and boost resiliency of communities against potential disasters more effectively than only relying on technical assessments (Berkes, 2007; Folke et al. 2005; Haque & Etkins, 2007).

Paradigmatic shifts in watershed management—and hazard and natural resource management in general—from 'top-down' to 'bottom-up' approaches to engage local stakeholders in management require expanding risk perception research to reflect on knowledge of complexities and uncertainties of local socio-ecological systems. Two aspects need to be considered by risk perception studies. The first aspect is the dynamic nature and heterogeneity of knowledge and the role that personal factors and local social and environmental contexts play in the development of local hazards knowledge and risk perception (Johnson, 1993; Fitchen et al., 1987; Flint & Luloff, 2005, 2007; Irwin, 2001; Irwin et al., 1999). Focusing on factual knowledge does not truly represent the nature of local knowledge; especially of those involved in collective action. Social interaction among stakeholders within the context of collective action is suggested to continuously influence both local knowledge and risk perception (Karjalainen & Habeck, 2004; Irwin, 2001). Also, considering only factual knowledge often leads to dismissing variations in knowledge and perceptions across partnership stakeholders representing various social groups (Johnson, 1993; Olson & Folke, 2001). A second aspect to consider is watershed partnerships stakeholders' belongingness to, and engagement in management of, complex socio-ecological systems—such as watersheds—where hazards are multiple and/or interrelated and uncertainties are multifaceted (health, social, and ecological). The notion that local knowledge and risk perception are influenced by the local context suggests that hazards knowledge of stakeholders belonging to and acting in such systems is complex, and their risk perceptions are multifaceted and even integrated. The level of complexity of local knowledge (Olson & Folke, 2001; Ghimire at al., 2004) and the level of integration of risk perception across stakeholders belonging to the same watershed partnership may vary. Thus, risk perception research needs to address heterogeneity in knowledge and risk perception to provide further directions for guiding stakeholders to devise holistic schemes that address the multiplicity and interrelatedness of hazards and uncertainties within complex systems.

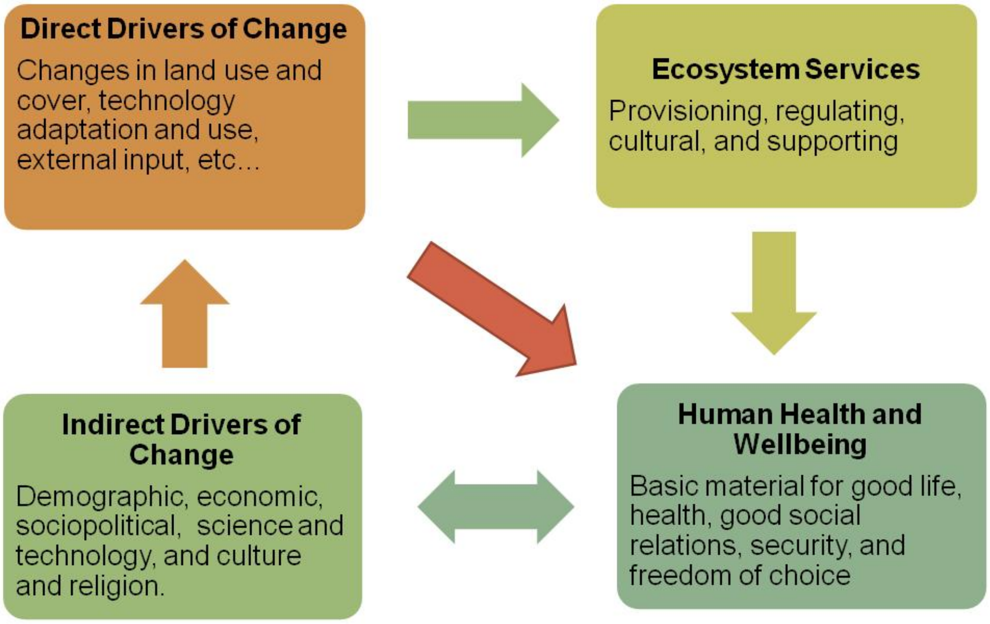
This study examined the relationship between the complexity of local hazards knowledge and integration of risk perception among stakeholders of watershed partnerships in Southern Illinois. It acknowledged the role of the local risk context, herein the watershed risk context, in influencing local knowledge and risk perception (Blaike et al., 1997; Flint & Luloff, 2005) and their relationship. The risk context is the setting in which the biophysical elements, hazards, and the social, economic, and political processes in a community interact to determine community vulnerability to hazards, risks, and disasters (Flint & Luloff, 2007; Tobin & Montz, 1997). Local hazards knowledge, risk perception, and their relationship were also expected to vary by stakeholder background, primarily stakeholders' organizational affiliation, role, and tenure in a partnership.

A conceptual approach was adopted in this study to understand the nature of local hazards knowledge and risk perception and the relationship between the two variables. This approach can provide insight into the variation of the complexity of local hazards knowledge among varied social groups (Johnson, 1993; Taylor-Gooby & Zinn, 2006). The Millennium Ecosystem Assessment Framework (MEA), a universal model to assess diverse contexts, was used in this study as a template or an expert model to assess stakeholders' local hazards knowledge. Comprehensively portraying interrelationships between direct and indirect drivers of change, ecosystem services, and human wellbeing, the MEA framework helped elicit a wide spectrum of stakeholders' perspectives on watershed problems and their effects on ecosystem services and human wellbeing (see Table 4.1and Figure 4.1).

Table 4.1

Definitions of the Millennium Ecosystem Framework Constituents

MEA Constituent	*Definition*
Direct and Indirect Forces of Change	"A driver is any natural or human-induced factor that directly or indirectly causes a change in an ecosystem. A direct driver unequivocally influences ecosystem processes and can therefore be identified and measured to differing degrees of accuracy. An indirect driver operates more diffusely, often by altering one or more direct drivers, and its influence is established by understanding its effect on direct drivers" (MEA, 2005, p.85). Direct drivers of change include physical, chemical, and biological forces (MEA, 2005). Indirect forces include socio-demographic, economic, political, institutional and legal factors.
Ecosystem Services	"They are the benefits people obtain from ecosystems" (MEA, 2005, p.49). Services are classified into *provisioning serv*ices such as food and water; *regulating services* such as flood and disease control; *cultural services* such as spiritual, recreational, and cultural benefits; and *supporting services*, such as nutrient cycling, and provisioning of habitat (p.49).
Human Wellbeing	"Human well-being has several key components: the basic material needs for a good life, freedom and choice, health, good social relations, and personal security" (MEA, 2005, p. 71). "Basic material needs include food, shelter, water, etc. Freedom of choice involves democracy and empowerment of individuals to be active participants in solving issues within their communities. Health includes the absence of disease and illness and healthy physical environment. Good social relations include respect, social cohesion, etc. Security includes access to natural resources and safety of properties and living in a secure environment which is *predictable and controllable*" (MEA, 2005, p. 74)



Direct Drivers of Change

Changes in land use and cover, technology adaptation and use, external input, etc…

Ecosystem Services

Provisioning, regulating, cultural, and supporting

Indirect Drivers of Change

Demographic, economic, sociopolitical, science and technology, and culture and religion.

Human Health and Wellbeing

Basic material for good life, health, good social relations, security, and freedom of choice

Figure 4.1. The Millennium Ecosystem Assessment Framework (Adapted from MEA, 2005)

Methods

The Research Context: Study Site and Watershed Partnerships

This study was framed within the context of rural Southern Illinois. Southern Illinois suffers from adverse environmental, social and economic developmental disparities relative to the rest of the state of Illinois. The region is characterized by its rolling topography, mixed farm-forest landscapes and unique natural areas, and industrial activities, which add to the complexity of the region's watersheds and their corresponding risks. Definitions for what constitutes Southern Illinois are elusive, as it varies by perspective spatial and vantage point. In this study, Southern Illinois was defined as the 16 southernmost counties delineated by the Delta Regional Authority (DRA) to constitute the region.

The 16 counties of Southern Illinois overlapped with six 8-digit HUC watersheds, delineated by the Illinois Environmental Protection Agency. Out of these six watersheds, four—the Big Muddy, Cache, Lower-Ohio Bay, and Saline—were selected as research sites based on the existence of partnerships within these watersheds and the consent of these partnerships to participate in this study. In the Big Muddy watershed, the partnership operated only at the level of the 12-digit HUC Kinkaid watershed. This led to further limiting the research site to the Kinkaid rather than the Big Muddy as a whole to ensure appropriate representation of the watershed (see Figure 4.2).

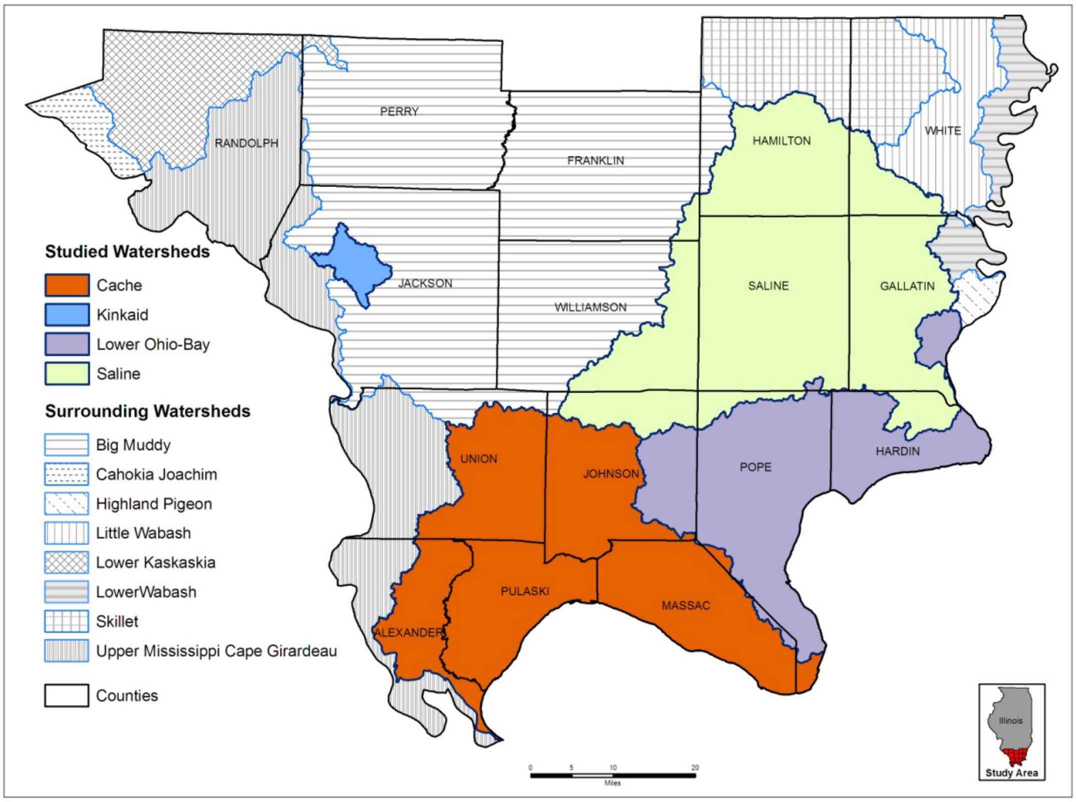


Figure 4.2. The Four Selected Watersheds in Southern Illinois

The four selected watersheds vary in terms of their biophysical and demographic features. They vary in size, land use, topography, population size, and socioeconomic characteristics. The smallest watershed is the Kinkaid watershed, which also has the smallest population. Two of the watersheds are mostly forested (Kinkaid and Lower Ohio Bay), and the other two (Cache and Saline) have a more agricultural profile. Assessment of socioeconomic vulnerability of the four watersheds showed that populations in the Cache, Saline, and the Lower Ohio Bay watersheds are socioeconomically compromised, and are therefore vulnerable to any potential disasters that might occur in the region. For the Kinkaid area, socioeconomic vulnerability assessment indicated low vulnerability (see Table 4.2). Assessment of socioeconomic vulnerability involved interpolating socioeconomic vulnerability indices —

obtained from the Hazards and Vulnerability Research Institute at the University of South Carolina— from the county to the watershed level using ArcGIS. The social vulnerability index is an aggregate score of both socioeconomic and built environment indicators obtained from the US Census data. The socioeconomic dimensions included in the index are socioeconomic status, age, gender, race and ethnicity, employment loss, occupation, family structure, education, population growth, health status, medical services, social dependence, and special needs populations. The built environment dimensions include urbanization, residential property, infrastructure and lifelines, renters, and the presence of commercial and industrial activities. In this study, watershed socioeconomic indices were computed as the sum of the product of county-level indices by the proportion of county population within a given watershed. The product was then divided by the sum of the proportions of county population in a watershed.

Table 4.2

Biophysical and Socioeconomic Attributes of the Four Studied Watersheds in Southern Illinois

Watershed	*Size (Sq. Miles)*	*Population*[1]	*Socioeconomic Index*[2]	*Land Use*	*Topography*
Kinkaid	40.2	1,323	-4.52	Mostly forests	Steep slopes
Cache	963.2	42,435	2.43	✓Mostly agriculture, some forests	✓Flat land in Lower Cache. Hilly in Upper Cache
Saline	1177.3	26,666	2.09	†Mainly agriculture, some forests, coal mining	†Upland area with very steep slopes
Lower-Ohio Bay	598.3	8,146	1.05	♦Minor agriculture, mostly forests	Mostly hilly

Sources: †Saline River Watershed: Rapid Assessment Report (NRCS, 2008)

✓ Cache River Area Assessment: Hydrology, Air Quality, and Climate (IDNR, 1997a)

♦ Shawnee Area Assessment: Water Resources (IDNR, 2002)

[1] Population estimates were obtained by interpolation of census tract data using ArcGIS.

[2] Watershed socioeconomic indices were estimated by ArcGIS interpolation of county level socioeconomic vulnerability indices obtained from the Hazards and Vulnerability Research Institute at the University of South Carolina.

Each of the four selected watersheds in Southern Illinois had one partnership. Thus, four watershed partnerships participated in this study; the Cache River Wetlands Joint Venture Partnership herein the Cache partnership, Saline Basin Partnership herein the Saline partnership, Kinkaid Watershed Partnership herein the Kinkaid partnership, and the Shawnee Ecosystem Partnership in the Lower Ohio Bay watershed, herein the Lower-Ohio Bay partnership. These partnerships varied by their size, type, and stakeholder composition and characteristics, government involvement, and type, level, and scale of activity. The Cache partnership is a mixed public-private partnership developed in 1991 to restore the Cache River and wetlands. The partnership includes three federal/state agencies, the US Fish and Wildlife Service (USFWS), Natural Resource Conservation Service (NRCS), and Illinois Department of Natural Resources (IDNR), and two non-governmental organizations, The Nature Conservancy (TNC) and Ducks Unlimited (DU). Both the private and public partners equally have a stake in planning and decision making (see Table 4.3).

The Saline, Kinkaid, and Lower-Ohio Bay partnerships are citizen-based groups formed under the Conservation 2000 (C2000) Program in 1999. The three partnerships primarily consist of private stakeholders (such as landowners, business owners, and representatives of farmer bureaus and soil and water conservation districts) representing different areas of their watersheds. State agencies in these partnerships have held an ‘encourager’ role (Koontz et al., 2004) and provided these partnerships with needed administrative, technical, and financial assistance. The Saline, Kinkaid, and Lower-Ohio Bay partnerships vary in their scope and scale of activities. The Lower-Ohio Bay partnership primarily works on erosion control through initiating a reforestation project in the Lower-Ohio Bay watershed. The Saline partnership primarily works on mitigating acid runoff from coal mines, technically assessing problems in a sub-watershed, and creating a management plan for these problems in order to obtain funds from the Illinois Environmental Protection Agency (IL EPA). Finally, the Kinkaid partnership mainly works on stabilizing lakeshore erosion and mitigating agricultural runoff into the Kinkaid Lake, which is the only water supplier to areas within and near the Kinkaid sub-watershed (see Table 4.3).

Table 4.3

Attributes of Participating Southern Illinois Watershed Partnerships

	Partnership			
Attributes	Cache	Lower-Ohio Bay	Saline	Kinkaid
Watershed	Cache	Lower Ohio-Bay	Saline	Kinkaid
Watershed Scale	8-digit HUC	8-digit HUC	8-digit HUC	12-digit HUC
Type of partnership†	Mixed	Citizen-based	Citizen-based	Citizen-based
Year established	1991	1999	1999	1999
Number of stakeholders	5 partners (219 total including other private stakeholders)	16	89	82
Organizational affiliation of partners	Federal and state agencies, and NGOs	Landowners and state agencies	Landowners, business owners, and state agencies	Landowners, business owners, NGOs, and federal and state agencies
Role of government✓	Leader	Encourager	Encourager	Encourager→Follower

† Characterization of partnerships was based on the typology of Moore and Koontz (2003).
✓ Characterization of government role was based on the typology of Koontz et al. (2004).

Participant Selection

Acknowledging the heterogeneity of watershed partnerships, a representative sample of stakeholders was selected for this study in order to capture a wide range of perspectives to capture a more complete understanding of the phenomenon under study (Leach, 2002; Leach & Pelkey, 2001). Participant selection was limited to those listed in the partnerships' contact lists;

irrespective of whether these participants were active or inactive members/non-members in their partnerships. These lists provided information about stakeholders' names, organizational affiliation, and contact information, including their mailing addresses, phone numbers, and, e-mail addresses which facilitated the communication and selection processes. Criterion-based sampling was conducted to ensure representation, whereby participants from diverse pools of organizational affiliations were randomly selected. The selection process concluded upon obtaining a diverse sample of participants and the saturation and recurrence of themes that emerged during the participant interview process.

Data Collection and Analysis

A mixed method approach was adopted in this study. Semi-structured interviews were conducted with 33 participants to elicit their local knowledge and risk perceptions of watershed problems. Participants were asked about ecosystem services provided by the watershed, major watershed problems, sources, and effects on ecosystem services and human wellbeing, and their concerns about water quality and watershed risks. Concerns about watershed risk were elicited by asking participants whether they believe in the importance of protecting their watersheds. Both face-to-face and phone interviews were conducted depending on availability of participants. The interview time ranged from 13 minutes to 1 hour and 41 minutes.

Interviews were audio-taped and transcribed verbatim. The transcripts were subjected to directed content analysis (Hsieh & Shannon, 2005) through predetermined coding schemes for analyzing local hazards knowledge and risk perception. Analysis of both local hazards knowledge and risk perception was conducted by coding words and phrases identified in the interview transcripts based on the researchers' interpretations of these themes.

The predetermined coding scheme used to analyze local hazards knowledge was designed in accordance to the elements of the Millennium Ecosystem Assessment framework (see Table 4.1). On the other hand, the coding scheme used to analyze risk perception consisted of three general themes: health, social, and ecological perceptions of risk. In this study, health risk perception referred to concerns about potential threats to human health by watershed hazards. Social risk perception referred to concerns about potential effects of hazards on economic wellbeing, stigmatization of communities and watersheds as places unattractive to live or engage in recreational activities, and potential conflicts among stakeholders due to these hazards. Ecological risk perception referred to concerns about potential effects of watershed hazards on the ecosystem.

The transcribed interviews were transformed into concept maps using a text extraction technique (Carley & Palmquist, 1992); originally used for exploring mental models, which are "internal representation and use of knowledge by learners" (Merrill, 2000, p.1). Text extraction involved transforming text into visual representations of coded concepts and their relationships. Text extraction involved only looking at concepts and relationships that were explicitly stated by participants to avoid any biased interpretations of these concepts. The Millennium Ecosystem Assessment framework was used as a template for constructing the maps. Construction of these maps involved plotting coded concepts generated by the directed content analysis, then defining the relationships between these concepts as evidenced in the interview transcripts. Numbered arrows represented these relationships. Assigning numbers to these arrows helped show the sequence and nature of relationships among concepts. Hence, analysis involved looking at patterns of unidirectional relationships (one-sided), indicating the influence of an Millennium

Ecosystem Assessment element, and bidirectional relationships (two-sided), indicating the influence of two Millennium Ecosystem Assessment elements on one another.

The generated concept maps were then quantified by computing scores that assess the complexity of stakeholders' local hazards knowledge. Complexity was conceptualized in terms of *structure* and *process* presented in the concept maps (Merrill, 2000) and assigned a total score as follows:

$$C = S * P$$

where,

C referred to *complexity*,

S referred to total score of *structure*, and

P referred to total score of *process*.

'Structure' of local hazards knowledge was conceptualized in terms of the presence of the four main elements of the Millennium Ecosystem Assessment framework (direct and indirect forces of change, human wellbeing, and ecosystem service). Each element present in the concept maps was assigned a score of "1." Thus, the total score for the structure of local hazards knowledge ranged from 1 to 4.

Analysis of 'process' conventionally examined four main characteristics of relationships between concepts: strength, sign, directionality, and meaning (Carley &Palmquist, 1992). In this study, only two of the relationship criteria, depicted above, were used to conceptualize process: strength (particularly presence) and directionality, as these two criteria met the objectives of this study, i.e., in terms of identifying the nature and number of relationships between the Millennium Ecosystem Assessment constituents. 'Presence' refers to "the existence of a statement in the text indicating a relationship between concepts" (Carley &Palmquist, 1992, p.613). This criterion is most commonly used for comparison across maps (Carley &Palmquist, 1992). Directionality, referring to “the direction of the relationship between two concepts” (Carley &Palmquist, 1992, p.613) was used to specify whether existing relationships were unidirectional or bidirectional. A score of “1” was given for each unidirectional relationship, and a score of “2” was given for each bidirectional relationship. Participants were then placed into three groups based on their local hazards knowledge complexity score: (a) not complex, (b) complex, and (c) very complex. Categorization of complexity scores was based on the distribution of these scores in relation to the median z-scores.

Regarding risk perception, participants’ integration of concerns was analyzed based on the number of concerns and the presence of a relationship between articulated concerns. Participants were then qualitatively grouped into three categories including those characterized by: (a) non-integrated risk perceptions, referring to the presence of one, two, or all three concerns without articulating any associations between concerns; (b) partially integrated risk perceptions indicating the presence of two or three concerns, but associations were drawn between only two concerns; and (c) integrated risk perceptions indicating articulations between all three concerns.

A matrix, with columns indicating the nature of local hazards knowledge and rows indicating the nature of risk perception was created. This matrix was used to sort participants in order to further identify factors that might contribute to the complexity of local hazards knowledge and integration of health, social, and ecological risk perception. These factors involved the local context, organizational affiliation, and tenure and role in watershed partnership.

Ensuring the trustworthiness of qualitative data analysis and construction of concept maps involved looking at issues of sampling and data analysis. In mixed methods, trustworthiness of data becomes more powerful if both purposive and probability sampling are adopted (Kemper, Stingfield, & Teddlie, 2003). In this study, trustworthiness of data was established by adopting criteria and random sampling. Criteria sampling was adopted to ensure the representation of stakeholders with varied organizational affiliations. Random sampling was then adopted to select participants from within each of the organizational groups. As for data analysis, interpretive validity (Johnson & Turner, 2003) was maintained by only considering themes and relationships that were explicitly stated by the participants, in order to accurately reveal the associations between the coded concepts. Interpretive validity was further established by validation of coded concepts and their relationships by two additional readers.

Several methodological limitations were inherent to this study that might hinder the complete reflection on the status of participants' knowledge. These limitations included the small sample size of participants, possible response bias related to interview time and participants' attention, and clarity of interview questions which evolved through the course of this study. In other words, a low complexity score does not necessarily mean that participants do not hold complex knowledge, as these participants might have found it difficult to articulate concepts during the course of the interview.

Results

Participants

A total of 33 stakeholders participated in this study; 12 from the Cache, 5 from the Shawnee, 7 from the Saline, and 9 from the Kinkaid. Participants varied by their organizational affiliation, and years of tenure, roles, and motives for involvement in partnership. They included the four coordinators of the participating watershed partnerships; five representatives of non-governmental organizations; thirteen business owners, land owners, and residents; eight representatives of federal or state agencies; five representatives of county/city councils; and two stakeholders belonging to the academic and media domains. Of the 33 participants, four were involved in their partnerships for less than 5 years, 16 were involved for 6 to10 years, seven were involved for 11to15 years, and two were involved for more than 15 years. Participants held various roles in their partnerships. Almost half of the participants (n = 16) were members in their partnerships, and less than one third (n = 8) were volunteers or supporters. Seven participants were technical advisors, two of whom were members in their partnerships.

Comparison of participant characteristics across the four studied watersheds revealed that there were more male participants than females. Participants of each watershed had varied organizational affiliations. In the Saline (n = 4), Kinkaid (n = 5), and Lower Ohio Bay (n = 3) almost half of the participants were members and board members of their partnerships, compared to the Cache where only two participants were members of their partnership. Years of involvement of participants also varied across the four watersheds. In the Cache watershed, two participants reported being involved in their partnership for more than 15 years. In the Saline watershed, most of the participants (n = 6) were involved for 6-10 years. In the Kinkaid, most of the participants (n = 8) were engaged in their partnership for more than 6 years. Finally, in the Lower Ohio Bay, three participants were involved for 6-10 years, and the other two were involved for less than 5 years (see Table 4.4).

Table 4.4

Distribution of Participant Characteristics by Watershed

	Watershed			
Participants' Attributes	Cache	Saline	Kinkaid	Lower Ohio Bay
Gender				
Male	7	5	9	4
Female	5	2	0	1
Total	12	7	9	5
Organizational affiliation				
Federal/State	4	1	1	2
County/City agency	2	1	2	0
Business/Landowners/ Residents	3	2	5	3
Non-governmental organization	2	3	0	0
Others	1	0	1	0
Total	12	7	9	5
Role in partnership				
President/Coordinator	1	1	1	1
Board member	0	0	3	0
Member	2	4	2	3
Not a member	6	0	0	0
Technical Advisor	1	2	2	1
Volunteer	1	0	1	0
Total	11	7	9	5
Years of involvement in partnership				
< 5 years	1	0	1	2
6-10 years	3	6	4	3
11-15 years	2	1	4	0
>15 years	2	0	0	0
Total	8	7	9	5

The Nature of Local Hazards Knowledge of Watershed Partnership Stakeholders

Around 76% of the participants (n = 25) articulated concepts relating to all four constituents of the Millennium Ecosystem Assessment framework. The remaining participants (n = 7, 21%) expressed concepts associated with only three constituents of this framework and articulated concepts primarily relating to direct forces, indirect forces, and ecosystem services. Only 3% (n = 1) referred to two constituents of the Millennium Ecosystem Assessment framework, primarily direct forces and ecosystem services. Around 88% of the participants (n = 29) did not articulate interrelationships between all the articulated constituents of the Millennium Ecosystem Assessment framework while discussing the effects of watershed problems on ecosystem services and human wellbeing.

When asked about major environmental problems (direct drivers of change), almost all participants reported multiple hazards in their watersheds. Most of the identified hazards were human-made, related to land use, erosion and sedimentation, and technology use (such as the post-creek cutoff in the Cache), were articulated by stakeholders of all four watershed partnerships. Natural hazards were identified to a much lesser extent. Both human and natural hazards were contextual and varied across watersheds. For natural hazards, flooding was articulated most by participants of the Cache (n = 8, 67%) and Saline (n = 6, 86%), but not by Kinkaid and Lower Ohio Bay.

When asked about the effects of environmental hazards on the ecosystem and human wellbeing, all participants articulated at least unidirectional relationships mostly indicating the effects of direct drivers of change on ecosystem services. They noted the effect of multiple direct drivers on at least one ecosystem service in their watersheds, primarily reporting on direct changes in provisioning services (mainly water resources, wildlife, and agriculture). Direct changes in regulatory services, especially in water regulation processes, cultural services (primarily recreation), and supporting services (mainly wildlife habitat) were also reported. Forty-nine percent of the participants (n = 16)—Cache (n = 9), Saline (n = 2), SEP (n = 2), and Kinkaid (n = 3)—also articulated indirect associations between drivers of changes and an ecosystem service, that were often mediated by other constituents of ecosystems services. For instance, a participant of the Cache mentioned that soil erosion and sedimentation (direct driver) has influenced the Cache River's aquatic habitat (supporting service), thus affecting fish populations (cultural service):

> My perception is that the sedimentation that occurred with large scale agricultural production in an area that had these—part of the watershed included these native communities—is that the increase in sedimentation affected the fisheries resource and the aquatic habitat and made it more difficult for the species to thrive and reproduce. (CJVP5)

Fifteen participants (46%) across the four watersheds, primarily participants of the Cache (n = 9, 75%), expressed bidirectional relationships between direct drivers of change and ecosystem services, a relationship not denoted in the Millennium Ecosystem Assessment framework. Disturbances in ecosystem services initially induced by direct drivers of change were perceived by participants to have augmented existing direct drivers or created other forms of direct drivers. For instance, a participant mentioned that straightening tributaries of the Cache River to drain water (direct driver) disrupted water regulation by increasing the flow of water (regulatory service), as the meanders of these tributaries were diminished. Accelerated flow led to stream bank erosion (direct driver):

> CJVP7: It's [flooding] original cause is natural, but as the tributaries coming into the Cache carry more and more water, the sides of those—the banks—of those tributaries are sloughing off, and huge amounts of silt are actually coming in from the sides of the tributaries, and the tributaries are getting larger. So, that's not natural. That's manmade.
>
> Interviewer: Can you please tell me how is that manmade?
>
> CJVP7: Because the tributaries have been straightened, and so instead of meandering and slowing the water down as it comes in, they've been straightened, and it rushes down and literally takes with it sides of the channel that it's going through.

Fifteen participants (46%) across all four watersheds articulated effects of direct drivers on human wellbeing. Most of these relationships were unidirectional in nature. These drivers were believed by participants across all four partnerships to have primarily impacted people's livelihood, safety, and security. For instance, in the Cache and Saline partnerships, participants mentioned that people's security was directly threatened by flooding and soil erosion. Flooding accelerated soil erosion from agricultural fields (direct drivers), thus threatening agricultural properties (security):

> The flooding will cause a certain amount of erosion every year. We have really good topsoil—carry it away. So, it would lessen the worth of the property … (SBP2)

In addition to impacts of direct drivers on the latter constituents of human wellbeing, participants belonging to the Kinkaid mentioned that direct drivers, primarily erosion and sedimentation, influenced people's accessibility to lake water (access to natural resources) for recreation:

> Well, the most dramatic impact has been the upper end of the lake... There used to be a small marina up there, and that silted in so badly that the boat slips for that marina ended up on dry land. There's tons and tons of silt. It basically eliminated that area of the lake. On the other side of highway 151 there used to be about forty acres of open water. There's nothing but cattails there now. There was a boat ramp with the marina. You can't launch a boat there anymore. Right across from it is Forest Service area called Johnson Creek which has a boat launch, but they're about to lose that, too. (KWP1)

Human wellbeing was thought by two participants of the Cache to have historically and directly contributed to direct forces in their watersheds. For instance, a participant assumed that drainage of wetlands (direct force) was implemented to eradicate malaria—an endemic disease (human wellbeing), which formerly constituted a major concern for the Cache watershed population:

> I have been told—I wasn't around before the post creek cut off. A lot of this area was stagnant at that time, and they said that there was a lot of malaria and diseases from insects—from mosquitoes from back at that time. After the post creek cut off, there was not as much stagnant water as there used to be back then, I guess, and that has increased the quality of life a lot. (CJVP9)

Relationships between direct drivers of change and human wellbeing mediated by a third factor were not commonly expressed by participants. Only nine participants (27.2%) belonging to the Cache (n = 2), Saline (n = 2), Kinkaid (n = 4), and Lower-Ohio Bay (n = 1) expressed the mediating role of ecosystem services in the relationship between direct drivers of change and human wellbeing. In other words, they believed that disturbances in ecosystem services induced by direct drivers of change affected some aspects of human wellbeing. For instance, a participant of the Kinkaid mentioned that soil erosion and sedimentation (direct drivers) reduced the

Kinkaid lake's water carrying capacity (regulating service), leading to less accessibility to some parts of the lake by people for recreation purposes (access to natural resource - human wellbeing):

> Sedimentation fills in the area, so it reduces the amount of area where people can fish and enjoy—do boat rides. They can't go everywhere where there's sediment. If the sediment—and what used to be a six or eight foot of water area and now there's only two feet of water—well, you can't take a boat in if it draws two feet of water. So, it restricts the area that people can have [for boating]. (KWP5)

Participants across all four partnerships articulated indirect forces underlying environmental problems in their watersheds. Participants commonly perceived watershed problems to be influenced by deficient partnership funding (economic), lack of maintenance of infrastructure, such as levies, and follow up schemes (governance), culture, and regulations (institutional and legal framework). Unlike the Saline, Lower Ohio Bay, and Kinkaid participants, participants of the Cache explained the historical contexts underlying environmental problems in their watersheds. For instance, the Cache participants noted that problems in the Cache were triggered historically by deteriorating economic conditions in their watershed. Extensive deforestation and drainage of wetlands through the post creek cutoff[1] into the Ohio River, was carried out in the last century for land speculation, commercial timber harvesting, and agricultural expansion.

Moreover, forces identified by the Millennium Ecosystem Assessment as indirect forces were particularly seen by participants of the Cache (n = 7) as having a direct influence on well-being. Political tensions (indirect forces) between the Cache partnership and local people have strained social relations between the two groups and limited the ability of locals to participate in the management activities (freedom of choice):

---

[1] Post creek cutoff: is a channel devised to drain wetland waters from the Cache watersheds into the Ohio River.

> You know, I'm not really sure. I think it's because [names of local people]—I think they have such a tight relationship with the DNR, being former employees. And they were not management. They were just—they're just considered to be locals, and so I think that some of the academics in the agency that are in higher levels of the bureaucracy—they kind of look down. There's kind of a class difference there, and so they think that [names of local people]—that they're trying to do too much, or that they don't deserve the position that they think they should have. And so they just cut 'em out. (CJVP9)

Stakeholders' Perceptions of Watershed Risks

All the participants expressed concerns about watershed risks. The nature of these concerns varied among stakeholders and across watersheds. Health concerns about watershed problems, mostly related to water quality risks, were mainly expressed by participants of Kinkaid (n = 6, 67%) and, to a lesser extent, by participants of Saline (n = 2, 29%). These concerns related to safety of drinking water, potential toxicity and illnesses, and community wellbeing:

> A high sulfur content eventually leaching into the water system—you know, if water is moving, it's not going to leach into your ground water, but if it's water that has been standing for several years, eventually that's going to cause some problems… Well, according to—it would be the professionals that tell us all this information—are saying that a high sulfur water is more dangerous to health concerns, eventually. (SBP4)

> Well, there again, if we would happen to pick up high amounts of mercury or high amounts of any chemical that's not suitable for human consumption—because like I say, there's about thirty thousand people that's depending on the waters that's coming out of the lake there. ... It will cause sickness, illness, you name it. You've got to have good water to exist. (KWP3)

> Since we're—what? Sixty-eight percent water—our bodies are. If we need to drink water every—the recreational is not as big a deal, but down the road, by drinking—just the fact of us having to drink water—the health of the community. (KWP5)

The Lower-Ohio Bay participants were not concerned about water quality and potential health effects as they believed their water quality to be among the best in the state. Also, in the Cache watershed, hardly any participants were concerned about water quality.

Ecological concerns about potential effects of watershed hazards were prevalent among participants across all four partnerships. Common concerns related to the loss of wildlife, both terrestrial and aquatic, and modifications of the physical and aesthetic attributes of watersheds:

> Fish and wildlife is being trapped in between these beaver dams, and the free movement is severely restricted... If they don't have free movement, due to these flow obstructions for one thing—now, the second thing is the true wetlands, as I know 'em to be, no longer—a lot of 'em no longer exist and have been transformed into shallow water swamps... And that is the very reason that all these oaks and all these forests grew in this basin years and years ago—because the conditions were dry in the summer time. Now, it always got periodically flooded, and that might last six months out of the year, but oak trees, cypress trees can very well tolerate them conditions. It's only when you put permanent water around an oak tree that it will kill it eventually. (CJVP1)

> If it's always about land use, whether it's wildlife habitat or water quality, you just have to keep your eye on what's going on in the watershed. If you're concerned about declining wildlife habitat it's because we're converting habitat—forest, grasslands—to permanent structures—parking lots, shopping malls. If its lakes and water quality is deteriorating, it's either uncontrolled waste water, sewage, private sewage, or sediment from the watershed. (KWP4)

Another concern common to participants of Kinkaid and Cache related to the loss of water resources. For instance, a Kinkaid participant was concerned about the loss of the Kinkaid Lake due to sedimentation. Two participants of the Cache were concerned about the loss of the Cache River and wetlands:

> Because I've seen the result. I've seen the sedimentation. In just the nineteen years I've been, I've seen acre upon acre that is just—trees are growing on it where as nineteen years ago it was over water. So, I'm concerned we won't see another lake like this, as far as I can imagine, in the next hundred years. So, I'm looking at people down the road. (KWP5)

> I think, first of all, if we don't maintain a flow of the river in the watershed and we don't maintain a watershed, then there won't be water to have a quality—and it could just disappear. (CJVP3)

In the Lower-Ohio Bay, a participant expressed concerns about keeping the watershed pristine and preserving water quantity. Two Saline participants were concerned about existing watershed hazards to have the potential to amplify other existing hazards. For instance, an SBP participant mentioned that flooding might increase stream-bank erosion. Another Saline participant explained that obstructions of water flow by debris and logs in streams might amplify flooding events:

> Also, there was a concern about debris in designated areas of Lamington. And when we talk about debris we talk about what the flooding would bring in—the tree limbs and things like that. (SBP6)

Social and economic concerns were expressed by around 67% of the participants (n = 22) across all four watershed partnerships. Commonly expressed concerns related to stigmatization of watersheds that might inflict economic and social repercussions. Seven participants (21%) from KWP (n = 4, 44%) and CJVP (n = 3, 25%) perceived that deteriorated watershed conditions might influence economic and cultural wellbeing with impacts on recreation:

> "There's a recreational implication. It won't be as nice a place for people to come and play". (KWP1)

Three participants (33%) of the KWP mentioned that deteriorated water quality caused by watershed hazards might lead to economic consequences in terms of increased cost of water treatment:

> The water's there, but because of the problems with the water quality, you have to spend an exorbitant amount of money to clean it before it's given to the public. And I've had enough of the board meetings at the lake here that I know how expensive it is to correct things. So, if you have water that has minimal treatment, you don't have to add a lot of chlorine to it or get solids out of it, you can keep the cost to the public down. (KWP2)

Moreover, an SBP participant expressed concerns about property security and two CJVP participants were concerned about hurdles that might be imposed by hazards on quality of life in their watersheds:

> Well, eventually my house is gonna fall into the stream [due to streambank erosion]. (SBP4)
>
> Well, without it [watershed] you can't raise crops on the ground. You can't—the value of the ground decreases if you can't farm it. There would be a lot of local roads that would be impassable a lot of times. There would be people that would be flooded out of their homes and their buildings. It would disrupt the school systems with the bus routes. (CJVP 10)

Finally, six participants (18%) across all four partnerships were concerned about sustaining their watersheds for future generations:

> My granddaughter is only two years old. I'd like her to grow up and be able to go to a lake that's nice. So, the future of—we'll only be on this land so long, but our kids are following us. Unless somebody says, "Let's do this and protect it and do the right things," when the kids show up it'll look like a piece of junk. (KWP8)

The number of concerns expressed by participants varied within partnerships and across watersheds. Results showed that around 39 % of participants of all four watershed partnerships expressed two forms of concerns (mostly social and ecological), 33% of all participants held one concern (primarily ecological), and around a quarter of all participants expressed all three concerns (24%). Whereas, more than half (56%) of the Kinkaid participants held health, social, and ecological concerns, hardly any of the SEP participants held all three concerns (see Table 4.5).

Table 4.5

Frequency Distribution of the Number of Concerns Held by Participants by Watershed

	No Concerns		*One concern*		*Two concerns*		*Three concerns*	
Partnership	n	%	n	%	n	%	n	%
Cache (n=12)	-	-	4	(33.3)	6	(50.0)	2	(16.7)
Kinkaid (n=9)	1	(11.1)	2	(22.2)	1	(11.1)	5	(55.6)
Saline (n=7)	-	-	2	(28.6)	4	(57.1)	1	(14.3)
Lower-Ohio Bay (n=5)	-	-	3	(60.0)	2	(40.0)	-	-
Total (n=33)	1	(3.0)	11	(33.3)	13	(39.4)	8	(24.2)

Relationship between Local Hazards Knowledge and Risk Perception

To reiterate, complexity scores of local hazards knowledge were computed as the product of *structure* (the number of articulated Millennium Ecosystem Assessment elements) and *process* (the number of relationships between articulated Millennium Ecosystem Assessment elements). Complexity scores varied across partnerships and watersheds. The median local hazards knowledge scores were highest for participants of the Caches (median = 32.0, *SD* = 18.2), lower for participants of Saline (median = 30.0, *SD* = 11.5) and Kinkaid (median = 20.0, *SD* = 13.2), and lowest for participants of the Lower-Ohio Bay (median = 18.0, *SD* = 11.2). Variations in the level of complexity of local hazards knowledge were also observed among stakeholders belonging to the same partnership. Variations were observed both in the number of concepts and their relationships as shown in Figures 4.3 a & b.

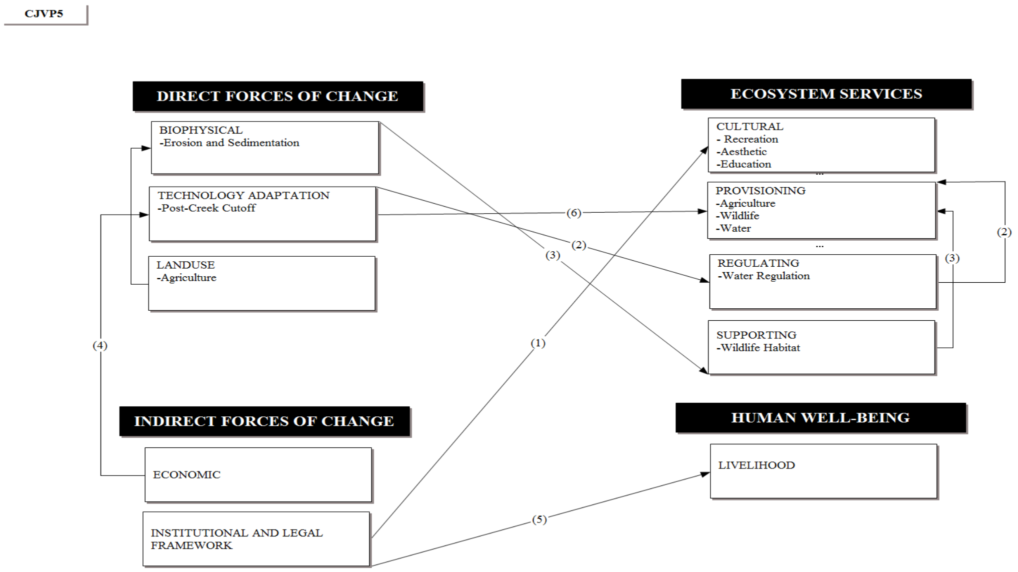


Figure 4.3 a. A Concept Map of a State Agency Representative belonging to CJVP

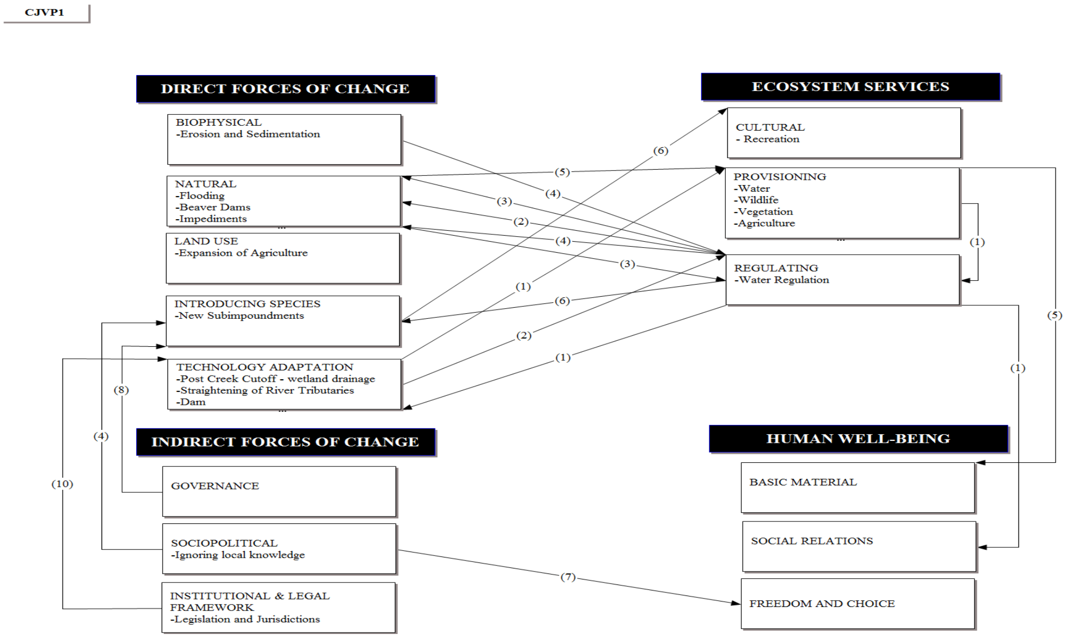


Figure 4.3 b. A Concept Map of a Non-Governmental Organization Representative belonging to CJVP and a Resident of the Cache Watershed

Around 90% (n = 31) of the participants had local hazards knowledge z-scores between (–1.69) and (+1.32) *SD*. Participants with z-scores below the median were considered “not complex”, those above or equal to the median (median = 0.008) were considered “complex”. Scores exceeding (+1.32) *SD* were considered “very complex”. More than half of the Cache (n = 8, 67%) and Saline (n = 5, 56%) participants held complex to very complex knowledge and had scores higher than or equal to the median local hazard knowledge score (median = 28.0). On the other hand, more than half of the participants of the Kinkaid (n = 6, 67%) and of the Lower Ohio Bay (n = 3, 60%) held non-complex local hazards knowledge, and scored less than the median score. As for risk perception, around 70% of the participants (n = 23), including all participants of the Lower-Ohio Bay (n = 5), held non-integrated perceptions of risk. In most instances, participants did not make association between the different forms of concerns (i.e. health, social, and ecological) they had expressed. Around 27% of the participants (n = 9)—four of which belonged to the Cache partnership—held partially integrated risk perceptions articulating relationships mainly between social and ecological concerns. For instance, a Cache participant stated the significance of protecting ecological value of the Cache watershed (ecological concern) to better promote recreation and educational opportunities provided by such ecological diversity:

> I’m a very firm believer that we should maintain natural areas, especially the ones that are incredibly unique. It’s just I think it’s our duty as citizens of this country to maintain areas like that and show—let subsequent generations see what this land was like. Plus, the recreational and educational opportunities are just phenomenal. (CJVP8)

Only one participant of the Cache held integrated perceptions, articulating associations among health, social, and ecological risk perceptions:

> What all of the research is showing us in terms of ecosystem services is that places like this are very important to our quality of life, just in terms of, “Do we have clean air to breath, fresh water to drink”—all of this stuff. So, there’s that, and then I personally

> would like to conserve this place—along with a host of others—because, again, I think it's going to be important to our future survival and flourishing as a species. So, from a very greedy perspective, I want my daughter and her children to be able, again, to have clean water to drink, fresh air to breathe and be able to have their needs met. (CJVP12)

A 3x3 matrix was generated based on the emergent categories of local hazards knowledge and risk perception. This matrix revealed that participants holding non-integrated risk were almost equally divided between the non-complex and the complex and very complex local hazards knowledge categories. Also, it was observed that participants holding partially integrated risk perceptions were equally divided between the non-complex and complex local hazards knowledge categories. The two participants holding very complex local hazards knowledge held either non-integrated or partially integrated risk perceptions (see Table 4.6).

Table 4.6

Cross-tabulation of the Complexity of Local Hazards Knowledge and the Level of Integration of Risk Perception by Participants

	Complexity of Local Hazards Knowledge				
Integration of Risk Perception	Not Complex		Complex		Very Complex
Not Integrated	SBP7	SBP3	CJVP10	CJVP9	CJVP11
	CJVP5	CJVP4	CJVP7	CJVP3	
	SEP3	SEP4	SBP6	SBP5	
	SEP5	KWP5	SBP2	SBP1	
	KWP7	KWP3	SEP2	SEP1	
	KWP4	KWP1			
Partially Integrated	KWP8	KWP6	KWP9	KWP2	CJVP1
	CJVP6	CJVP2	CJVP8	SBP4	
Integrated			CJVP12		

Participants with complex local hazards knowledge and partially integrated risk perception had been involved in their partnership for more than 10 years and had different organizational affiliations and roles in their partnerships. These participants were non-governmental stakeholders representing non-governmental organizations, local residents, and local agencies. Three of the four participants with complex local hazards knowledge and partially integrated risk perceptions were members in their partnerships.

Discussion

This study tackled an understudied domain relating to the complexity of local hazards knowledge and the nature and integration of risk perception. It looked at knowledge of and concerns about multiple local hazards, an aspect overlooked by most risk perception research which typically examined decontextualized and isolated risks, as suggested by Cutter (2003) and Renn (1998). Findings from this study revealed variations in local hazards knowledge and risk perceptions among stakeholders belonging to the same partnership and across contexts, thus supporting findings of other studies, such as Olson & Folke (2001) and Irwin (2001).

Watershed partnerships are dynamic heterogeneous groups (Cronin & Ostergen, 2007). Similar to a community, representatives of diverse social groups act together within these partnerships to improve the social and ecological wellbeing of their locale (Wilkinson, 1991), in this case their watershed. Findings from this study suggest that engagement of stakeholders in a watershed partnership for long durations may not eventually contribute to homogeneity of local hazards knowledge and risk perception. This study showed that richness and diversity of perspectives were maintained despite the longevity of stakeholders' involvement in their partnerships.

Variations in the complexity of local hazards knowledge were apparent both in terms of the nature and level of connections drawn by participants between the four elements of the Millennium Ecosystem Assessment framework. It was evident that participants predominantly articulated unidirectional relationships indicating direct effects of direct forces of change on ecosystem services and, to a lesser extent, human wellbeing. Moreover, bidirectional associations between direct forces of change and ecosystem services were articulated by stakeholders to varying extents. Also, not all participants belonging to the same partnerships articulated ecosystem services mediating associations between direct forces of change and human wellbeing. The number of each of the observed relationship patterns varied substantially across participants belonging to the same partnership. Yet, not articulating indirect relationships may not necessarily indicate lack of knowledge on the part of participants. In other words, these participants might have known about such relationships, despite not articulating them during the interviews (Fazey et al., 2006).

Complexity of local hazards knowledge seemed to be influenced by stakeholders' proximity to hazards and natural resources. Personal observation and experience provide additional inputs into the complexity of local hazards knowledge, as was evident with the case of one of the participants. This participant was a non-governmental organization representative and a non-member of the Cache partnership and attained the highest complexity score compared to participants of all four partnerships. The complexity of his/her knowledge was evident throughout his/her discourse and comments:

> The current situation is pretty unreal. Even though there's propaganda floating around to the contrary—most of it being spread by people that's outside the area that really don't know what's going on here. And by me being a seventy year resident of the area—and currently I live right next to the wetlands, which the wetlands is part of my back yard. I've monitored the conditions for years, and I'm not bragging. I'm just giving you the facts. I know more about the historical and present conditions of this system than any two human beings on planet Earth. (CJVP1)

Substantial variations in the complexity of local hazards knowledge were also apparent across the four watersheds. This variation highlights the role of the local risk context in shaping local knowledge (Blaike et al., 1997). In other words, complexity of watershed problems, in terms of their multiplicity, nature, and interconnectedness, and the historical progression of hazards and their effects on ecosystem and human wellbeing add to the complexity of local knowledge. Complexity of local hazards knowledge scores were higher for participant stakeholders of the Cache and Saline, compared to those of the Lower-Ohio Bay and the Kinkaid. The Cache participants, who attained the highest scores compared to the all other stakeholders, commonly referred to the historical context while discussing current conditions of hazards and their effects in their watershed. Hence, holding a historical perspective can lead to a more complex and holistic overview of watershed issues (Fazey et al., 2006).

By examining the nature of risk perception, this study provided an account of stakeholders' concerns in relation to contextualized multiple hazards, thus overcoming broad and vague assessments of risk perceptions often generated by studies that looked at factual knowledge of decontextualized and isolated hazards. In other words, this study looked at the nature of stakeholders' concerns about potential effects of multiple contextualized watershed hazards and the role of the complexity of local hazards knowledge in the integration of these concerns.

Following Flint & Luloff (2005), this study shows that local context influences risk perception. Variations in the nature of concerns were observed across the four watersheds. While social and ecological risk perceptions were common among participants of all four partnerships, health risk perception was particularly evident among Kinkaid participants. Communities in and close to the Kinkaid watershed depend on surface water, the Kinkaid Lake, for water supply and recreation, compared to communities in the Cache, Saline, and the Lower Ohio Bay that heavily depend on groundwater sources. Thus, this study showed that personal use of a water resource does not only influence risk perception (Canter, Nelson, & Everette, 1992-1993), but also influences the nature of risk perception.

A major finding of this study was that neither complexity of local hazards knowledge nor tenure and role in partnership were strong indicators of integration of concerns. Partially integrated risk perception was expressed by participants holding complex and non-complex knowledge. Partially integrated risk perceptions most often indicated associations between social and ecological concerns. Participants, including those who connected social and ecological concerns, did not draw associations between all three dimensions of risk perception (health, social, and ecological), even in the Kinkaid watershed. Hence, integration of social and ecological concerns might be associated with a form of bias associated with *availability heuristic*, known as the *illusory-correlation effect* (Tversky & Kahneman, 1974). The latter concept states that:

> … a judgment of how frequently two events co-occur could be based on the strength of the associative bond between them. When an association is strong, one is likely to conclude that the events have been frequently paired. Consequently, strong associates will be judged to have occurred together frequently. (Tversky & Kahneman, 1974, p. 1128)

The Southern Illinois area is known for its recreational and aesthetic properties. The region attracts tourists and is a home for rich biodiversity. However, disturbances to ecological wellbeing are perceived to diminish both recreational and economic opportunities in the region. Such conditions might have led participants to draw associations between their ecological and social concerns.

Conclusion

This study showed the need for building the capacity of stakeholders in watershed partnerships to think holistically about problems and uncertainties associated with complex socio-ecological systems. Stakeholders are advised to consider the interactions among social, health, and ecological dimensions of such systems. Attaining a holistic perspective by stakeholders belonging to the same partnerships does not mean that they should hold homogeneous views about their watersheds. It is highly recommended that stakeholders hold various holistic perspectives in order to diversify the portfolio of salient watershed issues to effectively tackle the complexity, diversity, and uncertainties of watersheds. However, building the capacity among stakeholders only through enhancing their knowledge structure is not enough. There is a need to integrate diverse knowledge structures (local and scientific), risk perceptions, and interests through establishing *communicative linkages* to find commonalities across all partnership stakeholders (Bridger & Luloff, 2001, p. 384). Such coordination among stakeholders is crucial to devise watershed management schemes inclusive of all their perspectives and to build resilience against potential risks and disasters in their watersheds.

CHAPTER 5

LOCAL KNOWLEDGE AND RISK PERCEPTION OF WATERSHED HAZARDS AMONG STAKEHOLDERS OF WATERSHED PARTNERSHIPS IN SOUTHERN ILLINOIS

Introduction

Collaborative watershed management has gained much popularity in the US during the past three decades, as thousands of partnerships between governmental and non-governmental stakeholders have emerged and shown promising capabilities to deal with the complexities and uncertainties of watersheds (Healey, 2001; Sabatier et al., 2005a). Collaboration is thought to enhance watershed governance and decision making by boosting resources, helping develop state of the art policies, and building the capacity of stakeholders to properly identify and address watershed problems (Imperial & Hennessey, 2000). Given these characteristics, collaborative watershed management has been particularly valued in rural watersheds where local government institutions often have limited financial, human, and technical capacities to deal with the complexities of watershed problems (Imperial & Hennessey, 2000).

Not all collaborative endeavors are successful in maintaining their sustainability and achieving their environmental potential, primarily due to inadequate funding, ineffective leadership, and poor designs of decision-making processes (Leach & Pelkey, 2001). While some barriers to success are known, the roots of the problem have not been fully explored. A watershed partnership's capacity to achieve its environmental potential can be also limited by stakeholders' competing interpretations of and concerns about hazards in the surrounding environment (Lupton, 1999). Hence, strengthening collaborative watershed management to prioritize and find solutions to complex watershed problems can be attained if varied stakeholders perspectives and concerns are addressed. Accordingly, understanding factors underlying variations in local hazards knowledge and risk perception can help watershed partnership stakeholders follow an integrated approach that incorporates varied perspectives and concerns and is considerate of stakeholders' personal background and experiences with watershed hazards. In this study, local hazards knowledge refers to stakeholders' awareness of the prevalence of multiple watershed hazards and their effects on ecological and human wellbeing. Risk perception refers to stakeholders' level of concern about the effects of watershed hazards on health, social, and ecological wellbeing.

This study examines factors underlying variations within and across four watershed contexts in Southern Illinois regarding: (a) watershed partnership stakeholders' awareness of the prevalence of multiple watershed hazards and their effects on ecological and human wellbeing; (b) their nature and level of concerns about these hazards; and (c) the relationship between local hazards knowledge and risk perceptions. A major challenge in this study relates to the tension between generality and specificity. Generalizing the relationship between local knowledge and risk perception to other contexts is rather limited given the contextual nature of both parameters (Greenwood & Levin, 2000).

Selection of Southern Illinois as a research area was related to its assorted topography, land cover, commercial and industrial activities, and rich history of environmental change. These characteristics provided a context to compare across different watershed contexts confined within the same region. A mixed method approach using both secondary data (water quality and flooding) and survey data is adopted in this study to assess the proposed conceptual framework delineating the relationship between the watershed risk context, local hazards knowledge, and risk perception.

Literature Review

Collaborative watershed management aims to conserve watersheds and to address environmental hazards in watersheds (Michaels, 2001). Through public-private partnerships, stakeholders act together to prevent and mitigate watershed hazards and their effects on ecological and human wellbeing (Corburn, 2003). Addressing watershed problems requires the input and integration of both local and scientific knowledge, interests, and concerns. Interaction among stakeholders within watershed partnerships, however, does not necessarily homogenize views and concerns (Chapter 4). Varied interpretations of local and scientific knowledge and risk perceptions often emerge among stakeholders belonging to the same partnership (Irwin, 2001; Olson & Folke, 2001; Ghimire et al., 2004). Such variations are expected given the diversity of stakeholders' personal, social, environmental, and institutional backgrounds (Blaike et al., 1997; Irwin, 2001). In other words, stakeholders' personal experience and observations, understandings, practices, values, beliefs, identity, belongingness to diverse social groups and watershed regions, and proximity to natural features and risks often diversify stakeholders' perspectives and concerns regarding watershed issues (Brody, Highfield, & Alson, 2004; Greider & Garkovich, 1994).

Examination of the relationship between hazards knowledge and risk perception has been a major domain in risk perception research. These studies were mostly quantitative comparative assessments of experts and lay factual knowledge and risk perception of decontextualized and isolated risks (Johnson, 1993; Cutter, 2003; Renn, 1998; Tversky & Kahneman, 1974). Factual knowledge has often been assessed by comparing laypeople's number of correct answers to factual questions about risks to those of experts (Johnson, 1993). These studies, however, resulted in divergent conclusions on the relationship between factual knowledge and risk perception (Johnson, 1993). For instance, a study conducted by Bord and O'Connor (1990) revealed a positive relationship between factual knowledge about food irradiation and health concerns. On the other hand, other studies found that levels of tolerance were not positively correlated with factual knowledge about smelter pollution (Baird, 1986) or radon (Golding et al., 1992). Pagneux et al. (2010) did not find a correlation between factual knowledge about the causes and attributes of flood and levels of worry and concern. Rather, risk perception was more tied to personal experiences with flooding events (Pagneux et al., 2010).

The ultimate objective of factual knowledge studies in the context of risk was to guide the development of risk communication schemes to diminish discrepancies between experts' and public's understandings of risk to better engage laypeople in managing specific hazards (Bord & O'Connor, 1990, 1992; Bostrom, Fischhoff, & Morgan, 1992; Cvetkovich & Earle, 1992; Lupton, 1999; Maharik & Fischhoff, 1992; Rowe & Wright, 2001; Sjöberg, 1999). However, enhancing laypeople's scientific literacy about a specified hazard through such schemes did not seem to effectively influence their environmental concerns (Blaike et al., 1997; Irwin et al, 1999). Failure of such schemes in addressing laypeoples' concerns was attributed to several factors. First, top-down risk communication schemes oversimplified the relationship between knowledge and concerns and did not account for the influence of social actions and interactions with the local environment on knowledge and concerns. Studies showed that laypeople are not passive learners. In fact, individuals tend to contextualize and reinterpret scientific knowledge and concerns in ways that adhere to their personal experiences and observations that often result from social action and interaction with their local environment (Irwin, 2001; Irwin et al., 1999; Karjalainen & Habeck, 2004). Second, top-down risk management schemes seem to invoke feelings of distrust among the public, when the public feel marginalized and excluded from the management process (Gregory & Satterfield, 2002). Finally, top-down management schemes are not often considerate of public's concerns about the long term effects of risks and risk solutions and their acceptance of technological solutions into their culture (Rowe et al., 1991).

There has been mounting interest in studying the relationship between local knowledge and risk perception, in order to direct the development of management schemes that are more considerate of public perspectives and concerns about risks and their effects. Most of these studies follow qualitative methodologies and point to a strong association between concern and local knowledge about the nature and sources of environmental hazards (e.g. Irwin, 2001; Irwin et al., 1999; Karjalainen & Habeck, 2004). Local concerns were found to be influenced by collective memory, daily life experiences and observations, and trust in government officials and formal sources of knowledge (Freudenberg, 1996; Irwin, 2001; Karjalainen & Habeck, 2004). However, these studies did not address variations of local hazards knowledge and risk perception and their relationship within the context of collective management of complex socio-ecological systems, such as watersheds, which are characterized by multiple hazards and uncertainties. Specifically, these studies did not look into the extent to which local knowledge of multiple hazards and their effects on ecological and human wellbeing influences level of concerns among those involved in collective management. Watershed partnership stakeholders belonging to and acting in complex and uncertain socio-ecological systems bring varied concerns and knowledge about the nature and prevalence of multiple hazards —into the management process— in order to prioritize and find solutions to these hazards (Chapter 4; Corburn, 2003). Thus, in watersheds, it is expected that variation in knowledge about multiple hazards leads to variation in the nature and levels of concerns about these hazards among stakeholders belonging to the same partnership and across watersheds contexts. Also, it is expected that level of concern is cumulative and reflective of stakeholders' awareness of the multiplicity and prevalence of hazards within a watershed. In other words, stakeholders expressing higher awareness of the prevalence of multiple watershed hazards are expected to have higher levels of health, social, and ecological concerns than those expressing lower prevalence of fewer or multiple hazards.

In this study, the watershed risk context is where biophysical and socioeconomic processes interact to influence vulnerability of watershed communities to hazards, risks, and disasters (Flint & Luloff, 2007; Tobin & Montz, 1997). The watershed risk context; i.e. the local context, is expected to influence stakeholders' local hazards knowledge and risk perception (Blaike et al., 1997; Flint & Luloff, 2005). Both local hazards knowledge and risk perception are influenced by stakeholders' personal observation and experiences with their surrounding socio-ecological environment. Accordingly, it is expected that stakeholders belonging to and acting in environmentally and socioeconomically compromised watersheds—and therefore technically assessed as having high biophysical and high socioeconomic vulnerability—to perceive higher prevalence of multiple hazards and their effects and to have higher concerns than their counterparts belonging to watersheds technically assessed as having low biophysical and low socioeconomic vulnerability.

In addition to the watershed risk context and local hazards knowledge, risk perception is suggested to be influenced by stakeholders' educational level and age (Brody et al., 2005), and years of residence in watershed (Flint & Luloff, 2007). Studies reveal that younger and more educated populations often have higher levels of concerns (Brody et al., 2005). Also, it is expected that older watershed stakeholders who have been living in their watershed longer to perceive a higher prevalence of multiple watershed problems and their effects; hence, have higher perceptions of risk than their younger counterparts.

Risk perception is also expected to be influenced by stakeholders' activeness in their partnerships and levels of satisfaction with their partnership's performance in dealing with watershed hazards and their effects (Samuelson et al., 2005). Lubell et al. (2002) found that the severity of watershed problems is positively associated with the activeness of stakeholders and the emergence of watershed partnerships. This finding supports results of studies in the field of natural resource management (e.g. Flint & Luloff, 2007; Luloff 1990; Luloff & Wilkinson 1979; Luloff & Swanson 1995).

Stakeholders' satisfaction in the performance of watershed partnership is expected to mediate the relationship between the local context and stakeholders' activeness in partnership. Stakeholder's satisfaction may lead either to increased or decreased stakeholder participation in a watershed partnership, depending on the type and level of their trust. Satisfaction is often associated with elevated levels of trust (Hurlimann et al., 2008) in a partnership's capacity to achieve the desired environmental objectives. In citizen-based partnerships, social trust, i.e. trust in other local stakeholders, may lead to increased stakeholder engagement as stakeholders may be more willing to cooperate with others to address watershed issues (Focht & Trachtenberg, 2005). On the other hand, official trust, that is trust in government stakeholders, may lead to decreased stakeholder participation in mixed or government partnerships, as stakeholders doubt government stakeholders' ability in addressing watershed issues (Focht & Trachtenberg, 2005).

The effects of stakeholder engagement in watershed partnerships might have different effects on levels of concerns. More stakeholder engagement may lead to lower level of concern, because stakeholders are satisfied with their partnership involvement (Peters et al., 1997). On the other hand, irrespective of stakeholders' satisfaction with their partnership, stakeholder engagement might also lead to higher levels of concern, since watershed partnerships may act as "risk amplification stations" (Renn et al., 1992), thus increasing risk awareness and perceptions among partnership stakeholders. Also, decreased stakeholder involvement as a result of satisfaction and trust in other stakeholders may lead to lower level of concern, as trust is known to be negatively correlated with risk perception. Moreover, decreased stakeholder involvement in partnership as a result of decreased trust in other stakeholders may lead to higher levels of concern (Freudenberg, 1993; Siegrist, 2000) (see Figure 5.1).

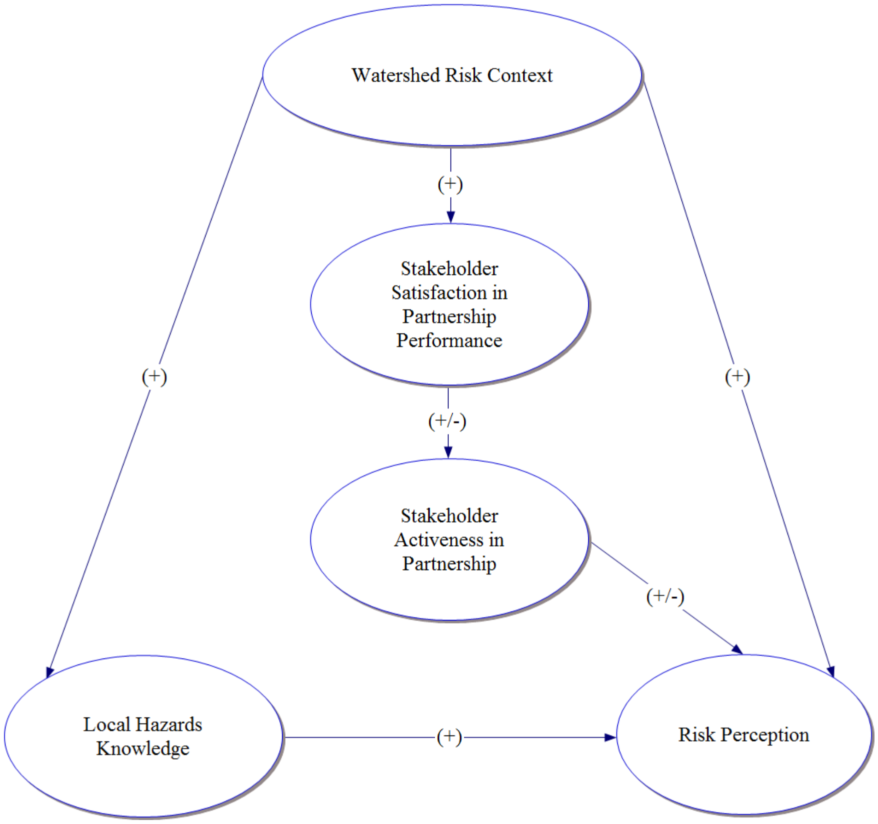


Figure 5.1. A Conceptual Model on the Relationship between Local Hazards Knowledge and Risk Perception

Methods

Study Site

This study was conducted in rural Southern Illinois, which is characterized by its diverse socioeconomic, topographic, and ecological characteristics and disparities compared to the rest of the State of Illinois. Given such diversity, the region provided the opportunity to examine the relationship between local hazards knowledge and risk perception across varied environmental and social contexts and vulnerabilities. In this study, Southern Illinois was delineated as the sixteen southernmost counties, following the precedent set by the Delta Regional Authority (DRA) (Chapter 4), an institution that working to improve the quality of life for parts Illinois, Kentucky, Tennessee, Alabama, Louisiana, Arkansas, Missouri, and Mississippi (DRA, 2008).

The Southern Illinois region contains six 8-digit HUC watersheds, as delineated by the Illinois Environmental Protection Agency (IL EPA). Of the six watersheds, only four—Big Muddy, Cache, Lower-Ohio Bay, and Saline—contained watershed partnerships. In the Big Muddy, the partnership's activities were confined to the boundaries of the 12-digit HUC Kinkaid watershed. As such, the Kinkaid watershed was instead selected as a research site to ensure its representation (Chapter 4) (see Figure 5.2).

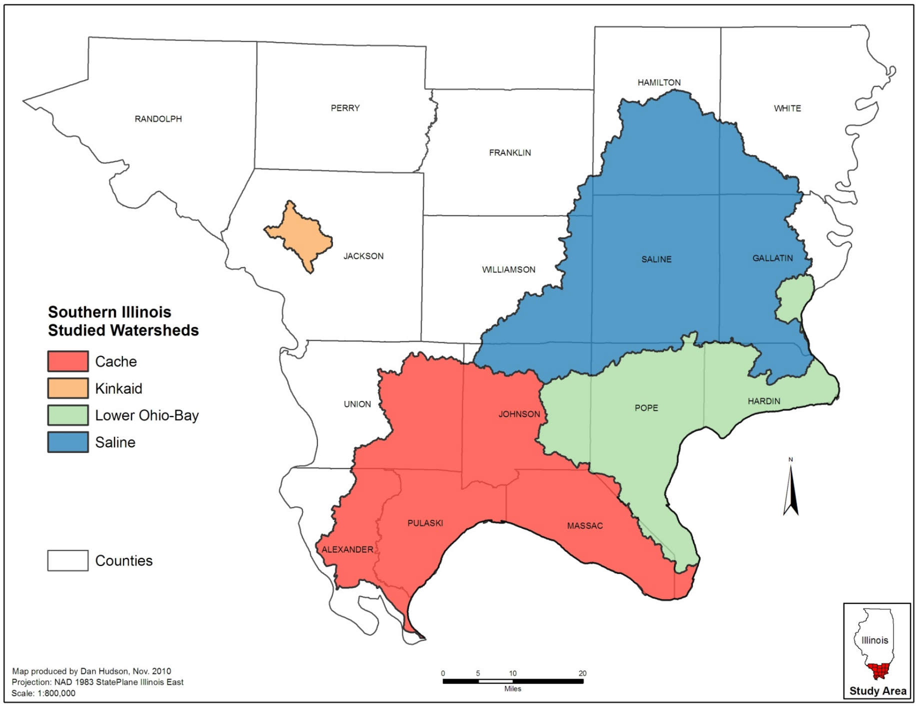


Figure 5.2. The Four Studied Watersheds in Southern Illinois

The four selected watersheds “vary in size, land use, topography, population size, and socioeconomic characteristics” (Chapter 4, p. 62). The Kinkaid watershed was the smallest among the four watersheds. Whereas the Kinkaid and Lower Ohio Bay watersheds were mostly forested with steeper slopes, the Cache and Saline watersheds were mainly flat and had more agricultural profiles (Chapter 4). Each of the four selected watersheds contains one watershed partnership. The four partnerships in the studied watersheds vary in size and structure. Characterization of these partnerships is conducted in accordance to the typology set forth by Moore & Koontz (2003). The Cache Joint Venture Partnership, herein the Cache partnership, is a ‘mixed partnership’; a public private partnership between the federal and state government and non-governmental organizations. In the Cache partnership, the federal and state governments are heavily involved in the management of the Cache Watershed. On the other hand, the Saline Basin Partnership, herein the Saline partnership, the Shawnee Ecosystem Partnership of the

Lower Ohio-Bay watershed, here in the Shawnee partnership, and the Kinkaid Watershed Partnership, herein the Kinkaid partnership, are ‘citizen-based partnerships’, mostly consisting of stakeholders (residents/business owners/ landowners) living in these three watersheds. Planning and decision making in the latter three partnerships is primarily conducted by non-governmental stakeholders with state representatives only providing technical assistance.

Assessment of Watershed Vulnerability to Risks

Assessment of vulnerability was conducted to evaluate the risk contexts of the four selected Southern Illinois watersheds. Vulnerability was assessed by three indicators: water quality, flooding, and socioeconomic conditions. Biophysical vulnerability was assessed by analyzing secondary data on water quality and flooding. Using water quality to assess biophysical vulnerability was tied to the notion that water quality is reflective of environmental conditions and change in a watershed, such as land use, erosion, agricultural runoff, and acid runoff (EPA, 2011). Also, the fact that flooding seemed to be a major problem in Southern Illinois led to including this parameter in the assessment of biophysical vulnerability.

The National Sanitation Foundation (NSF) Water Quality Index was used to assess water quality (Brown et al., 1970). The most recent water quality data (2005 data) were obtained from the IL EPA for each of the Cache, Saline, and Lower Ohio-Bay watersheds. These data included monthly reports of water quality parameters for major rivers and their tributaries. These parameters included pH, dissolved oxygen, turbidity, total phosphates, total nitrates and nitrites, total suspended solids, and fecal coliform. For the Kinkaid watershed, the 2008 water quality data for the Kinkaid Lake were obtained from the Kinkaid Reed’s Creek Conservancy District. Kinkaid’s water quality report was limited to pH, turbidity, and fecal coliform. Assessing the overall water quality for the four studied watersheds involved comparing their WQIs to a set of guidelines developed by the National Sanitation Foundation (Brown et al., 1970) (see Table 5.1).

A water quality vulnerability score was given to each watershed based on the guidelines for water quality indices presented in Table 5.1. The small number of watersheds (n = 4), providing limited variation in the data, and the projected level of contribution of water quality conditions to watershed vulnerability has directed the categorization of the water quality scores into three vulnerability groups: low = 1, medium = 1.5, and high = 2. The medium vulnerability score was considered as the median of the low and high vulnerability scores. Hence, watersheds having a good or excellent water quality, i.e. having a water quality index score ranging between 70—100 were assigned a score of 1 indicating low vulnerability. Watersheds with medium water quality and an index score ranging between 50—70 were assigned a score of 1.5 indicating medium vulnerability. Finally, watersheds bad or very bad water quality and with an index ranging between 0—50 were assigned a score of 2 indicating high vulnerability (see Table 5.1).

Table 5.1

Guidelines for Scoring Vulnerability to Water Quality

Watershed Risk Context	NSF Guidelines†	Vulnerability Score	Vulnerability Status
Water Quality Index†	90—100 indicated 'excellent' water quality	1	Low
	70—90 indicated 'good' water quality	1	Low
	50—70 indicated 'medium' water quality	1.5	Medium
	25—50 indicated 'bad' water quality	2	High
	0—25 indicated 'very bad' water quality	2	High

†Source: National Sanitation Foundation (Brown et al., 1970).

Assessment of flooding vulnerability involved analyzing flooding secondary data for the latest 10 years (1998—2008) for the 16 Southern Illinois counties obtained from the SHELDUS database of the Hazards and Vulnerability Research Institute of the University of South Carolina. Following the precedent set by Cutter et al. (1997), the number of flooding events for each of county was transformed to a probability by dividing the total number of flooding events for each county by the number of years; i.e. 10 years. Using ArcGIS, a weighted average of flooding z-scores for each watershed was computed by interpolating z-scores from county to watershed level. This weighted average was computed by two steps: first, county flooding z-scores were multiplied by the proportion of county area in a watershed. Second, the generated z-scores were added and divided by the sum of the counties' area proportions within a watershed.

Each watershed was then assigned a flooding vulnerability score compared to the median of adjusted z-scores of the four watersheds. Therefore, a watershed with a flooding z-score below the median z-score was considered low vulnerability and assigned a score of 1. A watershed with a flooding adjusted z-score equal to median was considered medium vulnerability and assigned a score of 1.5 and above the median was considered high vulnerability and assigned a score of 2.

A biophysical vulnerability score for each of the studied watersheds was then computed as the sum of the assigned water quality and flooding vulnerability scores. A watershed with an overall biophysical vulnerability score below the median score of all four watershed biophysical scores was considered low vulnerability. Watersheds with biophysical vulnerability score equal to the median score were considered medium vulnerability, and watersheds with a score above the median score were considered to have a high biophysical vulnerability.

Socioeconomic vulnerability was measured by using a county level social vulnerability index (SOVI) for the 16 Southern Illinois counties, obtained from the Hazards and Vulnerability

Research Institute website, of the University of South Carolina. SOVI is an aggregate score of both socioeconomic and built environment indicators obtained from the 2000 US Census data. The socioeconomic dimensions included in the SOVI were socioeconomic status, age, gender, race and ethnicity, employment loss, occupation, family structure, education, population growth, health status, medical services, social dependence, and special needs population. The built environment dimensions included urbanization, residential property, infrastructure and lifelines, renters, and the presence of commercial and industrial development (Cutter et al., 2003). Using ArcGIS, a weighted average of SOVIs for each watershed was computed by interpolating county SOVIs to the watershed level. The 2000 US Census tract data, which refers to "small, relatively permanent statistical subdivisions of a county" (US. Census Bureau, 2000, p.1), was used as a basis for interpolation. Watershed SOVIs were computed as the sum of the product of county SOVIs by the proportion of county population in a watershed divided by sum of county population proportions within a watershed.

Each watershed was then assigned a socioeconomic vulnerability score relative to the median of watershed adjusted SOVI z-scores. Hence, watersheds with an adjusted SOVI below the median of adjusted SOVIs for all four watersheds was considered low vulnerability and assigned a score of 1. Watersheds with an adjusted SOVI equal to the median was assigned a score of 1.5 indicating medium socioeconomic vulnerability, and watersheds with adjusted SOVIs above the median were assigned a score of 2 indicating high socioeconomic vulnerability.

Several limitations were inherent to the technical assessments of the four studied watersheds. First, discrepancies in water quality data provoked by inconsistencies and underreporting were found among all nine NSF ambient water quality parameters required for the construction of WQIs for the studied watersheds. Water quality data for the Cache, Saline, and Lower-Ohio Bay watersheds was only available for 2005. The 2005 water quality data used to construct WQIs may not have accurately represented current water quality conditions in these watersheds at the time of this study. With such discrepancies in water quality data, the constructed WQI represented loose measures of water quality and provided rough indications of water quality conditions in the studied watersheds. Second, the SOVIs of the 16 southernmost counties may not have accurately reflected socioeconomic conditions in these counties at the time of data collection, as these indices were based on the US 2000 census data. Third, interpolation of watershed indices from county level data for socioeconomic vulnerability presented a major challenge in this study, as watersheds spanned across multiple counties. Calculation of watershed socioeconomic indices assumed an even distribution of population in each county. Thus, these latter indices constituted rough descriptions rather than precise calculations due to the lack of spatial congruity between available data and watershed boundaries.

In light of the nature of the biophysical and socioeconomic vulnerability data, the resulting assessments of the four studied watersheds were also rough indications of the watershed risk context. However, creating a typology for the four watersheds provided a rich context to simplify the analysis and provided a better mechanism for interpretation of how the watershed risk context related to the relationship between risk perception and local hazards knowledge.

Sampling Frame and Sampling

Contact lists of stakeholders provided by all four watershed partnerships were used as the sampling frame for this study. Stakeholders are defined as “people whose personal or professional welfare depends substantially upon the outcomes of the partnership” (Leach, 2002,

p. 642). In this study, the term ‘stakeholder’ was broadly defined as individuals who were members of their partnerships or non-members who were designated by their partnerships as stakeholders. Adjustments to the obtained contact lists were made to eliminate incomplete or duplicate cases and to add newly elected city officials to the Cache partnership list to update specific categories of stakeholders. The Cache partnership list was substantially larger than the other lists due to the broader definition and inclusion of stakeholders. Therefore, the final sampling frame entailed a total of 406 participants; Shawnee partnership (16 participants), Kinkaid partnership (82 participants), Saline partnership (89 participants), and Cache partnership (219 participants). Given the relatively small size of these partnerships, all the stakeholders of these partnerships were sampled to ensure representation of their groups and to obtain an adequate sample size for robust statistical inferences.

Survey Administration

In April 2010, after working with two stakeholders from two watershed partnerships to refine the questionnaire, the survey was sent to stakeholders of the four participating watershed partnerships. The survey material included a cover letter, an 8-page questionnaire standardized to contain the same questions for comparison across all four watersheds, and a postage-paid return envelope. The survey was administered via the Tailored Design Method using three points of contact with potential participants (Dillman, Smyth, & Christian, 2008). The survey and the cover letter specified that respondents should be only be members or stakeholders working with the Kinkaid, Saline, Cache, and Shawnee watershed partnerships, whose name appeared on the survey.

A reminder/thank you postcard was sent to the participants two weeks after sending the initial survey. It was observed that stakeholders perceiving themselves as non-members were declining to complete the surveys. Hence, the second wave of surveys sent to non-respondents three weeks from the initial survey contained a modified cover letter encouraging non-member stakeholders to complete the survey, in order to improve the response rate.

Measurement of Variables

Dependent Variable

In this study, risk perception was the dependent variable and was operationalized by 13 items. Participants were asked about their level of concern about potential effects of watershed hazards on human health, safety of people, water supply for human use, accessibility to water resources, loss of job opportunities, effects on agricultural production, decrease in property value, effects on the desirability of watersheds as places to live, potential effects on the attractiveness of watersheds for recreation, effects on wildlife health, loss of rivers, lakes, wetlands, or ponds, and threats to ecological value of their watersheds. These items were designed in accordance to results obtained from semi-structured interviews conducted with a sample of stakeholders from the four watershed partnerships (Chapter 4) and the literature. All 13 items were measured by a 5-point Likert scale ranging from “1= not at all concerned” to “5 = very concerned”. Exploratory factor analysis (Principle Component Analysis with Varimax rotation) retained 11 items and indicated three factors underlying risk perception: health, social, and ecological factors. A composite score for overall risk perception was computed as the sum of the means of the items underlying each of the three extracted factors (alpha reliability coefficient = 0.69). With the absence of a theoretical justification, the three dimensions of risk perception were assigned equal weights to compute the overall risk perception score (see Table 5.2).

Table 5.2

Principal Component Analysis with Varimax Rotation for Risk Perception Items

Items	*Factor 1*	*Factor 2*	*Factor 3*
Ecological Risk Perception			
1. Lead to loss of rivers, lakes, ponds, or wetlands	.874		
2. Threaten ecological value of watershed	.855		
3. Affect health of wildlife	.851		
4. Make watershed an unattractive place for recreation	.679		
5. Limit access to river, lakes, wetlands, or ponds	.571		
Health Risk Perception			
6. Affect human health		.918	
7. Affect human safety		.864	
8. Limit water supply for human use		.853	
Social Risk Perception			
9. Decrease property value			.905
10. Affect agricultural production			.849
11. Make watershed an undesirable place to live			.774
Eigenvalues	4.680	2.288	1.291
Percent of variance explained	42.54	20.804	11.739
Alpha reliability coefficient (Cronbach's alpha)	.85	.90	.86

Independent Variables

Local hazards knowledge was hypothesized to be the primary independent variable influencing risk perception. Local knowledge has not often been judged against expert knowledge, formal knowledge, or objective standards, but rather assessed against societal views and interpretations, given that local knowledge is grounded in personal experiences and observations (Legree et al., 2005; Romney et al., 1986). The nature of local knowledge has directed the use of Likert scales to capture the range of perspectives from varied social groups holding varied views, experiences, and interests, thus allowing comparison across these perspectives (Legree et al., 2005). In this study, adoption of a Likert scale to assess knowledge helped to quantitatively assess variations in stakeholders' awareness on the prevalence of multiple watershed problems and their effects on ecological and human wellbeing against the pool of perspectives obtained from the participants.

In this study, local hazards knowledge was measured by asking participants questions about the extent to which they thought an array of watershed problems were prevalent. A comprehensive list of major watershed problems, causes, and effects on ecosystem and human wellbeing was derived from the results of qualitative interviews conducted with a representative sample of stakeholders belonging to all four watersheds (Chapter 4). These problems included agricultural runoff, poor water drainage, deforestation, acid runoff, erosion, and flooding. The prevalence of identified watershed problems and their effects on ecosystem and human wellbeing was measured by a 5-point Likert scale ranging from "1= not at all" to "5 = a lot". Participants were asked to skip sub-items associated with each watershed issue listed in the survey if they perceived these issues were not problems in their watersheds. A "don't know" option was also provided to participants to express unawareness of a specific issue. Both the 'inapplicable' and 'don't know' options were treated as missing values to avoid response biases and to ensure proper statistical analysis.

Sub-scores for each of the identified six watershed problems was computed as the mean of items corresponding to each of the six watershed problems. Selection of items was based on results of exploratory factor analysis (Principal Component Analysis with Varimax Rotation). A composite score for local hazards knowledge was computed as the sum of the latter six sub-scores (alpha reliability coefficient = 0.77). The generated local knowledge scores were only reflective of stakeholders' awareness of the level of prevalence of watershed hazards and their effects, as the 'don't know' values were omitted from computing these mean scores. Thus, a lower local hazards knowledge score did not impart lower stakeholder knowledge, but indicated that stakeholders are aware of a fewer number and a lower prevalence of watershed hazards and their effects (Table 5.3).

Table 5.3

Principal Component Analysis with Varimax Rotation for Items on Local Knowledge of the Six Identified Watershed Problems

Items	*Factor 1*
Agricultural Runoff	
1. Agricultural Runoff is degrading water quality	.958
2. Agricultural Runoff is affecting health of aquatic life	.955
3. Agricultural Runoff is causing algal blooms	.910
4. Agricultural Runoff is a problem	.877
5. Agricultural Runoff is caused by poor farming practices	.822
Eigenvalue	4.104
Percent of variance explained	88.285
Alpha reliability coefficient (Cronbach's alpha)	.95

Items	*Factor 1*
Poor Water Drainage	
1. Poor water drainage on ecosystem services is affecting health of wildlife	.828
2. Poor water drainage is a problem	.814
3. Poor water drainage is causing erosion	.740
4. Poor water drainage is causing flooding	.631
5. Poor water drainage on human wellbeing is limiting recreational activities	.628
6. Poor water drainage is caused by human alterations of river flow	.574
Eigenvalue	3.017
Percent of variance explained	50.276
Alpha reliability coefficient (Cronbach's alpha)	.79

Table 5.3 (Continued)

Items	*Factor 1*
Deforestation	
1. Deforestation is affecting water quality through erosion	.853
2. Deforestation is causing erosion	.849
3. Deforestation is affecting scenic beauty	.826
4. Deforestation is limiting recreational opportunities	.793
5. Deforestation is affecting wildlife habitat	.747
6. Deforestation is caused by commercial timber harvesting	.713
7. Deforestation is a problem	.697
8. Deforestation is causing flooding	.694
9. Deforestation is caused by changes in land use	.631
Eigenvalue	5.192
Percent of variance explained	57.688
Alpha reliability coefficient (Cronbach's alpha)	.90

Items	*Factor 1*
Acid Runoff	
1. Acid runoff is affecting water quality	.976
2. Acid runoff is aggravated by flooding	.963
3. Acid runoff is affecting recreational activities	.963
4. Acid runoff is affecting agricultural production	.960
5. Acid runoff is affecting wildlife	.945
6. Acid runoff is affecting human health	.940
7. Acid runoff is a problem	.937
8. Acid runoff is affecting aquatic health	.934
9. Acid runoff is caused by coal mines	.831
Eigenvalue	7.946
Percent of variance explained	88.285
Alpha reliability coefficient (Cronbach's alpha)	.98

Table 5.3 (Continued)

Items	*Factor 1*
Erosion	
1. Erosion is affecting wildlife habitat	.848
2. Erosion is affecting water quality	.772
3. Erosion is caused by deforestation	.767
4. Erosion is affecting health of aquatic life	.766
5. Erosion is leading to flooding	.752
6. Erosion is limiting recreational activities	.675
7. Erosion is a problem	.638
8. Erosion is affecting livelihood of people	.637
9. Erosion is caused by quarrying activities	.602
10. Erosion is caused by poor farming practices	.583
11. Erosion is limiting accessibility to water resources	.566
12. Erosion is caused by poor streambank stabilization	.480
13. Erosion is affecting agricultural production	.471
14. Erosion is aggravated by flooding	.468
Eigenvalue	6.019
Percent of variance explained	42.996
Alpha reliability coefficient (Cronbach's alpha)	.89

Items	*Factor 1*
Flooding	
1. Flooding is disrupting people's lives	.838
2. Flooding is affecting agricultural production	.799
3. Flooding is a problem	.788
4. Flooding is caused by poor water drainage	.782
5. Flooding is threatening people's safety	.756
6. Flooding is affecting private properties	.749
7. Flooding is increasing erosion	.645

Table 5.3 (Continued)

Items	*Factor 1*
Flooding	
8. Flooding is affecting wildlife	.613
9. Flooding is caused by beaver dams	.572
10. Flooding is caused by flat topography	.563
11. Flooding is caused by siltation	.551
12. Flooding is caused by artificial dams	.506
Eigenvalue	5.700
Percent of variance explained	47.504
Alpha reliability coefficient (Cronbach’s alpha)	.89

Other independent variables included stakeholders’ socio-demographic characteristics, activeness in partnership, and satisfaction with partnership performance in dealing with watershed problems. Socio-demographic characteristics of stakeholders included educational level, age, gender, years of residence in watershed, and organizational affiliation. Age was measured as a continuous variable in years. Educational level was measured by 5 items on educational attainment (primary or middle school, high school or equivalent, technical college or 2-year associate degree, college degree, and postgraduate degree). Gender was a dichotomous variable (0 = male, 1 = female). Years of residence in watershed was a continuous variable measured in years. Stakeholders’ organizational affiliation was measured by a set of dichotomous variables coded as (0 = No, 1 = Yes), and included: federal/state representatives, non-governmental organization representatives, landowners/ business owner/resident of watershed, and others.

Stakeholders’ activeness was measured by four indicators: years of involvement in partnership, stakeholders’ membership status in partnership, attendance of partnership meetings, and participation in partnership's activities, such as writing proposal, developing and implementing watershed plans, etc. Years of involvement in partnership was a continuous variable measured in years. Membership in partnership was measured by a dichotomous variables (0 = No, 1 = Yes). Attendance of partnership meetings was a dichotomous variable (0 = No, 1 = Yes). Participation in partnership activities was a dichotomous variable (0 = No, 1 = Yes).

Satisfaction with partnership performance in dealing with watershed problems was measured as an interval variable. A 5-point Likert scale ranging from "1 = not satisfied" to "5 = very satisfied" was used to measure the construct.

Control Variable

The watershed risk context was a control variable measured as a categorical variable (1 = low biophysical/ low socioeconomic vulnerability, 2 = low biophysical/high socioeconomic vulnerability, 3 = high biophysical/low socioeconomic vulnerability, and 4 = high biophysical/high socioeconomic vulnerability).

Data Analysis

Non-parametric bivariate statistics were used to understand variations in and the relationship between local hazards knowledge and risk perception within each watershed. The use of non-parametric statistics was guided by the small sample size of respondents within each watershed partnership and the non-normal distributions of local hazards knowledge scores within each watershed. Kruskal Wallis test was used to examine differences in local hazards knowledge across the four studied watersheds. The Mann-Whitney *U*-test was used to examine variations in local hazards knowledge scores across dichotomous variables. Also, Spearman correlation was used to examine the relationship between local hazards knowledge and continuous variables. On the other hand, parametric statistics were used to examine factors influencing variations in risk perception, since the distributions of risk perception score were close to normality in all four watersheds, irrespective of the small sample sizes in each watershed. Welche's *F*-test was used to examine variations in risk perception across the four studies watersheds, since the sample sizes varied across the watersheds. Welche's *F*-test is normally used for unbalanced ANOVA designs. Finally, *t*-tests were used to examine variations in risk perception across dichotomous variables.

Results

Response Rates

A total of 406 surveys were sent to stakeholders of all four watershed partnerships in Southern Illinois. Completed surveys were returned by 117 individuals. Therefore, the overall response rate was 31.54%, after adjusting for 33 surveys returned as undeliverable due to inaccurate addresses of participants. The response rate for each of the four watershed partnerships varied: Cache (n = 69; 33.99%), Saline (n = 18; 22.5%), Kinkaid (n = 21; 28.77%), and Shawnee (n = 9; 60%).

In this study, the overall response rate of this study was less than the response rate (36.6%) of a survey sent in October of 1996 to landowners asking about land use dynamics in the Cache watershed in Southern Illinois (Lant et al. 2001). In this study, the lower response rate might be associated with the time of the year at which the survey was sent (April 2010). Given the agricultural profile of Southern Illinois, April might not have been a suitable time for participants, particularly landowners, to complete the survey, thus resulting in a lower response rate than that of the study conducted by Lant et al. (2001).

Participants

Eighty percent of the respondents were males. The mean age of all respondents was 58.8 years (*SD* = 11.74), and around 66% of them were college graduates with bachelors and postgraduate degrees. Fifty-nine percent of all participants were residents of their watersheds. Of all the respondents, 45.3% were members in their partnerships. Also, 39.7% of the respondents were business owners, residents, or landowners, 29.3% of participants were federal or state agency representatives, 25.9% were representatives of non-governmental organizations, 13.8% were county or city agency representatives, and 6% were others (such as academia, schools, etc.). Around 42% of all participants engaged in partnership activities and one third of all participants (31.6%) never attended partnership meetings. Finally, the mean years of involvement in watershed partnership for the respondents was 11.06 years (*SD* = 7.28).

Upon comparing participant characteristics across the four watersheds, it was found that respondents were comparable in terms of their gender, age, and educational level. More than half of the respondents were residents who lived for a long time in their watersheds. However, respondents' membership in partnerships varied across the four watersheds. The lowest partnership membership rate was observed among participants of the Cache watershed (36.8%), compared to the Saline (53.3%), Kinkaid (70.0%), and Lower Ohio Bay (50.0%). Variations were also observed in respondents' participation in partnership activities. In the Cache watershed, 42.6% of the respondents reported participation in partnership activities compared to 75% in the Lower Ohio Bay, 31.6% in the Kinkaid, and 33.3% in the Saline watersheds. Moreover, respondents were shown to vary in terms of their attendance of partnership meetings.

The proportion of respondents attending partnership meetings were comparable in the Saline (66.7%) and Cache watersheds (62.7%), and was highest in the Lower Ohio Bay (83.3%). As for mean years of participants' involvement in partnership, it was observed it was highest in the Cache (*M* = 13.04, *SD* = 7.64) and lowest in the Lower Ohio Bay (*M* = 5.91, *SD* = 3.05). A distribution of participant characteristics by watershed is presented in Table 5.4.

Table 5.4

Distribution of Participant Characteristics by Watershed

	Watershed			
Participants' Attributes	Cache	Saline	Kinkaid	Lower Ohio Bay
Gender				
Males	73.5%	86.7%	100.0%	75.0%
Females	26.5%	13.3%	0.0%	25.0%
Mean age (years)	58.85 (*SD* = 12.1)	61.2 (*SD* = 9.8)	60.4 (*SD* = 13.6)	55.92 (*SD* =12.7)
College degree	65.2%	60.0%	70.0%	66.7%
Residence in watershed	59.4%	76.9%	55.0%	63.6%
Mean years of residence in watershed	20.82 (*SD* = 22.2)	27.25 (*SD* = 25.9)	17.9 (*SD* = 18.7)	22.45 (*SD* = 25.6)
Organizational affiliation				
Federal/State	30.0%	21.4%	25.0%	41.7%
County/City agency	11.4%	21.4%	10.0%	25.0%
Business/Landowners/ Residents	31.4%	78.6%	40.0%	41.7%
Non-governmental organization	31.4%	0.0%	40.0%	0.0%
Others	8.6%	0.0%	0.0%	8.3%
Membership in partnership	36.8%	53.3%	70.0%	50.0%
Mean years of involvement in partnership	13.04 (*SD* = 7.64)	9.67 (*SD* = 8.26)	9.00 (*SD* = 5.00)	5.91 (*SD* = 3.05)
Attendance of partnership meetings	62.7%	66.7%	73.7%	83.3%
Engagement in partnership activities	42.6%	33.3%	31.6%	75.0%

Watershed Biophysical and Socioeconomic Vulnerability

As part of examining the proposed conceptual framework, this study assessed the biophysical and socioeconomic vulnerability of the four studied watersheds. Water quality indices (WQIs) indicated that the Kinkaid, Saline, and Cache watersheds had “good’ water quality. The WQI of the Lower Ohio Bay indicated an “excellent” water quality for this watershed. Hence, the data indicated the low vulnerability of communities in these four watersheds to water quality issues. Accordingly, each of the four watersheds was assigned a score of 1. However, the four watersheds varied in terms of their vulnerabilities to flooding. Findings revealed the high vulnerability of Kinkaid and Cache watersheds (score = 2) and the low vulnerability of the Saline and Lower Ohio Bay to flooding (score = 1). Therefore, the biophysical vulnerability score for each watershed was as follows: Kinkaid and Cache had a score of 3 indicating high biophysical vulnerability, and the Saline and Lower Ohio Bay had a score of 2 indicating low biophysical vulnerability. On the other hand, interpolation of socioeconomic indices of the 16 southernmost counties to the watershed level showed that the four studied watersheds varied in terms of their socioeconomic vulnerability. Whereas the Kinkaid and Lower Ohio Bay had low socioeconomic vulnerability (score = 1), the Cache and Saline had high socioeconomic vulnerability (score = 2). Given their biophysical and socioeconomic vulnerability scores, the four watersheds exhibited distinctive biophysical and socioeconomic contexts (see Table 5.5).

Table 5.5

A 2 by 2 Matrix of the Biophysical and Socioeconomic Vulnerability of the Four Studied Southern Illinois Watersheds

	Biophysical Vulnerability	
Socioeconomic Vulnerability	Low	High
Low	Lower-Ohio Bay	Kinkaid
High	Saline	Cache

Variations in Stakeholders' Local Knowledge and Risk Perceptions of Hazards across the Four Studied Watershed Risk Contexts

There were statistically significant differences in stakeholders' local knowledge across watersheds and within partnerships indicating variations in stakeholders' awareness on the number and prevalence of hazards within and across these watersheds, as revealed by the Kruskal Wallis test ($X^2 = 21.19$, $p < .05$). On average, stakeholders in both the Saline ($M = 18.65$, $SD = 4.67$) and Cache ($M = 16.75$, $SD = 5.35$) watersheds perceived a larger number and a higher prevalence of hazards than those in Kinkaid ($M = 12.27$, $SD = 4.83$) and the Lower-Ohio Bay ($M = 12.32$, $SD = 3.63$) watersheds (see Table 5.6).

Table 5.6

Descriptive Statistics of Total Local Knowledge Scores by Watershed

	Total Local Hazards Knowledge Scores						Kruskal Wallis Test	
Watersheds	M	Mdn	SD	Minimum	Maximum	Range	X^2	Sig.
Cache	16.75	16.39	5.35	4.00	30.00	26.0	21.19	.00
Saline	18.65	19.71	4.67	9.06	24.91	15.8		
Kinkaid	12.27	10.54	4.83	6.55	24.71	18.2		
Lower Ohio Bay	12.32	11.94	3.63	8.11	18.02	9.9		

Variations across the four watersheds were also observed in terms of the perceived prevalence of watershed hazards. Agricultural runoff was commonly perceived as a prevalent problem in all four watersheds. Statistically significant differences in perceived prevalence of agricultural runoff were not observed across the four watersheds, as was revealed by the Kruskal Wallis test ($X^2 = 1.50$, $p > .05$). Other hazards were contextual and related to specific watersheds. For instance, acid runoff was indicated as a problem in the Saline watershed ($M = 3.33$, $SD = 1.73$), but not in the Cache ($M = 1.48$, $SD = 1.12$), Kinkaid ($M = 1.37$, $SD = .99$), and Lower Ohio Bay ($M = 1.00$, $SD = .00$). Also, while perceived to be a widespread problem in the Saline ($M = 3.43$, $SD = 1.05$) and the Cache ($M = 3.52$, $SD = 1.05$), flooding was not perceived as problematic by stakeholders of the Kinkaid ($M = 1.59$, $SD = .85$) and Lower-Ohio Bay ($M = 2.12$, $SD = 1.05$) watersheds (see Table 5.7).

Table 5.7

Mean Local Hazards Knowledge Scores by Watershed

	Watershed Hazards											
	1		2		3		4		5		6	
Watersheds	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Cache	3.21	1.36	3.14	1.25	2.97	1.41	1.48	1.12	3.71	.72	3.52	1.05
Saline	2.78	1.56	3.16	1.19	2.67	1.24	3.33	1.73	3.48	.61	3.43	1.05
Kinkaid	3.22	1.13	1.88	1.12	1.54	1.07	1.37	.99	3.16	.85	1.59	.85
Lower Ohio Bay	2.87	1.02	2.18	1.33	1.77	1.32	1.00	.00	3.28	.99	2.12	1.05
X^2	1.50		15.60		17.36		19.91		8.54		37.61	
df	3		3		3		3		3		3	
Sig.	.682		.001*		.001*		.000*		.036*		.000*	

1 = agricultural runoff; 2 = poor water drainage; 3 = deforestation; 4 = acid runoff; 5 = erosion; 6 = flooding.
* Statistical significance of Kruskal Wallis test was at $p < 0.05$

As for risk perception (i.e. level of concern), there were variations across watersheds in the mean overall risk perception scores ($F = 3.557$, $p < .05$). Respondents of the Saline ($M =$

9.40, *SD* = 2.66) and the Cache (*M* = 9.65, *SD* = 2.73) watersheds held higher levels of concern than those in the Kinkaid watershed (*M* = 7.79, *SD* = 2.56) and Lower-Ohio Bay watersheds (*M* = 7.56, *SD* = 2.84) (see Table 5.8).

Table 5.8

Mean Risk Perception Scores of Stakeholders by Watershed

	Overall Risk Perception Scores		Unbalanced ANOVA	
Watersheds	M	SD	Welch's F	Sig.
Cache	9.65	2.73	3.557	.026
Saline	9.40	2.66		
Kinkaid	7.79	2.56		
Lower Ohio	7.56	2.84		

The overall local hazards knowledge and risk perception scores did not precisely match the technical vulnerability assessments of the four watersheds. Both local hazards scores and risk perception scores were generally highest among stakeholders belonging to watersheds technically assessed as having high socioeconomic vulnerability, irrespective of their assessed biophysical vulnerability. Non-parametric and parametric *t*-tests revealed a statistically significant difference between watersheds with low and high socioeconomic vulnerability in both local hazards knowledge ($U = 564.5$, $p < .05$) and risk perception scores ($t = -3.33$, $p < .05$). Statistically significant differences in local hazards knowledge scores and risk perception scores were not detected between watersheds technically assessed as low and high biophysical vulnerability.

The Nature and Level of Concern within Partnerships and Across Watersheds

The three dimensions of risk perception (health, social, and ecological) were watershed specific. Stakeholders of the Saline watershed held the highest health concerns (*M* = 3.26, *SD* =

1.04), compared to stakeholders of the Cache, Kinkaid, and the Lower Ohio Bay (see Table 5.8). However, differences in health risk perception were not statistically significant as revealed by Kruskal Wallis test ($X^2 = 4.10$, $p > .05$). On the other hand, there were statistically significant differences in social ($X^2 = 16.97$, $p < .05$) and ecological risk perceptions ($X^2 = 9.69$, $p < .05$) across the four watersheds, as revealed by the Kruskal-Wallis tests. On average, stakeholders of the Cache (*Mdn* = 3.00, *SD* = 1.22), the Saline (*Mdn* = 3.00, *SD* = 1.14), and the Shawnee (*Mdn* = 3.00, *SD* = 0.82) watersheds held the highest levels of social concerns, while stakeholders of the Kinkaid watershed held the lowest levels of social concerns (*Mdn* = 1.67, *SD* = 1.67). Statistically significant differences in ecological risk perception were also apparent across the four watersheds. Ecological concerns were highest among stakeholders of the Cache watershed (*Mdn* = 3.70, *SD* = 1.02) and lowest among stakeholders of the Lower-Ohio Bay (*Mdn* = 2.70, *SD* = 1.23) (see Table 5.9).

Table 5.9

Descriptive Statistics and Kruskal-Wallis Tests of Health, Social, and Ecological Risk Perception Scores across the Four Studied Watersheds

	Risk Perception					
	Health		Social		Ecological	
Watersheds	Mdn	SD	Mdn	SD	Mdn	SD
Cache	3.00	1.28	3.00	1.22	3.70	1.02
Saline	3.17	1.04	3.00	1.14	3.40	1.04
Kinkaid	2.67	1.44	1.67	1.67	3.27	0.97
Lower Ohio	2.00	1.14	3.00	0.82	2.70	1.23
X^2	4.10		16.97		9.69	
df	3		3		3	
Sig.	.251		.001*		.021*	

** Statistical significance of Kruskal Wallis test was at p < 0.05*

Within Partnership Variations in Stakeholders' Local Hazards Knowledge and Risk Perceptions

As previously shown in Tables 5.6 and 5.8, there were variations in local hazards knowledge and risk perception scores among stakeholders belonging to the same watershed partnership. The highest variation in local knowledge scores were observed among stakeholders of the Cache watershed (range = 26 points). Variations were lower in the Kinkaid watershed (range = 18.2 points) and the Saline watershed (range = 15.8), and lowest in the Lower Ohio Bay watershed (range = 9.9 points). Stakeholders belonging to the same watershed varied in their awareness of the number and prevalence of the six watershed hazards and their effects. However, distributions of these scores varied across watershed and were largely skewed either to left or the right (see Figures 5.3 a—f). For instance, acid runoff was skewed to the right in the Saline watershed. Fifty percent of the Saline respondents perceived acid runoff and its effects to be very prevalent and had mean scores ranging between 4 and 5. The other 50% varied in their awareness of the problem and their scores ranged between 1 and approximately 4. On the other hand, acid runoff was not generally seen as a problem in the other three watersheds. In the Cache and Kinkaid watersheds, there were outlier cases who considered acid runoff to be slightly, moderately, or very prevalent in their watershed, and were therefore represented as whiskers in the corresponding box plot (see Figure 5.3 d).

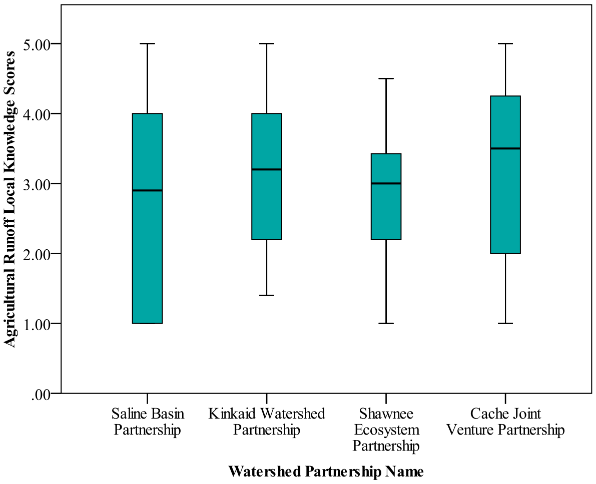


Figure 5.3 a. Boxplot of Agricultural Runoff Local Knowledge Scores by Partnership

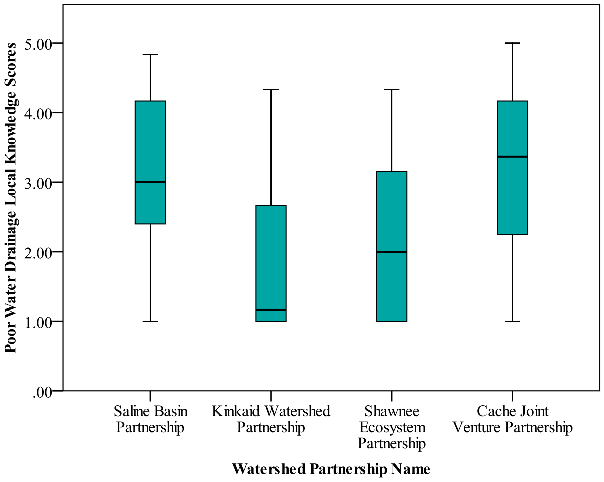


Figure 5.3 b. Boxplot of Poor Water Drainage Local Knowledge Scores by Partnership

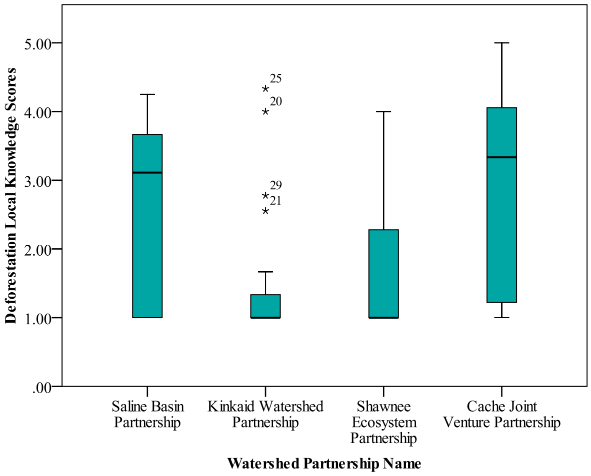


Figure 5.3 c. Boxplot of Deforestation Local Knowledge Scores b Partnership

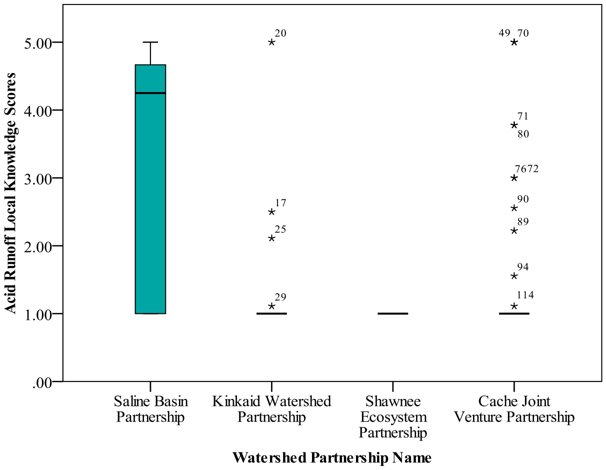


Figure 5.3 d. Boxplot of Acid Runoff Local Knowledge Scores by Partnership

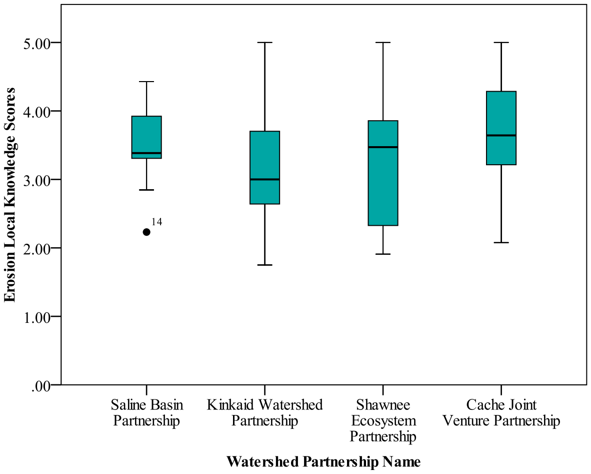


Figure 5.3 e. Boxplot of Erosion Local Knowledge Scores by Partnership

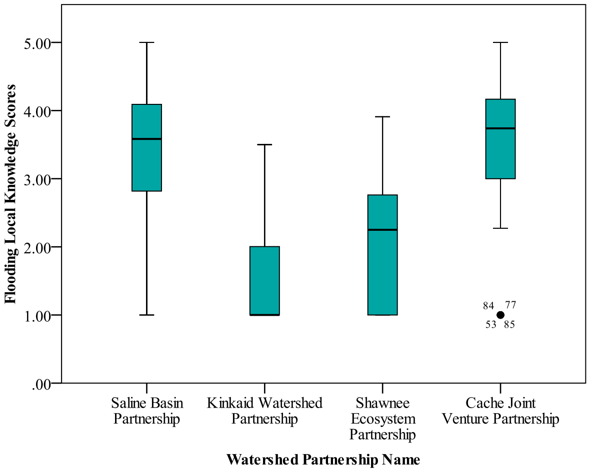


Figure 5.3 f. Boxplot of Flooding Local Knowledge Scores by Partnership

In all watersheds, variations in local hazards knowledge were not explained by stakeholders' activeness in partnership, and satisfaction with their partnership performance. Of the sociodemographic characteristics, only organizational affiliation explained variations in local hazards knowledge scores in the Cache watershed, but not in the other three watersheds. In the Cache, stakeholders belonging to non-governmental organizations held higher local hazards knowledge scores than their counterparts, as revealed by Mann-Whitney *U*-test ($U = 298.0$, $p < .05$). Differences in local hazards knowledge scores were not statistically significant for the other categories of organizational affiliation (state/federal, landowner/residents/business owners, and others) (see Table 5.10).

On the other hand, factors leading to variations in risk perception varied across the four watersheds. For instance, in the Kinkaid, of the stakeholder activeness indicators, only years of involvement in partnership had a statistically significant positive moderate correlation with risk perception ($\rho = .53$, $p < .05$). In the Cache, of the socio-demographic indicators, only years of residence had a statistically significant, but weak positive relationship with risk perception ($\rho =$

.34, $p < .01$). Regarding organizational affiliation, differences in risk perception scores between federal/state representatives and their counterparts were statistically significant only in the Cache watershed ($t = 2.42$, $p < .05$), but not in the other watersheds. In the Cache, government stakeholders held lower levels of concerns than non-governmental stakeholders (see Table 5.10).

Table 5.10

Bivariate Statistics of Local Hazards Knowledge (LHK) and Risk Perception (RP) across Stakeholders' Sociodemographic Characteristics, Activeness in Partnership, and Satisfaction with Partnership Performance

	Watershed Partnership							
	Cache		Saline		Lower Ohio Bay		Kinkaid	
	LHK	RP	LHK	RP	LHK	RP	LHK	RP
Sociodemographic characteristics								
Gender	$U = 411.5$	$t = -1.43$	$U = 3.00$	$t = -.49$	$U = 12.00$	$t = -.08$	-	-
Educational level	$X^2 = .93$	$F = 1.90$	$X^2 = 1.23$	$F = 1.15$	$X^2 = 1.31$	$F = .23$	$X^2 = 1.92$	$F = 1.82$
Age	$\rho = .19$	$\rho = .03$	$\rho = -.13$	$\rho = -.07$	$\rho = -.13$	$\rho = -.38$	$\rho = .21$	$\rho = .23$
Years of residence watershed	$\rho = -.05$	$\rho = .34^{**}$	$\rho = -.37$	$\rho = .23$	$\rho = -.10$	$\rho = -.29$	$\rho = -.40$	$\rho = -.32$
Organizational Affiliation								
Federal/State	$U = 422.0$	$t = 2.42^{*}$	$U = 13.0$	$t = -1.68$	$U = 10.00$	$t = -1.58$	$U = 21.00$	$t = .63$
Non-governmental organization	$U = 298.0^{*}$	$t = -1.29$					$U = 40.0$	$t = -1.01$
Landowners/business owners/residents	$U = 479.0$	$t = -.03$	$U = 14.0$	$t = .94$	$U = 12.00$	$t = .05$	$U = 19.00$	$t = .08$
Activeness in Partnership								
Years of involvement in partnership	$\rho = .08$	$\rho = .08$	$\rho = -.48$	$\rho = -.16$	$\rho = .58$	$\rho = .32$	$\rho = .31$	$\rho = .53^{*}$
Membership in partnership	$U = 470.0$	$t = .53$	$U = 16.0$	$t = -1.01$	$U = 12.0$	$t = 1.20$	$U = 35.0$	$t = .53$
Attendance in partnership meetings	$U = 362.0$	$t = -.64$	$U = 18.0$	$t = -.47$	$U = 6.0$	$t = -.42$	$U = 20.0$	$t = -.57$
Participation in partnership activities	$U = 493.0$	$t = 1.54$	$U = 15.0$	$t = -1.24$	$U = 5.0$	$t = -.61$	$U = 30.0$	$t = -.20$
Satisfaction with partnership performance	$\rho = -.03$	$\rho = -.16$	$\rho = -.59$	$\rho = -.16$	$\rho = -.25$	$\rho = .35$	$\rho = -.03$	$\rho = -.24$

** Statistical significance of Spearman Correlations, Mann-Whitney, and t-tests was at *$p < 0.05$ and ** $p < .01$*

The Relationship between Local Hazards Knowledge, Nature, and Level of Risk perception

Variations in risk perception were moderately associated with local hazards knowledge only in the Cache watershed ($\rho = .35, p < .01$). In the Saline watershed, local hazards knowledge and risk perception had a very weak negative correlation, but was not statistically significant ($\rho = -.24, p > .05$). On the other hand, local hazards knowledge and risk perception had a positive moderate correlation in the Lower Ohio Bay ($\rho = .53, p > .05$) and a weak positive correlation in the Kinkaid ($\rho = .32, p > .05$). In the latter two cases, correlations between local hazards knowledge and risk perception were not statistically significant. Local hazards knowledge was not significantly correlated with any of the three dimensions of risk perception (health, social, and ecological) in the Saline and Kinkaid watershed, but there was a statistically significant positive moderate correlation between local knowledge and social risk perception in the Lower Ohio Bay watershed ($\rho = .63, p < .05$). In the Cache watershed, local hazards knowledge had a weak positive correlation with health risk perception ($\rho = .32, p < .05$) and a moderate positive correlation with ecological risk perception ($\rho = .51, p < .05$) (see Table 5.11).

Table 5.11

Spearman Correlations Examining the Relationship between Local Hazards Knowledge (LHK) and Risk Perception (RP) across the four Studied Watersheds

	Watershed Partnership							
	Cache		Saline		Lower Ohio Bay		Kinkaid	
	RP	LHK	RP	LHK	RP	LHK	RP	LHK
LHK	$.35^{**}$	1.00	-.24	1.00	.53	1.00	.32	1.00
RP	1.00		1.00		1.00		1.00	
HRP[†]		$.32^{*}$		-.12		.45		.29
SRP[†]		.01		-.32		$.63^{*}$		.24
ERP[†]		$.51^{**}$		-.08		.49		.11

[†] HRP: health risk perception; SRP: social risk perception; ERP: ecological risk perception

Statistical significance: $^{*}p < .05$; $^{**}p < .01$

Discussion

This study aimed to quantitatively assess: (a) factors underlying variations in local hazards knowledge and risk perception among stakeholders of four watershed partnerships in Southern Illinois; (b) the nature and levels of concerns of partnership stakeholders within and across watershed contexts; and (c) the extent to which local hazards knowledge influence levels of concerns among stakeholders of the studied partnerships. Results of this study supported prior work regarding the influence of the local risk context on local knowledge and risk perception (Blaike et al., 1997; Fitchen et al., 1987; Flint & Luloff, 2005; Irwin, 2001). Statistically significant variations in risk perception and local knowledge were observed across the four watershed contexts. The lowest levels of concern were held by stakeholders of the Lower Ohio Bay watershed; a watershed technically assessed as having both low biophysical and socioeconomic vulnerability, and highest in the Cache watershed which was technically assessed as having both high biophysical and socioeconomic vulnerability.

Regarding local hazards knowledge, results showed discrepancies between stakeholders' awareness of the prevalence of multiple watershed hazards and results of the technical assessment of watershed vulnerability. For instance, despite that the Saline watershed was technically assessed as low biophysical vulnerability, stakeholders of the Saline watershed on average held the highest local hazards knowledge scores indicating an awareness of a higher number and prevalence of multiple watershed hazards than their counterparts in the Cache, Kinkaid, and the Lower Ohio Bay watersheds. Inconsistencies between local hazards knowledge and technical assessments are expected and well documented in the literature (Berkes, 2007; Garcia-Quinjano, 2009). Unlike stakeholders' perspectives on local hazards and their effects, technical assessments might lack the level of specificity required to accurately reflect local environmental conditions (Berkes, 2007; Garcia-Quinjano, 2009). In this study, water quality indices and interpolated flooding data from the county to the watershed level used to assess the overall biophysical vulnerability of these watersheds may not accurately reflect local environmental conditions in these watersheds. Overgeneralizations of water quality and flooding conditions generated by technical watershed assessments may mask local environmental conditions within a given watershed and may have led to the observed discrepancies between local and scientific knowledge. Another possibility is that stakeholders may not be truly aware of problems in their watersheds; explaining such discrepancies between technical assessments and local knowledge.

Within partnership variations in local hazards knowledge and risk perception were also observed, as local hazards knowledge and risk perception scores ranged among stakeholders of the same partnership. Variations in local hazards knowledge were not explained by stakeholders' age, gender, educational attainment, activeness in partnership, and satisfaction with their partnerships' performance. Organizational affiliation explained variations in local hazards knowledge in the Cache, whereby stakeholders belonging to non-governmental organizations expressed higher awareness of the prevalence of watershed hazards than their counterparts. Non-governmental organizations in the Cache contain residents of the watersheds who work on improving the environmental conditions in the watershed. Hence, membership of stakeholders in such organizations might lead to more awareness of hazards than those not involved.

Factors influencing variations in risk perception varied across watersheds. In the Cache watershed, variations in risk perception were associated with stakeholders' organizational affiliation (governmental vs. non-governmental) and years of residence in the watershed. Generally, government stakeholders held lower levels of concerns than non-government stakeholders. The fact that the Cache partnership was a mixed partnership—where government stakeholders had a leadership role and are therefore in control of watershed management activities—may explain their lower levels of concern compared to their counterparts. Sense of controllability of hazards is well documented in the literature and is suggested to attenuate risk perceptions (Slovic, 1992) among government stakeholders. Also, in the Cache, there is a long history of dispute between governmental and non-governmental stakeholders in regards to ways on solving environmental issues in the watershed. Elevated levels of concerns among non-governmental stakeholders are attributed to their skepticism about the government's role in the Cache Joint Venture Partnership and their belief that government recreancy is diminishing the efficacy of the Cache watershed management process (Freudenberg, 1996). Therefore, the structure of the partnership and leadership roles that stakeholders hold might influence the extent to which watershed partnership stakeholders are concerned about hazards and their effects on ecological and human wellbeing. This is a testable hypothesis in need of further investigation.

Whereas years of residence in the Cache watershed were associated with levels of concern, years of involvement in partnership was found to influence variations in risk perception in the Kinkaid watershed. This finding might be explained by variations in the historical and water use profiles of the Cache and the Kinkaid watershed. In the Cache watershed, environmental problems are associated with a long history of forces that have led to serious deterioration of the Cache River and wetlands. Deforestation and the Post Creek Cutoff have led over the years to habitat fragmentation, major alterations in river flow, and severe erosion leading to effects on aquatic life (Kraft et al., 2004). With the relationship between risk perception and local hazards knowledge being statistically significant in the Cache, longer years of residence is suggested to have led to an accumulation of stakeholders' awareness of environmental changes in their watershed, thus leading to higher level of concern. On the other hand, in the Kinkaid watershed, the fact that the lake constitutes a major resource for water supply and recreation for the City of Murphysboro and neighboring areas might explain why stakeholders in the partnership might be more concerned about watershed problems compared to their counterparts (Canter, Nelson, & Everette, 1992-1993). Interaction with other partnership stakeholders might highlight the importance of the lake as a resource and accordingly lead to an amplification of their perceptions of risk.

In this study, the contextualization of multiple watershed hazards made it possible to unravel the nature of concerns across contexts and overcome broad and vague assessments of risk often associated by studies that looked at decontextualized and isolated risks (Chapter 2). The nature of risk perception and level of health, social, and ecological concerns varied across watersheds. While ecological concerns were highest in the Cache, social risk perception was highest in the Saline watershed. Health risk perception was low in the Lower Ohio Bay, moderate in the Cache and the Kinkaid, but was highest in the Saline watershed. The latter finding corroborated with results of semi-structured interviews with selected stakeholders of the Saline watershed, which revealed acid runoff as one of the major hazards in the basin (Chapter 4). These stakeholders associated acid runoff with health concerns, as is shown in the following quote:

> A high sulfur content eventually leaching into the water system—you know, if water is moving, it's not going to leach into your ground water, but if it's water that has been standing for several years, eventually that's going to cause some problems… Well, according to—it would be the professionals that tell us all this information—are saying that a high sulfur water is more dangerous to health concerns, eventually. (SBP4)

Conclusions, Implications, and Future Research

Rural watersheds are characterized by limited financial, human, and technical capacities to deal with the complexities of watershed problems (Imperial & Hennessey, 2000). Enhancing collaborative endeavors within such contexts may come from building the capacity of stakeholders in watershed partnerships to integrate local and scientific knowledge structures and risk perceptions (Chapter 4). Integrating diverse forms of knowledge and risk perception broadens the range of salient watershed issues to be solved and avoids conflicts among stakeholders that may erupt as a result of marginalization (Lubell, 2005; Lupton, 1999). Also, integrating different perspectives and concerns helps develop holistic and preventative management schemes that build resilience against potential local watershed risks and disasters. Following a preventative holistic approach can diminish financial, human, and technical challenges often faced in rural settings in the face of watersheds hazards and disasters. Hence, partnership stakeholders are encouraged to bring to the table various holistic perspectives to collectively and effectively tackle the complexity, diversity, and uncertainties of their watershed (Chapter 4).

This study showed that local knowledge and concerns are not necessarily complementary to each other and to technical assessments of risks. Hence, partnerships are encouraged to include local voices, especially longtime watershed residents who are aware of the historical progression of hazards in their watersheds. Enhancing the *interactional capacity* (Flint & Luloff, 2005) of these partnerships is recommended in order to create *communicative linkages* which can facilitate the integration of varied perspectives and concerns in order to create common grounds across all partnership stakeholders (Bridger & Luloff, 2001, p. 384).

Results of this study cannot be generalized to other contexts, given the contextualization of hazards within four specific rural watersheds in Southern Illinois. Further research is required to understand the nature and level of concerns as well as the relationship between local hazards knowledge and risk perception in other contexts, such as urban contexts where institutional infrastructure might have an influence on the dynamics of watershed partnerships and stakeholders’ perspectives and concerns about watershed problems and their effects on ecological and human wellbeing (Chapter 4).

CHAPTER 6

DISCUSSION AND CONCLUSIONS

This study examined a conceptual framework delineating the relationship between the watershed risk context, local hazards knowledge and risk perception. Results generated from this study add to our understanding of an understudied domain on the relationship between local hazards knowledge and risk perception and serve as a starting point to understanding the role of these two parameters in enhancing the efficacy of collaborative watershed management.

Prior risk perception research—focusing on the relationship between factual knowledge and risk perception—provides a narrow perspective on managing hazards and risks within the context of complex and uncertain socio-ecological systems. These previous studies largely dealt with decontextualized and isolated hazards, generated broad and vague assessments of risk perception, and overlooked variations in stakeholders' knowledge and concerns. In retrospect, results generated by this study help explain factors underlying variations in local knowledge and risk perception of contextualized multiple hazards particularly among watershed partnerships stakeholders acting within complex socio-ecological systems characterized by multiple hazards and multifaceted uncertainties (health, social, and ecological).

One of the critical issues in understanding the relationship between local knowledge and risk perception related to the tension between specificity and generality. The fact that local knowledge and risk perception are heavily ingrained in the local context renders generalization to other contexts a challenging task (Greenwood & Levin, 2000). This study comparatively analyzed the relationship between local hazards knowledge and risk perception across four different watersheds in Southern Illinois: Cache, Saline, Lower Ohio Bay, and Kinkaid. This comparative analysis first involved examination of the specifics of the local context within each of the four watersheds in terms of: (a) the structure and functions of watershed partnerships in the four watersheds; (b) the biophysical and socioeconomic attributes of the watersheds; (c) major environmental problems in these watersheds; and (d) local conditions underlying these problems, as both local knowledge and risk perception emanate from and are influenced by the local context. The second step of the comparative analysis explored patterns of the relationship between local knowledge and risk perception and how this relationship varied across the four watersheds in order to generalize across different contexts. Yet, differences in the relationship between local knowledge and risk perception across watersheds were then explained by the factors embedded within the local context inherent of the four studied watersheds. As such, the ability to generalize the relationship between local knowledge and risk perception to watersheds beyond this study is limited as factors underlying variations in the relationship between the two parameters were contextual and tied to conditions specific to each of the four watersheds. Clarification of this tension is further explained in the sections to follow.

An Analysis of Study Results

This study acknowledged the complexity and dynamic nature of stakeholders' local knowledge and risk perception, which is an aspect overlooked by most risk perception research. It expanded risk perception research by synthesizing literature on local knowledge and risk perception to account for the complexities and uncertainties of complex socio-ecological systems. Results generated by this study were congruent with those of prior research regarding the influence of the local context on local hazards knowledge and risk perception (Blaike et al., 1997; Flint & Luloff, 2005; 2007; Irwin, 2001). There were substantial variations in stakeholders’ local knowledge and risk perception across the four studied watersheds. Variations in local knowledge across the four watersheds were observed both in the level of complexity of stakeholders’ local knowledge and their level of awareness of the prevalence of multiple watershed hazards and their effects on ecological and human wellbeing. Analysis of concept maps showed that complexity scores were highest for the stakeholders of the Cache watershed, followed by those of the Saline watershed. The lowest complexity scores were held by stakeholders of the Lower Ohio Bay. On the other hand, survey results showed that local knowledge scores were highest for stakeholders of the Saline watershed, followed by the Cache, and were lowest for the Kinkaid watershed. While there appears a discrepancy in the data between the concept maps and survey results, this discrepancy does not imply contradiction. The Saline and Cache watersheds were comparable in terms of stakeholders’ views on the prevalence of agricultural runoff, poor water drainage, deforestation, erosion, and flooding. Saline had an additional problem which was acid runoff; a hazard not reported by stakeholders as a prevalent problem in the Cache watershed. Hence, this additional problem in the Saline explains the higher scores compared to those of the stakeholders of the Cache watershed. Despite the larger number of problems facing the Saline watershed, the complexity scores from the Cache watershed were higher than those of the Saline. In the Cache watershed, stakeholders commonly referred to the historical context, as compared to stakeholders of the Saline and the other watersheds. The Cache stakeholders—unlike their counterparts in the other three studied watersheds—discussed causes underlying direct forces of change in their watershed. Hence, stakeholders’ understanding of the historical progression of environmental change in the Cache watershed is suggested to have led to a richer and a more complex overview of watershed issues (Fazey et al., 2006).

Both the qualitative and quantitative methods applied in this study showed heterogeneity in the nature and levels of stakeholders’ risk perceptions across the four studied watershed contexts. However, there were differences in results between the two methodologies regarding the nature of concerns. Semi-structured interviews revealed that social and ecological concerns were prevalent among stakeholders of all watersheds. On the other hand, survey results revealed that social concerns were barely prevalent among respondents of the Kinkaid watershed. Also, whereas semi-structured interviews revealed health concerns to be more common among participants of the Kinkaid, survey results showed health concerns to be prevalent among respondents of the Saline watershed and, to a lesser extent, in the Kinkaid. Such discrepancies in results between the quantitative and qualitative methods can be explained by several aspects. First, conceptualizations of health and social risk perceptions varied between the respondents and the researcher. For the respondents, health risk perception primarily related to stakeholders’ concerns about the potential occurrence of a disease or an infirmity resulting from existing watershed hazards, as was revealed by the semi-structured interviews. For the researcher, a broader definition of health was considered in the survey to include the possible effects of watershed hazards on human health, safety, and water supply. Differences in conceptualizations of social risk perception between interviewees and researchers are also suggested to have resulted in discrepancies in results between the quantitative and qualitative methods. Another aspect to consider is the larger pool of respondents who were involved in the survey compared to the pool of interviewees of the qualitative interviews. In the survey, a wider range of perspectives were obtained than those elicited from semi-structured interviews, which might have led to divergent results.

Watershed partnerships are dynamic heterogeneous groups (Cronin & Ostergen, 2007). Similar to a community, representatives of diverse social groups act together within these partnerships to improve the social and ecological wellbeing of their locale, in this case their watershed (Wilkinson, 1991). Engagement of stakeholders in a watershed partnership for long durations does not generally contribute to homogeneity of the nature of both local hazards knowledge and risk perception. This study showed that richness and diversity of perspectives were maintained despite the longevity of stakeholders' involvement in their partnerships. Variations in the complexity of local hazards knowledge were apparent both in terms of the nature and level of connections drawn by participants between the four elements of the Millennium Ecosystem Assessment framework. Also, survey results showed variations in stakeholders' perspectives on the prevalence of multiple watersheds hazards and their effects on ecological and human wellbeing. However, such variations were not influenced by years of involvement in partnerships, thus supporting the hypothesis generated by the semi-structured interviews which indicated an absence of a relationship between longevity of involvement in the partnership and local hazards knowledge. As such, variations in stakeholders perspectives on watershed hazards and their effects might be explained by their diverse personal experience and observations, understandings, practices, values, beliefs, identity, belongingness to varied watershed regions (Brody, Highfield, & Alson, 2004; Greider & Garkovich, 1994), as well their interactions with their surrounding environment (Irwin et al., 1999; Karjalainen & Habeck, 2004).

Regarding risk perception, semi-structured interviews with participants showed that not all stakeholders held all three dimensions of risk perception (health, social, and ecological). Also, almost all of them did not have integrated perceptions of risks, and many only held partially integrated perceptions of risks mostly showing associations between social and ecological risk perceptions. A possible explanation may be that stakeholders may have held all three concerns but was not easy for them to verbally articulate the connections between these concerns during the interview process.

Factors underlying variations in risk perception varied across the four studied watersheds. Whereas years of residence were positively associated with risk perception in the Cache, years of involvement in partnership explained variations in risk perception in the Kinkaid watershed. On the other hand, the latter two factors did not explain variations in risk perception in both the Saline and Lower-Ohio Bay watersheds. As previously mentioned, semi-structured interviews reflected the dependence of stakeholders of the Cache on the historical context of watershed issues to explain the current situation and to project into the future, and thus stakeholders living in the watershed for longer periods of time exhibited higher levels of concerns. On the other hand, in the Kinkaid watershed, years of involvement in the partnership and interaction with other stakeholders might have highlighted the importance of the Kinkaid Lake as a major water resource for the area; hence amplifying stakeholders' perceptions of risk. This phenomenon is well documented in the literature as the use of water resource is known to influence risk perception (Canter, Nelson, & Everette, 1992-1993). Moreover, risk perception seemed to vary by organizational affiliation. Government stakeholders in the Cache watershed seemed to have lower levels of concern than non-government stakeholders. This finding was not established in other watersheds. Government stakeholders in the Cache held a leadership position in the partnership. A sense of control of environmental change and conditions and risks is known to attenuate level of concerns (Slovic, 1992).

This study showed that the complexity of local hazards knowledge did not seem to be a strong indicator of integration of the three dimensions of risk perception (health, social, and ecological), as participants mostly drew associations between social and ecological concerns. It seemed that integration of concerns might be associated with a form of bias influencing *availability heuristic*, known as the *illusory-correlation effect* (Tversky & Kahneman, 1974), whereby connections between health, social, and ecological concerns are determined by the extent to which people perceive these concerns co-occur. In this study, associations made between social and ecological concerns related to stakeholders' awareness of the repercussions associated with degraded ecological wellbeing. Degradation of wildlife and their habitats were perceived to influence tourism and economic wellbeing in Southern Illinois, thus raising both ecological and social concerns and strengthening the bonds between these two concerns.

On another note, survey results showed divergent results in the relationship between local hazards knowledge and risk perception. A statistically significant positive association between local knowledge and risk perception was only found in the Cache but not in the Kinkaid, Saline, and Lower-Ohio Bay. Local hazards knowledge is cumulative (Blaike et al., 1997; Davidson-Hunt & O'Flahtery, 2007; Davis & Wagner, 2003), and it is suggested that knowledge of the historical context might have affected how stakeholders experience their surrounding environment, and as such increase their levels of concerns.

Policy and Management Implications

With limited institutional capacity to readily deal with complex environmental problems and with socioeconomically suppressed populations, watershed partnerships in Southern Illinois may have limited capacity to build resilience against watershed risks. Findings of this study suggested that watershed partnership stakeholders do not often share common views on and concerns about major watershed hazards and their effects on ecological and human wellbeing. Also, not all stakeholders hold sophisticated views of their watersheds' complexities and health, social, and ecological uncertainties. Thus, enhancing the efficacy of collaborative watershed management and building resiliency may be attained by empowering stakeholders in Southern Illinois and building their capacity to think holistically about hazards, and health, social, and ecological uncertainties associated with their watersheds (Margerum & Hooper, 2001).

Heterogeneity in watershed stakeholders' local knowledge and concerns was reaffirmed by a workshop conducted at the University of Illinois Dixon Springs Agricultural Center, on December 9, 2011. Ten stakeholders attended the workshop and belonged to the Cache, Kinkaid, Saline watersheds. These stakeholders were representatives of government agencies (IDNR, IL EPA, Forest Service), and the Soil and Water Conservation District. Also, many of these stakeholders were landowners in their watersheds and were influential individuals holding leadership positions in their watersheds and capacity to promote the concepts addressed in the workshop. When asked about the most pressing environmental hazards in their watersheds, these stakeholders had varied views regarding the type and nature of salient hazards and their effects on their watersheds. The list of hazards generated by the stakeholder panel largely coincided with the list of hazards generated from the semi-structured interviews conducted with 33 stakeholders who participated in this study. Flooding, erosion, acid runoff, and agricultural runoff were among the problems considered to be salient to the panel of stakeholders. Despite their differences on the type and nature of hazards, the stakeholder panel agreed on factors hindering the management of these problems, including: lack of funding, lack of coordination and competing agendas among agencies, and jurisdictional boundaries. These factors were also identified by participants of this study during the semi-structured interviews.

Further discussion about watershed issues among the ten stakeholders drew and highlighted complex connections between the listed watershed issues and concerns and the ten stakeholders were therefore able to visualize those connections. Such discussion concluded with the need to understand, integrate, and acknowledge the complexity of and variations in the nature of local hazards knowledge and risk perception among partnership stakeholders in order to adopt a preventative and a holistic approach to watershed management. In other words, the idea of a holistic approach to understanding and communicating about watershed risks resonated with the workshop participants. Given their positions of leadership in the region, such an approach might be a key to push forward management processes in the region's watersheds.

A holistic approach to watershed management helps stakeholders deal with prevalent complex environmental conditions and sets the stage for developing preventative plans that can mitigate hazards before their inception. The process for designing such schemes does not necessitate homogenization of stakeholders' views. Rather, it is highly recommended that stakeholders attain varied holistic perspectives in order to diversify the portfolio of salient watershed issues to effectively tackle the complexity, diversity, and uncertainties of watershed hazards and their effects. Such an exercise can help stakeholders assess the costs and benefits of tackling these environmental problems (Lubell, 2005). Moreover, properly identifying hazards and mitigating them before their onset may help watershed partnerships maintain their sustainability by boosting and efficiently using their financial, technological, and human resources, which are known to be particularly limited in rural watersheds (Imperial & Hennessey, 2001).

Building the capacity of Southern Illinois stakeholders to think holistically about their watersheds cannot be achieved by only enhancing their scientific knowledge structure. Knowledge does not seem to be a prerequisite of risk perception. This study showed a divergence between the results of technical assessment and local knowledge. Technical assessments, particularly those depending on aggregate data, might not necessarily provide clear and detailed insights on local environmental conditions. Hence, modifying the knowledge structure of stakeholders by imposing results of technical assessments might not necessarily lead to modifications in stakeholders' concerns and behaviors. As previously mentioned, stakeholders are not passive learners (Karjaleinen & Habeck, 2004). They rather tend to contextualize and reinterpret scientific knowledge and concerns based on their personal experiences and observations resulting from social action and interaction with their local environment (Irwin, 2001; Irwin et al., 1999; Karjalainen & Habeck, 2004). Accordingly, integration of diverse knowledge structures (local and scientific), risk perceptions, and interests, should be encouraged. Integration might enhance the efficacy of collaborative management as it provides a panoramic perspective on watershed issues (Beall, 2011) and provides more legitimacy to the management process by avoiding the marginalization of local voices (Lubell, 2005).

In addition to integration of knowledge and concerns, enhancing collaborative endeavors in Southern Illinois can be achieved by an in-depth understanding of the biophysical, social, political, and historical contexts of environmental forces and change within a watershed. Understanding factors underlying direct forces of change in watersheds helps in building resiliency against watershed risks. Vulnerability is a function of both the attributes of a hazard and the social infrastructure that instigate and augment hazards and their effects (Cutter, 2003). In other words, only addressing biophysical hazards might not yield the desired outcomes, and inducing modifications to the social dimensions of these hazards might boost the effectiveness of management processes.

Examining the local context can help in understanding variation in local hazards knowledge and risk perception within and across watershed risk contexts. Understanding variations in and the relationship between both parameters can have positive implications on collaborative endeavors in a single watershed or involving several watersheds. Factors underlying variations in perspectives and concerns were found to differ by geographical scale. Variations within a watershed are more related to personal stakeholder characteristics relating to organizational affiliation, years of residence in a watershed, and years of involvement in a partnership. On the other hand, variations in both local knowledge and risk perception across watersheds may relate more to the structure and dynamics of watershed partnerships, and the dependence of stakeholders on natural resources, such as surface water.

With heterogeneity in perspectives and concerns within and across watersheds, there is always the possibility of *inappropriate intensification* or *inappropriate attenuation* of risks (Leiss, 2003, p. 357) by stakeholders. Schisms in perspectives and concerns may lead to elevated levels of skepticism, mistrust, and conflict among the various players (Lupton, 1999) in a partnership or across partnerships. Therefore, it is highly recommended that collaboration within and across watersheds account for both personal and group variations, as well as stakeholders' interactions with their surrounding environment (such as landuse, dependency on natural resources, etc.). Understanding such variations can help create a collaborative environment with reduced levels of mistrust and skepticism among the various players, and further facilitates the integration of varied perspectives and concerns. With enhanced integration of perspectives, it would be possible to properly indentify salient watershed issues and, therefore, avoid *inappropriate amplification* or *attenuation* of risks that may lead to inefficiencies in the use of resources allocated to improperly prioritized and amplified risks and undesired consequences due to overlooking salient risks deemed to be insignificant by certain groups of stakeholders (Leiss, 2003).

Understanding the uniqueness of watersheds and factors underlying variations in knowledge and risk perception to develop holistic and preventative management schemes within or across watersheds can be achieved by the process of generalization (Kaufman, 1959; Wilkinson, 1991). Theodori (2005, p. 665) explained generalization as:

> …actions that are expressed through the interests of a broad range of actors and associations, are clearly located within a locality, involve a substantial proportion of the local population as participants and/or beneficiaries, are conducted by local actors and associations, are aimed toward changing or maintaining the locality, are carried out in an organized or purposive manner, and have coordination among fields of interest as a major objective. Such actions contribute to the emergence of the community field in local settlements.

Generalization may help in coordinating activities across various stakeholders belonging to different social groups (i.e. different watershed partnerships, governmental and non-governmental institutions), by finding commonalities across varied knowledge structures, concerns and interests existing among stakeholders. Creating commonalities can also facilitate collaboration by diffusing existing jurisdictional and institutional incompatibilities generated by differences in the missions, goals, policies and procedures, and resources of different social groups, which may impede the management process (Forester, 2005; Wondolleck & Yaffee, 2000). Establishing *communicative linkages* (Bridger & Luloff, 2001, p. 384), which are in a sense personal networks (Horlick-Jones et al., 2003), is suggested to create such commonalities across all partnership stakeholders and watershed contexts. Such linkages are not suggested to totally purge disagreement, but are rather thought to initiate dialogue across the various players in order to minimize *transaction costs*, which include the costs of the process for searching, choosing, and enforcing equitable policies (Lubell, 2005; Susskind, 2005).

In Southern Illinois, federal and state agencies—funding and delegating watershed management responsibilities to local stakeholders in Southern Illinois—are encouraged to initiate, foster, and/or facilitate the generalization process. In the Cache watershed, a long history of dispute and tension between local stakeholders and the Cache partnership exists due to high levels of mistrust and skepticism between the two groups. Local stakeholders feel marginalized and threatened by the technical watershed solutions implemented by the partnerships' technical experts. Given their leadership roles in the partnership, it is highly recommended that the federal and state agencies create social networks and opportunities for initiating discussion with local stakeholders, particularly long time residents, in order to understand their perspectives and concerns and factors underlying variations in these perspectives and concerns, and to find commonalities across the various groups about which watershed problems to address and how. Such discussion helps address not only the biophysical impacts of technical assessments and solutions on watersheds, but also their social impacts as local watershed residents are, in fact, the ones who experience watershed changes on a daily basis. Ultimately, these discussions also help federal and state agencies design holistic management schemes that account for both the biophysical and socioeconomic attributes of the Cache watershed.

Regarding the Saline, Lower Ohio Bay, and Kinkaid watersheds—where state representatives have an encourager role and only provide financial, technical, and administrative assistance—board members of watershed partnerships are encouraged to create venues to mobilize local communities to get more engaged in the management process. It is suggested that board members not only communicate the objectives, roles, and outcomes of their partnerships, but also obtain local communities' perspectives and concerns to find commonalities across, prioritize, and act on salient watershed problems. While board members of these partnerships have a role in initiating and fostering these communicative linkages, state agencies also have a crucial role in facilitating the communication process. State agencies are encouraged to promote the concept of holistic and preventative approaches to watershed management. It is recommended that state agencies communicate with watershed partnerships the need to create comprehensive lists of, prioritize, delineate the interrelationships between multiple watershed hazards and their effects and the interrelationships between the health, social, and ecological uncertainties arising from hazards, and identify proposed solutions to these hazards. Facilitating this process requires state agencies to highlight the need for watershed partnerships to integrate varied stakeholders' perspectives and concerns in order to develop holistic and preventative management schemes that can address the complexities and health, social, and ecological uncertainness of socio-ecological systems.

Future Research

It is acknowledged that results of this study cannot be generalized to other contexts, as this study was framed within the context of four specific watersheds. Further research is required to understand the relationship between local hazards knowledge and risk perception in other contexts characterized by higher degrees of complexities and uncertainties (Gartin et al., 2011), such as urban contexts where institutional infrastructure might have an influence in developing the complexity of knowledge and risk perception. Hence, comparative analysis of local hazards knowledge and risk perception between urban and rural watersheds might reveal patterns in variations in these two parameters and their relationship.

Results generated from this study suggest the need to further understand factors underlying variations in local hazards knowledge, risk perception, and their relationship. The structure of watershed partnerships and interaction among watershed stakeholders seem to influence local knowledge and concerns. Hence, an in-depth examination of the management process and interaction among partnership stakeholders with each other and with the community might reveal more insights into variations in local hazards knowledge and risk perception. Such research might also provide further indications or hints on how these two parameters influence the efficacy of the management process.

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APPENDIX A

SEMI-STRUCTURED INTERVIEW QUESTIONS

Background Information

1- What is your name?
2- Do you belong to a governmental or a non-governmental organization?
    a. Can you please tell me more about your organization?
    b. What is your role in your organization?
3- What is the name of your watershed partnership?
4- For how long have you been involved in your watershed partnership?
5- Why are you involved in your partnership?
6- How did you get involved in your partnership?
7- What is your role in your partnership? What activities are you engaged with?
8- Were you previously involved in other partnerships?

Your Watershed: Description and functions

9- In your opinion, what is a watershed?
10- Can you please tell me more about your watershed (in terms of boundaries, topography/landscapes, animals and plants, and communities)?
11- In your opinion, what resources does a watershed provide to both humans and ecosystem?
12- What are the functions of a watershed?
    a. Do you think that these functions are related to each other? If yes, how?

Your Watershed: Major Issues and Hazards

13- What do you think are the most pressing environmental concerns (i.e. hazards) in your watershed?
14- Are these hazards natural or manmade?
15- What are the sources of environmental hazards in your watershed?
    a. Where are these sources located (upstream, downstream, or both)?
16- What impacts do these hazards have on your watershed? (This question intends to explore how hazards influence the hydrological services of a watershed).

Water Quality in Your Watershed

17- Do the hazards, you mentioned, influence the water quality in your watershed? How?

18- Where do you think these hazards impact the water quality in your watershed more, upstream or downstream? Why?

19- Do you think that the water quality influences the ecosystem in your watershed?
    a. If yes, how?
    b. If no, why not?

20- What is the major source of water supply for the communities in your watershed (surface or groundwater)?

21- Do you think water quality influences people in your watershed?
    a. If yes, in what sense?
    b. If no, why not?

22- Do you think these hazards influence residents in your watershed?
    a. If yes, how? And are these impacts more prevalent in upstream or downstream communities?
    b. If no, why not?

Sources of Information about your watershed

23- What sources of information do you rely on to build your knowledge of your watershed?

Water Quality and Watershed Risk Perceptions

24- Are you concerned about the water quality in your watershed? If yes, to what extent are you concerned about water quality?

25- What concerns do you have regarding water quality in your watershed? Why are you concerned?

26- In your opinion, is your partnership improving or capable of improving the water quality in your watershed?

27- Do you think that protecting your watershed is important? Why?

28- Is there anything you would like to add?

APPENDIX B
SURVEY QUESTIONNAIRE

YOUR WATERSHED AND WELLBEING

This survey aims to assess your perceptions of watersheds and human wellbeing. Filling out this survey is voluntary and should take about 20-30 minutes. This survey is not expected to have any risks beyond those in everyday life.

This survey should *only* be completed by members or stakeholders working with the Kinkaid, Saline, Cache, and Shawnee watershed partnerships, whose name appears on the survey envelope. Your contact information was obtained from the membership/stakeholder list provided by your watershed partnership. We assure you that your name, contact information, and answers will *not* be released to anyone.

Any questions about the study can be directed to Dr. Courtney Flint, 217-244-1840, cflint@illinois.edu or Lama BouFajreldin, 217-766-5658, lboufaj2@illinois.edu, Department of Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign. Please note this contact information before returning the survey.

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I. BACKGROUND INFORMATION

Q1. What is the name of your watershed partnership?	☐ Saline Basin Partnership	☐ Kinkaid Watershed Partnership	
	☐ Shawnee Ecosystem Partnership	☐ Cache Joint Venture Partnership (The Cache Project)	
Q1a. If you belong to more than one partnership, please choose one partnership to complete this survey and write the name of the partnership you selected in the space provided.		______________________________	
Q2. What is your role in your watershed partnership? (Please check any that apply).	☐ Member	☐ Not a member	☐ Technical advisor
	☐ Board member	☐ Partnership coordinator/ President	☐ Others (Please specify)_______
Q3. Which of the following best describes your organization or affiliation? (Please check any that apply).	☐ Federal/State agency	☐ County/City agency	☐ Business owner/ Landowner/ Resident
	☐ Non-governmental organization/Clubs	☐Others (please specify)_____________	
Q4. How long have you been involved in your watershed partnership? _______ years			
Q5. How often do you attend your watershed partnership meetings?	☐ Always	☐ Sometimes	☐ Never
Q6. Do you participate in any of your watershed partnership's activities (e.g. writing proposals, developing or implementing watershed management plans, etc.)?		☐ Yes	☐ No
Q7. Do you have any current or previous involvement with other watershed partnerships?		☐ Yes	☐ No
Q8. Do you live in the watershed in which you are a partnership member or stakeholder?		☐ Yes	☐ No
Q8a. If yes, for how long have you been living in this watershed?		__________ years	
Q9. Do you live close to a river, lake, pond, or wetland?		☐ Yes	☐ No
Q9a. If yes, how close do you live to a river, lake, pond, or wetland?		____________________________	

Q10. Rate your level of satisfaction with your watershed partnership's performance in dealing with problems in your watershed:

Very unsatisfied				***Very satisfied***
1	2	3	4	5

Q11. Why are you involved in your watershed partnership? (Please indicate how important each reason below is to you)

	Not at all important 1	2	3	4	*Very important* 5
a. To know more about issues in my watershed.	☐	☐	☐	☐	☐
b. To protect myself and my family from watershed problems.	☐	☐	☐	☐	☐
c. To protect my property from watershed problems.	☐	☐	☐	☐	☐
d. To protect my community from watershed problems.	☐	☐	☐	☐	☐
e. To protect water resources in my watershed.	☐	☐	☐	☐	☐
f. To preserve my watershed for future generations.	☐	☐	☐	☐	☐
g. To keep my watershed pristine.	☐	☐	☐	☐	☐
h. Because my watershed is ecologically valuable.	☐	☐	☐	☐	☐
i. To report back to my organization about the activities of my watershed partnership.	☐	☐	☐	☐	☐
j. To provide the watershed partnership with technical assistance.	☐	☐	☐	☐	☐
k. Because it is a requirement for my employment.	☐	☐	☐	☐	☐
l. Because I care about my watershed.	☐	☐	☐	☐	☐

II) YOUR WATERSHED AND WELLBEING

Q12. In your view, which of the following items describes your watershed? (Please indicate how important each item below is to you)

My watershed:	*Not at all important* 1	2	3	4	*Very important* 5
a. consists of water resources and surrounding land.	☐	☐	☐	☐	☐
b. is a place where people live.	☐	☐	☐	☐	☐
c. is a place where people interact socially.	☐	☐	☐	☐	☐
d. supplies water for human use.	☐	☐	☐	☐	☐
e. provides natural resources, such as timber and minerals.	☐	☐	☐	☐	☐
f. provides recreational opportunities.	☐	☐	☐	☐	☐
g. provides beautiful scenery.	☐	☐	☐	☐	☐
h. provides job opportunities.	☐	☐	☐	☐	☐
i. controls soil erosion.	☐	☐	☐	☐	☐
j. controls floods.	☐	☐	☐	☐	☐
k. controls human diseases.	☐	☐	☐	☐	☐
l. purifies the air.	☐	☐	☐	☐	☐
m. purifies water.	☐	☐	☐	☐	☐
n. recharges water resources.	☐	☐	☐	☐	☐
o. provides habitat for wildlife.	☐	☐	☐	☐	☐
p. supplies nutrients and water for wildlife.	☐	☐	☐	☐	☐
q. provides a healthy environment for people.	☐	☐	☐	☐	☐

Q13. In your view, to what extent are the following conditions occurring in your watershed?

a. From my perspective:	***Not at all***				***A lot***	***I don't know***
	1	**2**	**3**	**4**	**5**	**0**
1. Agricultural runoff (fertilizers and pesticides) is a problem. (*If not at all, please skip to section "b" below*).	☐	☐	☐	☐	☐	☐
2. Agricultural runoff is caused by poor farming practices.	☐	☐	☐	☐	☐	☐
3. Agricultural runoff is degrading water quality.	☐	☐	☐	☐	☐	☐
4. Agricultural runoff is causing algal blooms.	☐	☐	☐	☐	☐	☐
5. Agricultural runoff is affecting the health of aquatic life.	☐	☐	☐	☐	☐	☐
b. From my perspective:						
1. Poor water drainage is a problem. (*If not at all, please skip to section "c" below*).	☐	☐	☐	☐	☐	☐
2. Poor water drainage is caused by the flat topography.	☐	☐	☐	☐	☐	☐
3. Poor water drainage is caused by human alterations of river flow.	☐	☐	☐	☐	☐	☐
4. Poor water drainage is caused by beaver dams.	☐	☐	☐	☐	☐	☐
5. Poor water drainage is causing erosion.	☐	☐	☐	☐	☐	☐
6. Poor water drainage is causing flooding.	☐	☐	☐	☐	☐	☐
7. Poor water drainage is limiting recreational activities.	☐	☐	☐	☐	☐	☐
8. Poor water drainage is affecting the health of wildlife.	☐	☐	☐	☐	☐	☐
c. From my perspective:						
1. Deforestation is a problem. (*If not at all, please skip to section "d" below*).	☐	☐	☐	☐	☐	☐
2. Deforestation is caused by changes in land use.	☐	☐	☐	☐	☐	☐
3. Deforestation is a result of commercial timber harvesting.	☐	☐	☐	☐	☐	☐
4. Deforestation is contributing to flooding.	☐	☐	☐	☐	☐	☐
5. Deforestation is causing erosion.	☐	☐	☐	☐	☐	☐
6. Deforestation is affecting water quality through erosion.	☐	☐	☐	☐	☐	☐
7. Deforestation is affecting wildlife habitat.	☐	☐	☐	☐	☐	☐
8. Deforestation is affecting scenic beauty.	☐	☐	☐	☐	☐	☐
9. Deforestation is limiting recreational opportunities.	☐	☐	☐	☐	☐	☐
d. From my perspective:						
1. Acid runoff is a problem. (*If not at all, please skip to section "e" on page5*).	☐	☐	☐	☐	☐	☐
2. Acid runoff is coming from coal mines.	☐	☐	☐	☐	☐	☐
3. Acid runoff is aggravated by flooding.	☐	☐	☐	☐	☐	☐
4. Acid runoff is affecting water quality.	☐	☐	☐	☐	☐	☐
5. Acid runoff is affecting aquatic health.	☐	☐	☐	☐	☐	☐
6. Acid runoff is affecting wildlife.	☐	☐	☐	☐	☐	☐
7. Acid runoff is affecting human health.	☐	☐	☐	☐	☐	☐
8. Acid runoff is affecting agricultural production.	☐	☐	☐	☐	☐	☐
9. Acid runoff is affecting recreation.	☐	☐	☐	☐	☐	☐

e.	**From my perspective:**	***Not at all***				***A lot***	***I don't know***
		1	**2**	**3**	**4**	**5**	**0**
1.	Erosion is a problem. (*If not at all, please skip to section "f" below*)	☐	☐	☐	☐	☐	☐
2.	Erosion is caused by steep slopes.	☐	☐	☐	☐	☐	☐
3.	Erosion is caused by poor farming practices.	☐	☐	☐	☐	☐	☐
4.	Erosion is caused by poor stream bank stabilization.	☐	☐	☐	☐	☐	☐
5.	Erosion is caused by deforestation.	☐	☐	☐	☐	☐	☐
6.	Erosion is caused by quarrying activities.	☐	☐	☐	☐	☐	☐
7.	Erosion is aggravated by flooding.	☐	☐	☐	☐	☐	☐
8.	Erosion is limiting accessibility to water resources (rivers, lakes, wetlands).	☐	☐	☐	☐	☐	☐
9.	Erosion is limiting recreational opportunities.	☐	☐	☐	☐	☐	☐
10.	Erosion is degrading water quality.	☐	☐	☐	☐	☐	☐
11.	Erosion has affected the health of aquatic life.	☐	☐	☐	☐	☐	☐
12.	Erosion is affecting wildlife habitat.	☐	☐	☐	☐	☐	☐
13.	Erosion is contributing to flooding.	☐	☐	☐	☐	☐	☐
14.	Erosion is affecting agricultural production.	☐	☐	☐	☐	☐	☐
15.	Erosion is affecting the livelihood of people.	☐	☐	☐	☐	☐	☐
f.	**From my perspective:**						
1.	Flooding is a problem. (*If not at all, please skip to question "Q14" below*).	☐	☐	☐	☐	☐	☐
2.	Flooding is caused by the flat topography.	☐	☐	☐	☐	☐	☐
3.	Flooding is caused by siltation.	☐	☐	☐	☐	☐	☐
4.	Flooding is caused by heavy rain.	☐	☐	☐	☐	☐	☐
5.	Flooding is caused by poor water drainage.	☐	☐	☐	☐	☐	☐
6.	Flooding is occurring due to climate change.	☐	☐	☐	☐	☐	☐
7.	Flooding is caused by beaver dams.	☐	☐	☐	☐	☐	☐
8.	Flooding is caused by artificial dams.	☐	☐	☐	☐	☐	☐
9.	Flooding is affecting wildlife.	☐	☐	☐	☐	☐	☐
10.	Flooding is increasing erosion.	☐	☐	☐	☐	☐	☐
11.	Flooding is affecting private properties.	☐	☐	☐	☐	☐	☐
12.	Flooding is affecting agricultural production.	☐	☐	☐	☐	☐	☐
13.	Flooding is disrupting the lives of people.	☐	☐	☐	☐	☐	☐
14.	Flooding is threatening the safety of people.	☐	☐	☐	☐	☐	☐

Q14. Please rate the level of involvement of government agencies in your watershed partnership:

	Not at all involved				***Very involved***
	1	**2**	**3**	**4**	**5**
a. Federal agencies	☐	☐	☐	☐	☐
b. State agencies	☐	☐	☐	☐	☐

Q15. Please rate your level of satisfaction with the involvement of government agencies in your watershed partnership activities:

	Very unsatisfied				*Very satisfied*
	1	**2**	**3**	**4**	**5**
a. Involvement of federal agencies	☐	☐	☐	☐	☐
b. Involvement of state agencies	☐	☐	☐	☐	☐

Q16. Compared to conditions 10-20 years ago, how do you generally rate the current conditions of problems in your watershed?

	Worse	*Same*	*Better*	*Has never been a problem*	*I don't know*
	1	**2**	**3**	**4**	**0**
a. Agricultural runoff	☐	☐	☐	☐	☐
b. Acid runoff	☐	☐	☐	☐	☐
c. Deforestation	☐	☐	☐	☐	☐
d. Poor water drainage	☐	☐	☐	☐	☐
e. Soil erosion	☐	☐	☐	☐	☐
f. Flooding	☐	☐	☐	☐	☐
g. Poor water quality	☐	☐	☐	☐	☐

Q17. In your opinion, do the following factors contribute to problems in your watershed?

	Not at all				*A lot*
	1	**2**	**3**	**4**	**5**
a. Poor socioeconomic situation in my watershed	☐	☐	☐	☐	☐
b. Limited funding for watershed partnership	☐	☐	☐	☐	☐
c. Conflicts among members of watershed partnership	☐	☐	☐	☐	☐
d. Conflicts between watershed partnership and the local community	☐	☐	☐	☐	☐
e. Ignoring local people's knowledge of their watershed	☐	☐	☐	☐	☐
f. Local people mistrust in state agencies	☐	☐	☐	☐	☐
g. Lack of state follow-up plans	☐	☐	☐	☐	☐
h. Minimal coordination between state, county, and local agencies	☐	☐	☐	☐	☐

Q18. What sources of information do you rely on to know more about your watershed? (Check any that apply).

☐ Formal partnership meetings	☐ Studies done by government agencies or universities	☐ Talking with partnership members
☐ Personal observations or experience	☐ Media (newspapers, magazines, TV, newsletters, etc.)	☐ Talking with neighbors, family, and friends

III) PERCEPTIONS OF WATERSHED RISKS

Q19. To what extent are you currently concerned about the following problems in your watershed?

	Not at all concerned				*Very concerned*
	1	**2**	**3**	**4**	**5**
a. Agricultural runoff	☐	☐	☐	☐	☐
b. Acid runoff	☐	☐	☐	☐	☐
c. Deforestation	☐	☐	☐	☐	☐
d. Poor water drainage	☐	☐	☐	☐	☐
e. Soil erosion	☐	☐	☐	☐	☐
f. Flooding	☐	☐	☐	☐	☐
g. Poor water quality	☐	☐	☐	☐	☐

Q20. To what extent are you concerned about the possible effects of problems in your watershed?

These problems may:	*Not at all concerned*				*Very concerned*
	1	**2**	**3**	**4**	**5**
a. affect human health.	☐	☐	☐	☐	☐
b. affect human safety.	☐	☐	☐	☐	☐
c. limit water supply for human use.	☐	☐	☐	☐	☐
d. limit your access to rivers, lakes, wetlands, or ponds.	☐	☐	☐	☐	☐
e. lead to the loss of job opportunities.	☐	☐	☐	☐	☐
f. affect agricultural production.	☐	☐	☐	☐	☐
g. be a source of conflict among people.	☐	☐	☐	☐	☐
h. decrease property value.	☐	☐	☐	☐	☐
i. make my watershed an undesirable place to live.	☐	☐	☐	☐	☐
j. make my watershed an unattractive place for recreation.	☐	☐	☐	☐	☐
k. affect the health of wildlife.	☐	☐	☐	☐	☐
l. lead to the loss of rivers, lakes, ponds, or wetlands.	☐	☐	☐	☐	☐
m. threaten the ecological value of my watershed.	☐	☐	☐	☐	☐

IV) PERSONAL INFORMATION

Your personal information will be kept strictly confidential and will never be released in reporting results of this study.

Q21. What is your age? _________ years

Q22. What is your gender? ☐ Male ☐ Female

Q23. What is your highest level of education?

☐ Primary or middle school
☐ High school graduation or equivalent
☐ Technical college or 2-yr associate degree
☐ College degree
☐ Post graduate degree

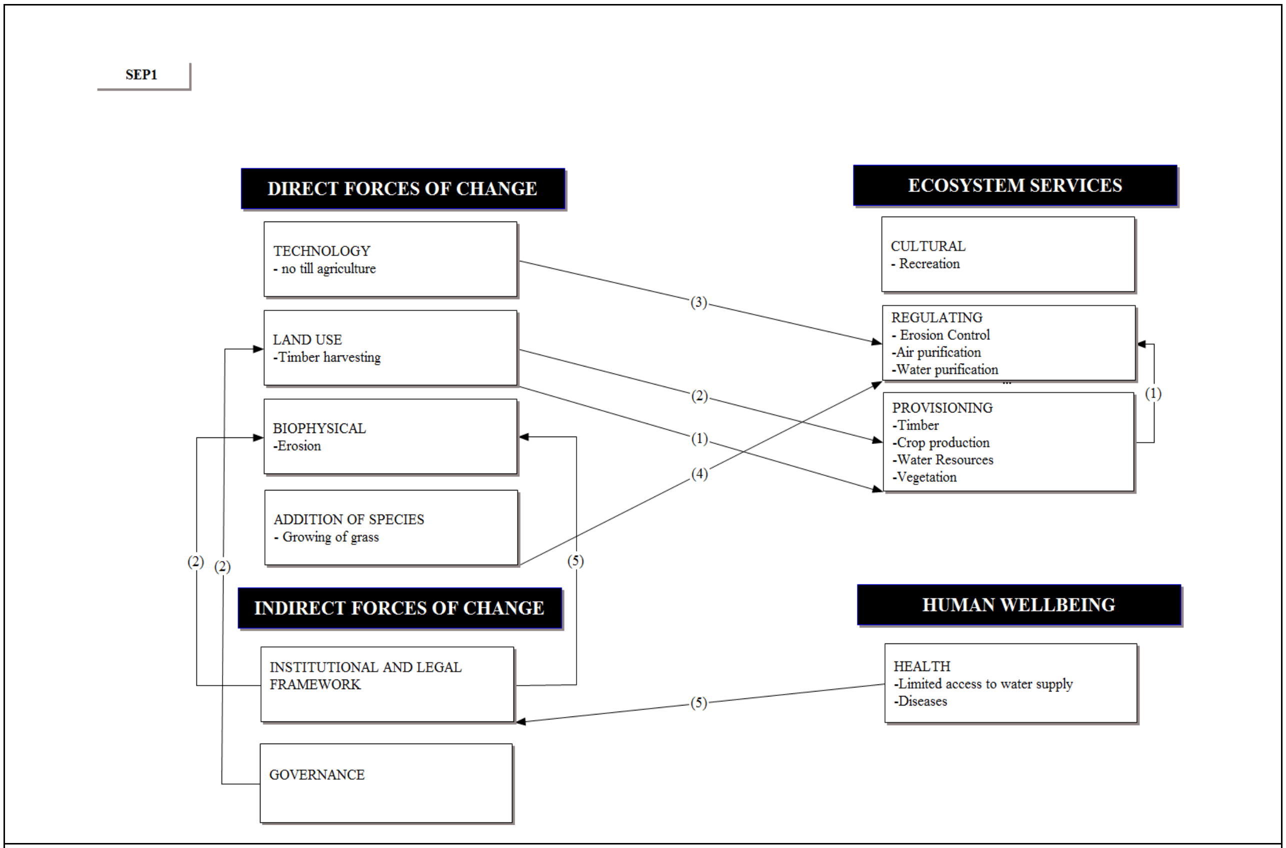
Q24. Please check if you have participated in any of the following activities during the past 12 months (Check all that apply).

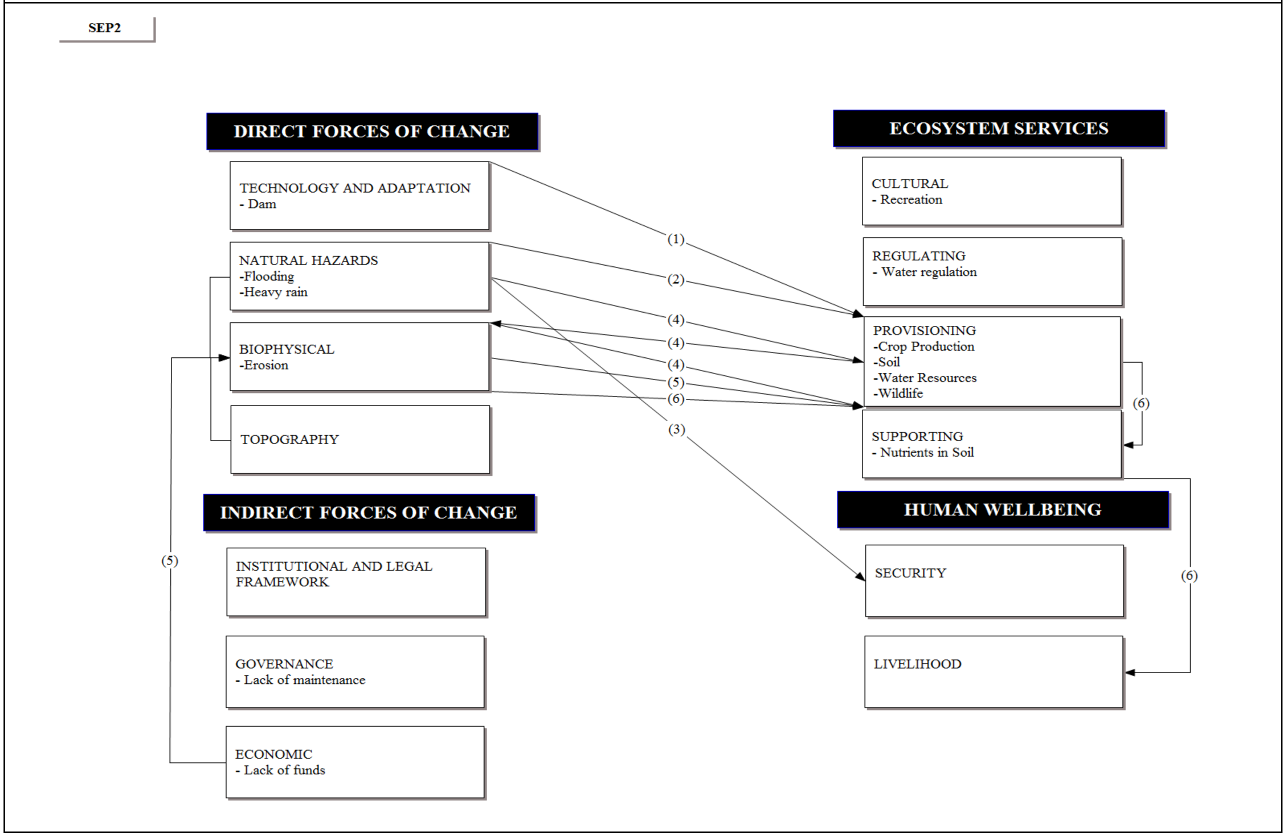
☐ Attended a local community event (e.g. school activity, community festival).
☐ Contacted a public official or community leader about an issue.
☐ Worked with others in your community to solve a community issue or problem.
☐ Attended a public meeting in your community (e.g. school board, planning).
☐ Served as an officer or a leader in a community organization.
☐ Served in an elected or other government position.
☐ Voted in a local election.

Thank you very much for taking the time to complete this survey. Please feel free to write any additional comments in the blank spaces of this survey or on the lines below.

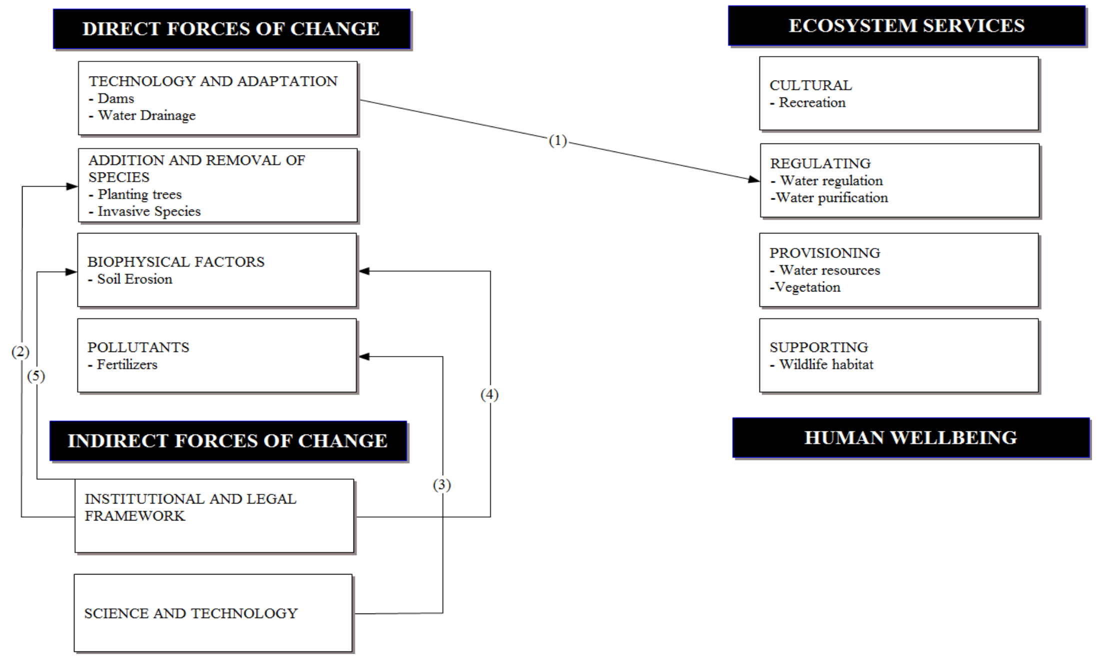
APPENDIX C

PARTICIPANTS' CONCEPT MAPS

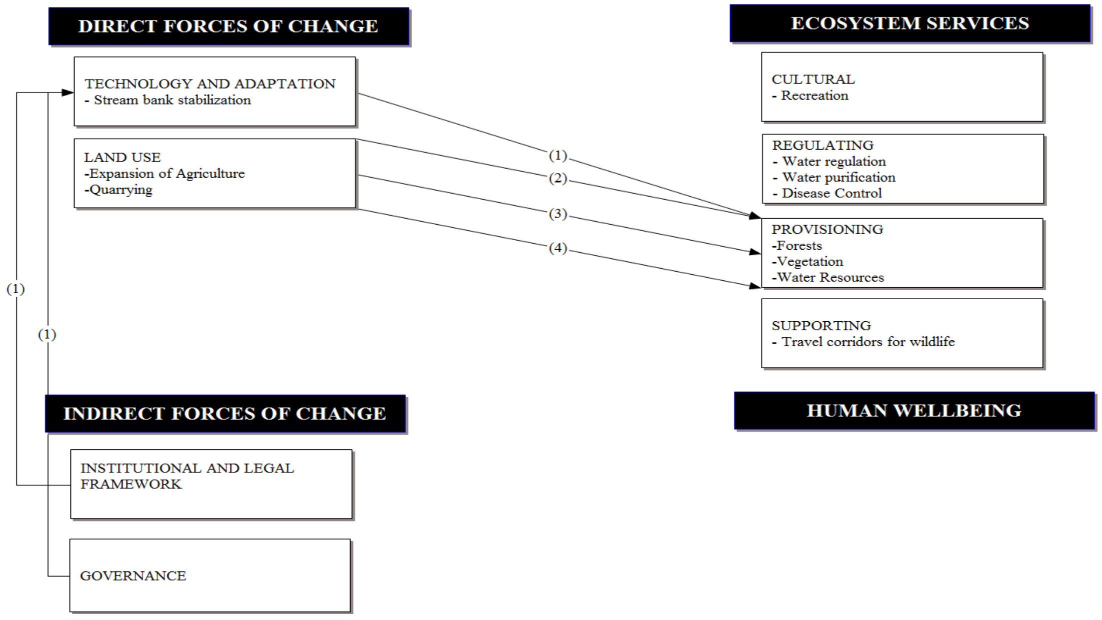

SEP1
DIRECT FORCES OF CHANGE
TECHNOLOGY
- no till agriculture
LAND USE
-Timber harvesting
BIOPHYSICAL
-Erosion
ADDITION OF SPECIES
- Growing of grass
INDIRECT FORCES OF CHANGE
INSTITUTIONAL AND LEGAL FRAMEWORK
GOVERNANCE
ECOSYSTEM SERVICES
CULTURAL
- Recreation
REGULATING
- Erosion Control
-Air purification
-Water purification
PROVISIONING
-Timber
-Crop production
-Water Resources
-Vegetation
HUMAN WELLBEING
HEALTH
-Limited access to water supply
-Diseases
(1)
(2)
(3)
(4)
(5)

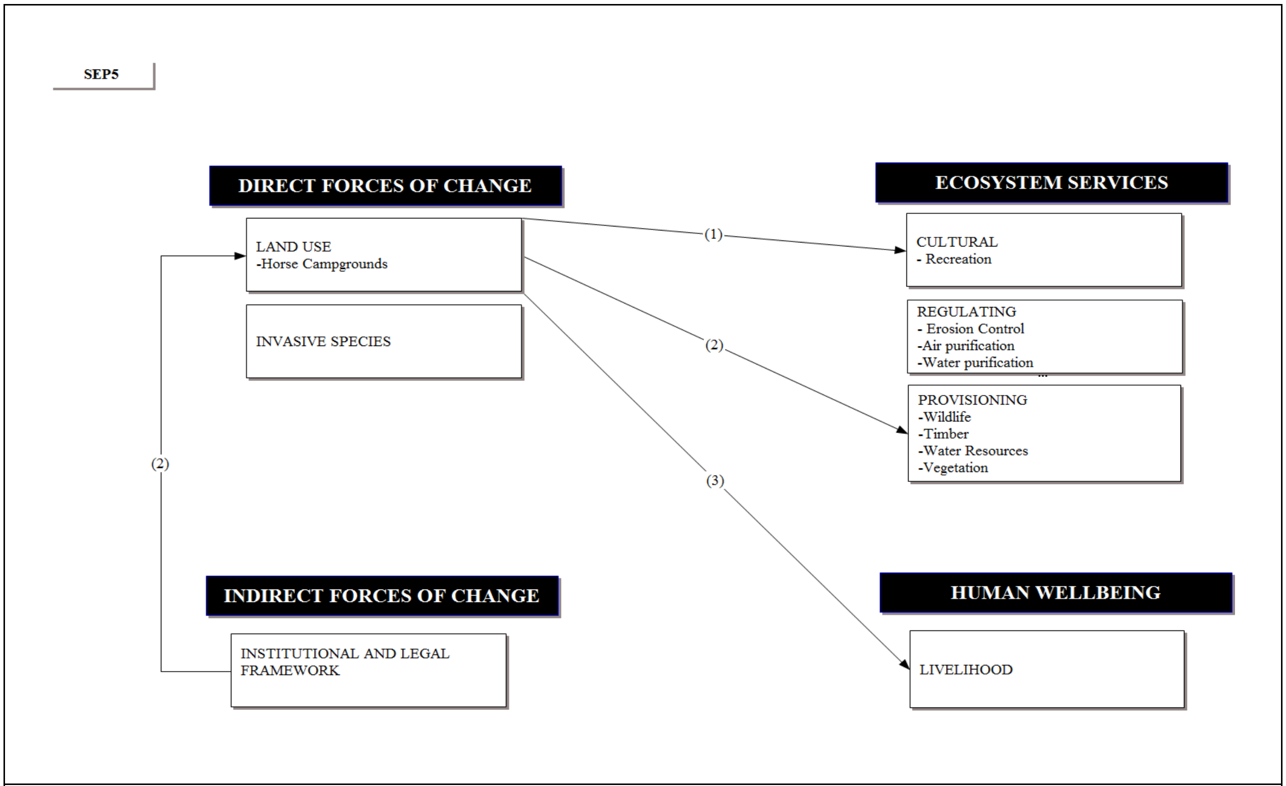

SEP2
DIRECT FORCES OF CHANGE
TECHNOLOGY AND ADAPTATION
- Dam
NATURAL HAZARDS
-Flooding
-Heavy rain
BIOPHYSICAL
-Erosion
TOPOGRAPHY
INDIRECT FORCES OF CHANGE
INSTITUTIONAL AND LEGAL FRAMEWORK
GOVERNANCE
- Lack of maintenance
ECONOMIC
- Lack of funds
ECOSYSTEM SERVICES
CULTURAL
- Recreation
REGULATING
- Water regulation
PROVISIONING
-Crop Production
-Soil
-Water Resources
-Wildlife
SUPPORTING
- Nutrients in Soil
HUMAN WELLBEING
SECURITY
LIVELIHOOD
(1)
(2)
(3)
(4)
(5)
(6)

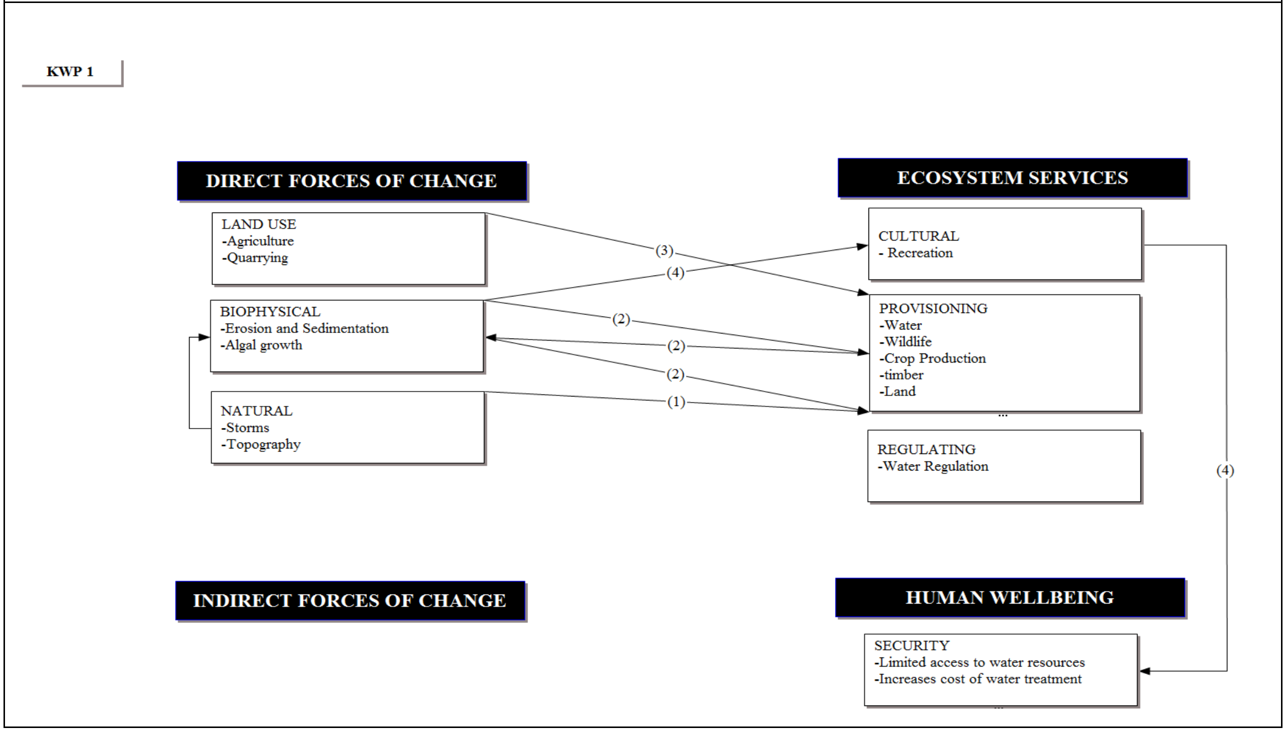
SEP3

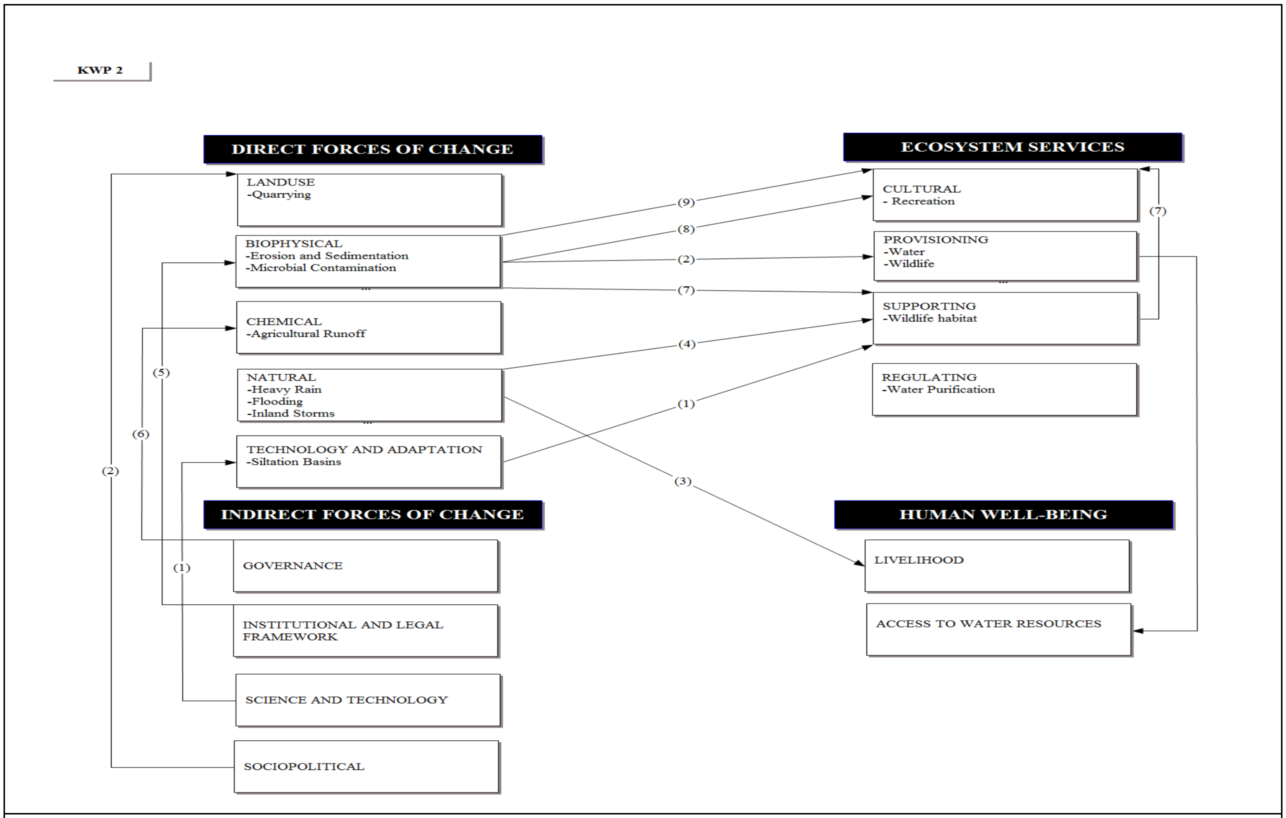

DIRECT FORCES OF CHANGE
TECHNOLOGY AND ADAPTATION
- Dams
- Water Drainage
ADDITION AND REMOVAL OF SPECIES
- Planting trees
- Invasive Species
BIOPHYSICAL FACTORS
- Soil Erosion
POLLUTANTS
- Fertilizers
INDIRECT FORCES OF CHANGE
INSTITUTIONAL AND LEGAL FRAMEWORK
SCIENCE AND TECHNOLOGY
ECOSYSTEM SERVICES
CULTURAL
- Recreation
REGULATING
- Water regulation
-Water purification
PROVISIONING
- Water resources
-Vegetation
SUPPORTING
- Wildlife habitat
HUMAN WELLBEING
(1)
(2)
(3)
(4)
(5)

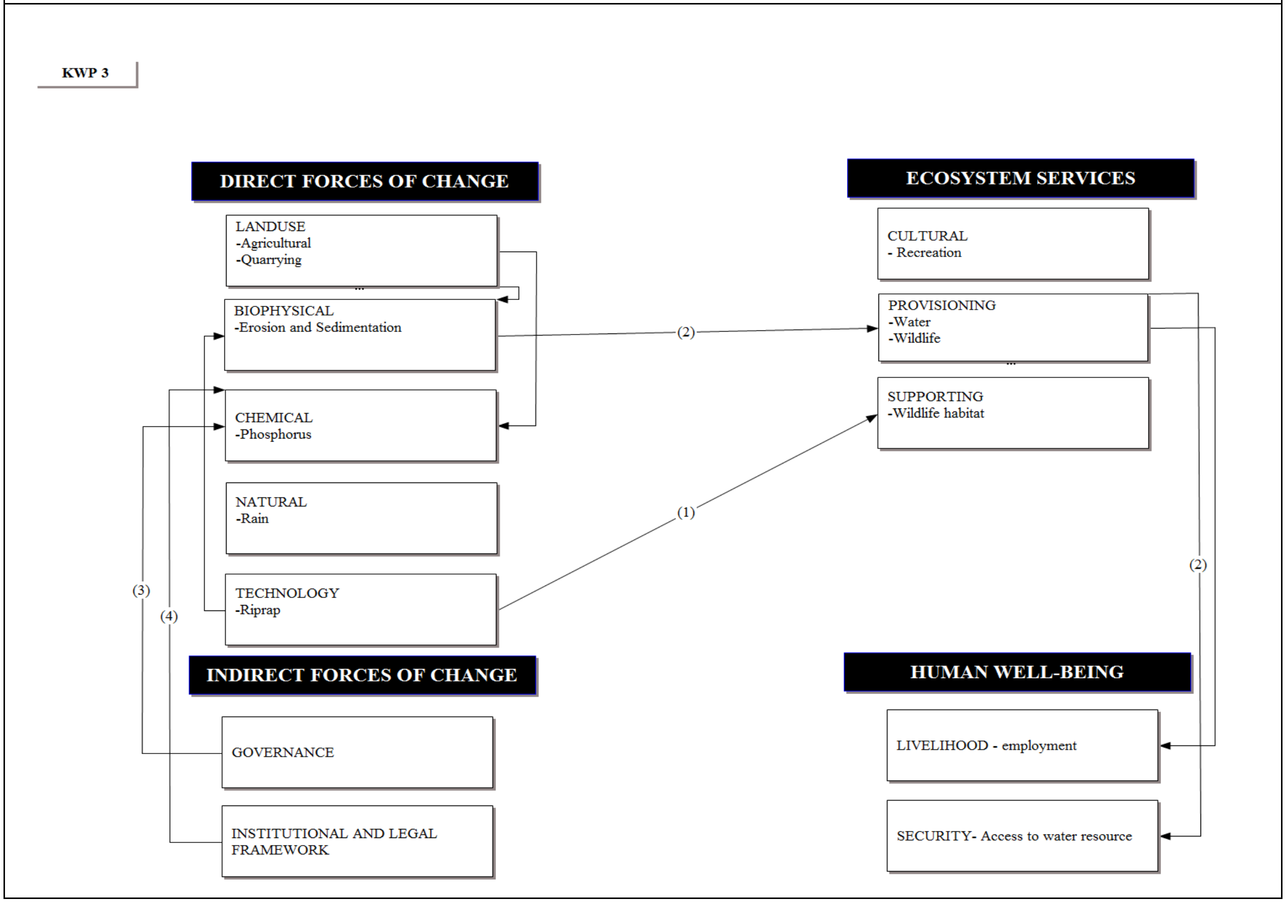
SEP4


DIRECT FORCES OF CHANGE
TECHNOLOGY AND ADAPTATION
- Stream bank stabilization
LAND USE
-Expansion of Agriculture
-Quarrying
INDIRECT FORCES OF CHANGE
INSTITUTIONAL AND LEGAL FRAMEWORK
GOVERNANCE
ECOSYSTEM SERVICES
CULTURAL
- Recreation
REGULATING
- Water regulation
- Water purification
- Disease Control
PROVISIONING
-Forests
-Vegetation
-Water Resources
SUPPORTING
- Travel corridors for wildlife
HUMAN WELLBEING
(1)
(2)
(3)
(4)
(1)
(1)

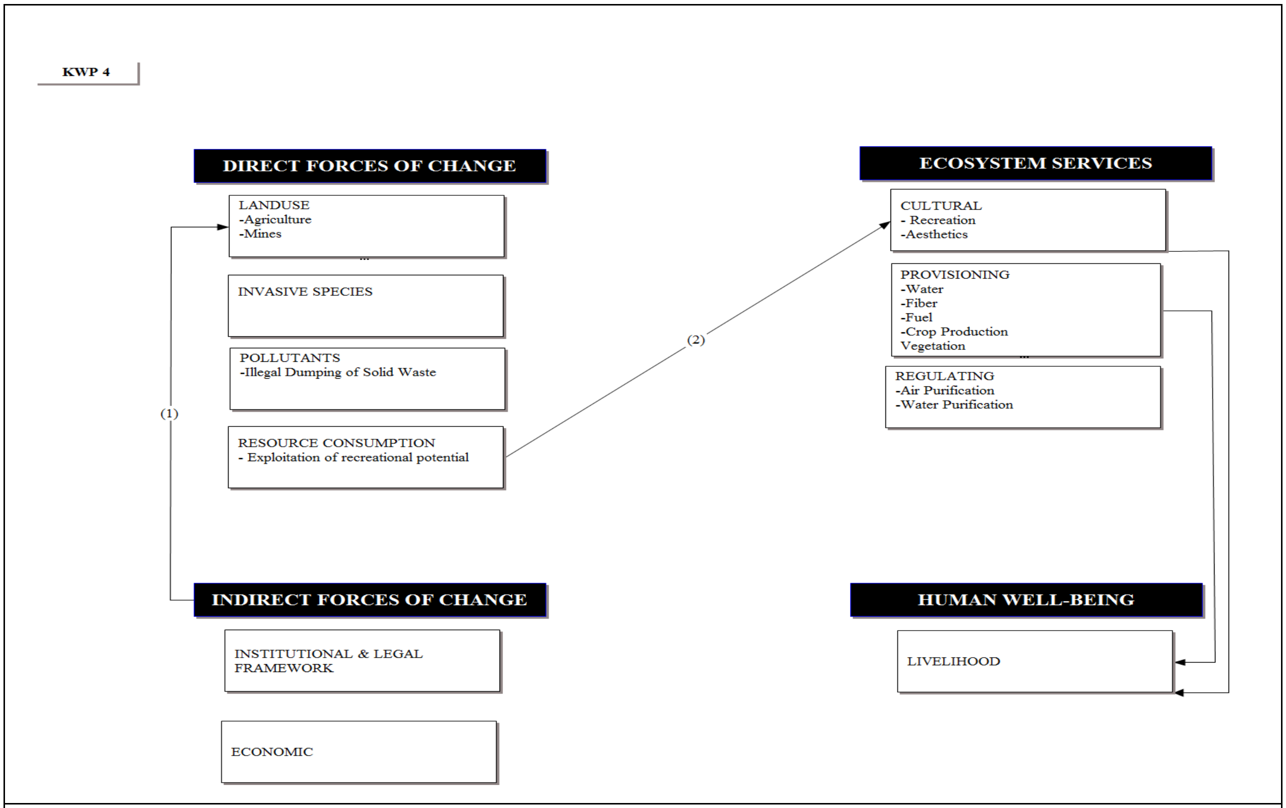

SEP5
DIRECT FORCES OF CHANGE
LAND USE
-Horse Campgrounds
INVASIVE SPECIES
INDIRECT FORCES OF CHANGE
INSTITUTIONAL AND LEGAL FRAMEWORK
ECOSYSTEM SERVICES
CULTURAL
- Recreation
REGULATING
- Erosion Control
-Air purification
-Water purification
PROVISIONING
-Wildlife
-Timber
-Water Resources
-Vegetation
HUMAN WELLBEING
LIVELIHOOD
(1)
(2)
(2)
(3)


KWP 1
DIRECT FORCES OF CHANGE
LAND USE
-Agriculture
-Quarrying
BIOPHYSICAL
-Erosion and Sedimentation
-Algal growth
NATURAL
-Storms
-Topography
INDIRECT FORCES OF CHANGE
ECOSYSTEM SERVICES
CULTURAL
- Recreation
PROVISIONING
-Water
-Wildlife
-Crop Production
-timber
-Land
REGULATING
-Water Regulation
HUMAN WELLBEING
SECURITY
-Limited access to water resources
-Increases cost of water treatment
(3)
(4)
(2)
(2)
(2)
(1)
(4)

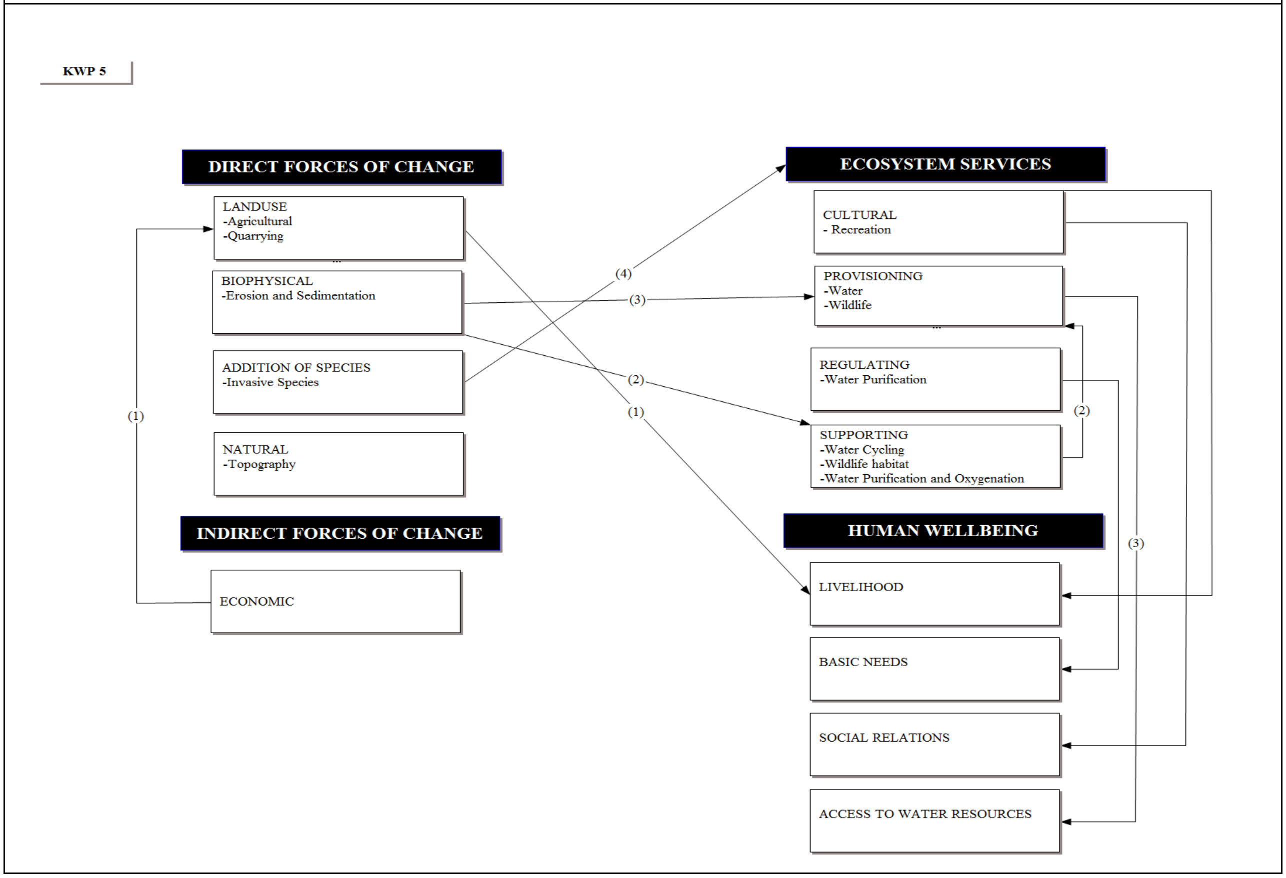

KWP 2
DIRECT FORCES OF CHANGE
LANDUSE
-Quarrying
BIOPHYSICAL
-Erosion and Sedimentation
-Microbial Contamination
...
CHEMICAL
-Agricultural Runoff
NATURAL
-Heavy Rain
-Flooding
-Inland Storms
...
TECHNOLOGY AND ADAPTATION
-Siltation Basins
INDIRECT FORCES OF CHANGE
GOVERNANCE
INSTITUTIONAL AND LEGAL FRAMEWORK
SCIENCE AND TECHNOLOGY
SOCIOPOLITICAL
ECOSYSTEM SERVICES
CULTURAL
- Recreation
PROVISIONING
-Water
-Wildlife
...
SUPPORTING
-Wildlife habitat
REGULATING
-Water Purification
HUMAN WELL-BEING
LIVELIHOOD
ACCESS TO WATER RESOURCES
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)


KWP 3
DIRECT FORCES OF CHANGE
LANDUSE
-Agricultural
-Quarrying
...
BIOPHYSICAL
-Erosion and Sedimentation
CHEMICAL
-Phosphorus
NATURAL
-Rain
TECHNOLOGY
-Riprap
INDIRECT FORCES OF CHANGE
GOVERNANCE
INSTITUTIONAL AND LEGAL FRAMEWORK
ECOSYSTEM SERVICES
CULTURAL
- Recreation
PROVISIONING
-Water
-Wildlife
...
SUPPORTING
-Wildlife habitat
HUMAN WELL-BEING
LIVELIHOOD - employment
SECURITY- Access to water resource
(1)
(2)
(3)
(4)

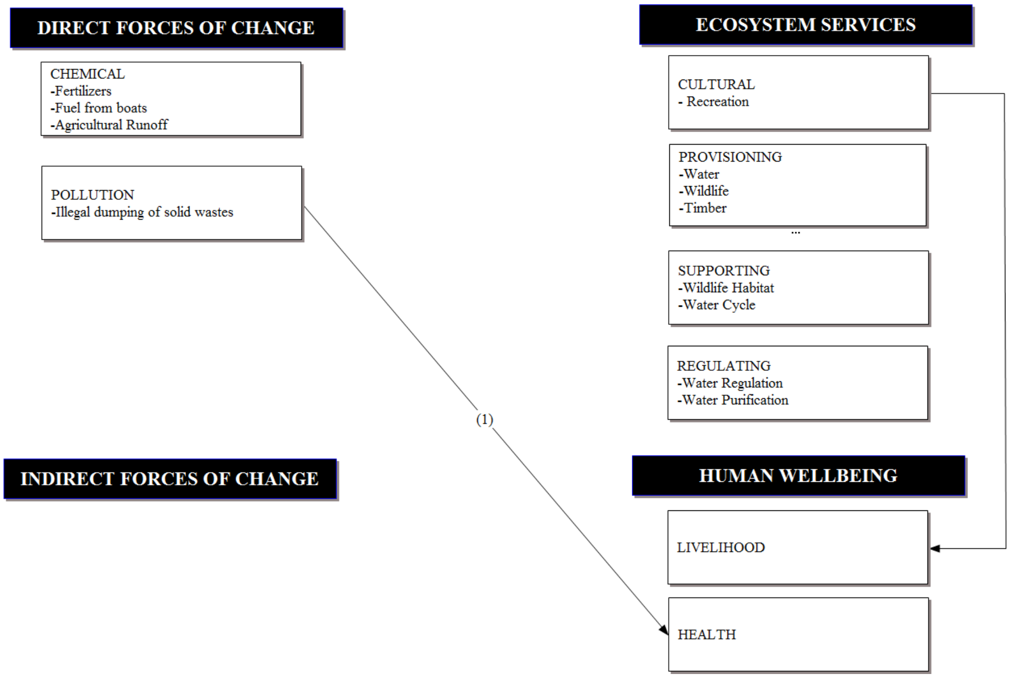
KWP 4


DIRECT FORCES OF CHANGE
LANDUSE
-Agriculture
-Mines
...
INVASIVE SPECIES
POLLUTANTS
-Illegal Dumping of Solid Waste
RESOURCE CONSUMPTION
- Exploitation of recreational potential
(1)
(2)
INDIRECT FORCES OF CHANGE
INSTITUTIONAL & LEGAL FRAMEWORK
ECONOMIC
ECOSYSTEM SERVICES
CULTURAL
- Recreation
-Aesthetics
PROVISIONING
-Water
-Fiber
-Fuel
-Crop Production
Vegetation
...
REGULATING
-Air Purification
-Water Purification
HUMAN WELL-BEING
LIVELIHOOD

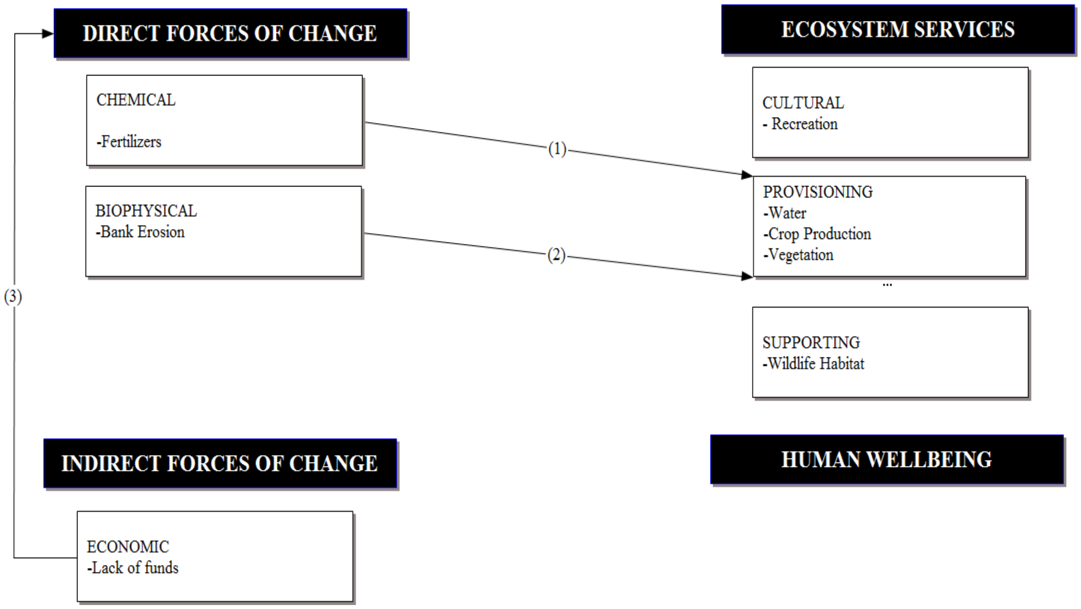
KWP 5


DIRECT FORCES OF CHANGE
LANDUSE
-Agricultural
-Quarrying
...
BIOPHYSICAL
-Erosion and Sedimentation
ADDITION OF SPECIES
-Invasive Species
NATURAL
-Topography
INDIRECT FORCES OF CHANGE
ECONOMIC
(1)
(4)
(3)
(2)
(1)
ECOSYSTEM SERVICES
CULTURAL
- Recreation
PROVISIONING
-Water
-Wildlife
...
REGULATING
-Water Purification
SUPPORTING
-Water Cycling
-Wildlife habitat
-Water Purification and Oxygenation
(2)
(3)
HUMAN WELLBEING
LIVELIHOOD
BASIC NEEDS
SOCIAL RELATIONS
ACCESS TO WATER RESOURCES

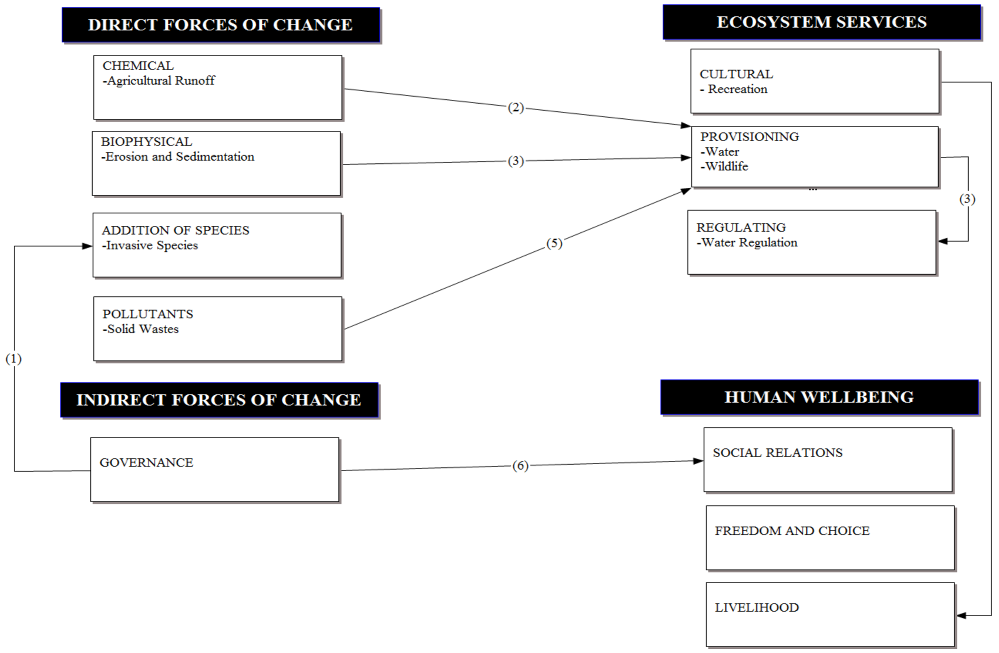
KWP 6


DIRECT FORCES OF CHANGE
CHEMICAL
-Fertilizers
-Fuel from boats
-Agricultural Runoff
POLLUTION
-Illegal dumping of solid wastes
INDIRECT FORCES OF CHANGE
ECOSYSTEM SERVICES
CULTURAL
- Recreation
PROVISIONING
-Water
-Wildlife
-Timber
...
SUPPORTING
-Wildlife Habitat
-Water Cycle
REGULATING
-Water Regulation
-Water Purification
HUMAN WELLBEING
LIVELIHOOD
HEALTH
(1)

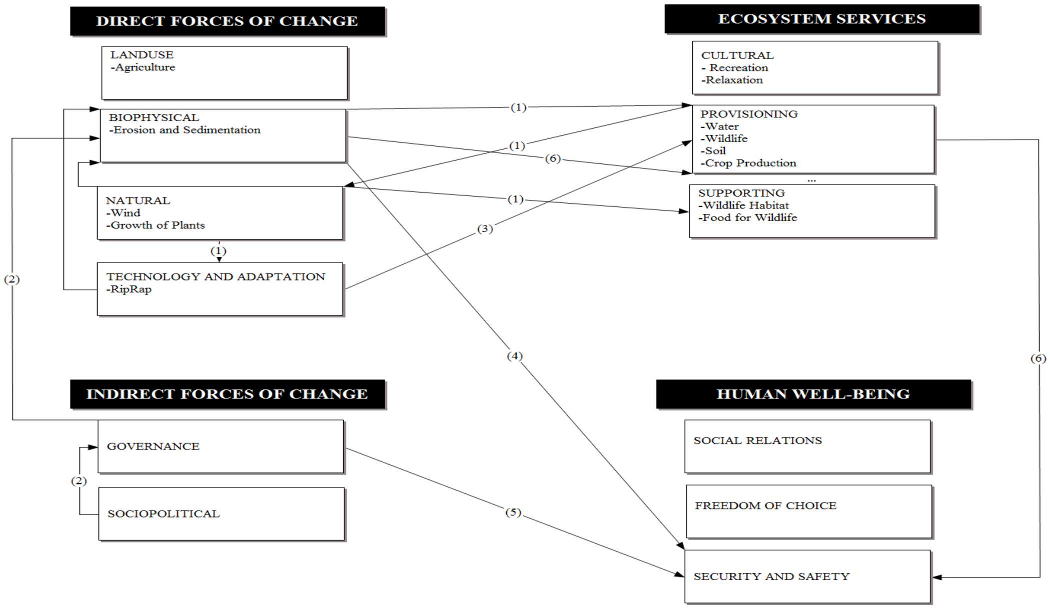
KWP 7


DIRECT FORCES OF CHANGE
CHEMICAL
-Fertilizers
BIOPHYSICAL
-Bank Erosion
INDIRECT FORCES OF CHANGE
ECONOMIC
-Lack of funds
ECOSYSTEM SERVICES
CULTURAL
- Recreation
PROVISIONING
-Water
-Crop Production
-Vegetation
...
SUPPORTING
-Wildlife Habitat
HUMAN WELLBEING
(1)
(2)
(3)

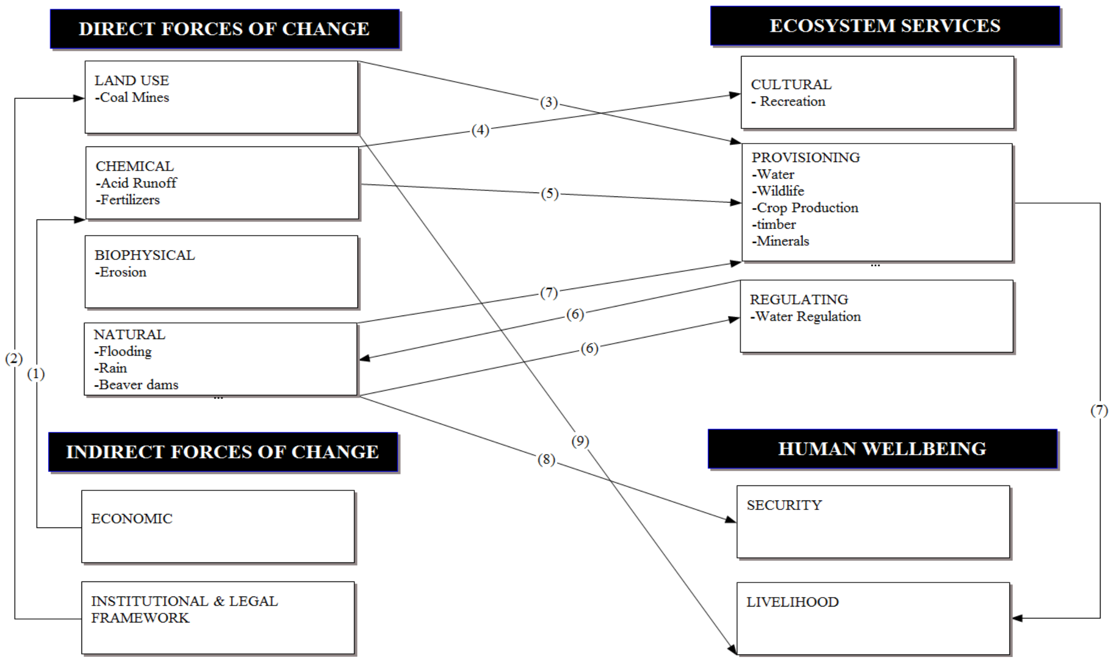
KWP 8


DIRECT FORCES OF CHANGE
CHEMICAL
-Agricultural Runoff
BIOPHYSICAL
-Erosion and Sedimentation
ADDITION OF SPECIES
-Invasive Species
POLLUTANTS
-Solid Wastes
INDIRECT FORCES OF CHANGE
GOVERNANCE
ECOSYSTEM SERVICES
CULTURAL
- Recreation
PROVISIONING
-Water
-Wildlife
...
REGULATING
-Water Regulation
HUMAN WELLBEING
SOCIAL RELATIONS
FREEDOM AND CHOICE
LIVELIHOOD
(1)
(2)
(3)
(3)
(5)
(6)

KWP 9


DIRECT FORCES OF CHANGE
LANDUSE
-Agriculture
BIOPHYSICAL
-Erosion and Sedimentation
NATURAL
-Wind
-Growth of Plants
TECHNOLOGY AND ADAPTATION
-RipRap
INDIRECT FORCES OF CHANGE
GOVERNANCE
SOCIOPOLITICAL
ECOSYSTEM SERVICES
CULTURAL
- Recreation
-Relaxation
PROVISIONING
-Water
-Wildlife
-Soil
-Crop Production
...
SUPPORTING
-Wildlife Habitat
-Food for Wildlife
HUMAN WELL-BEING
SOCIAL RELATIONS
FREEDOM OF CHOICE
SECURITY AND SAFETY
(1)
(1)
(6)
(1)
(3)
(1)
(2)
(4)
(2)
(5)
(6)

SBP 1


DIRECT FORCES OF CHANGE
LAND USE
-Coal Mines
CHEMICAL
-Acid Runoff
-Fertilizers
BIOPHYSICAL
-Erosion
NATURAL
-Flooding
-Rain
-Beaver dams
...
INDIRECT FORCES OF CHANGE
ECONOMIC
INSTITUTIONAL & LEGAL FRAMEWORK
ECOSYSTEM SERVICES
CULTURAL
- Recreation
PROVISIONING
-Water
-Wildlife
-Crop Production
-timber
-Minerals
...
REGULATING
-Water Regulation
HUMAN WELLBEING
SECURITY
LIVELIHOOD
(1)
(2)
(3)
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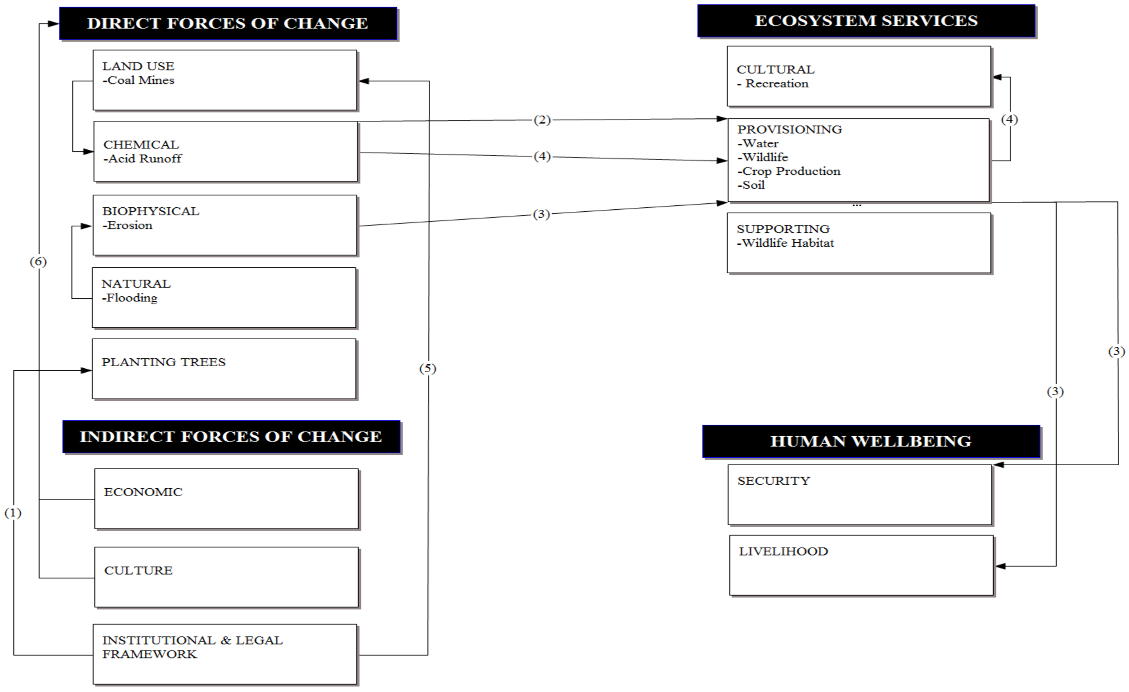
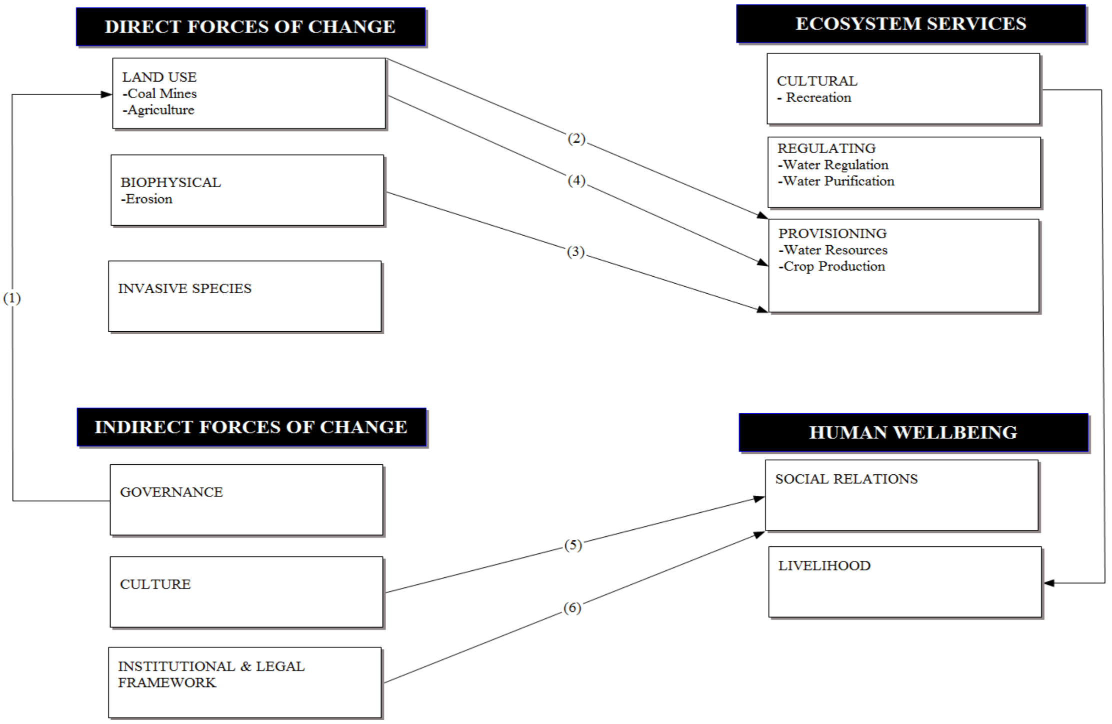
(6)
(7)
(7)
(8)
(9)

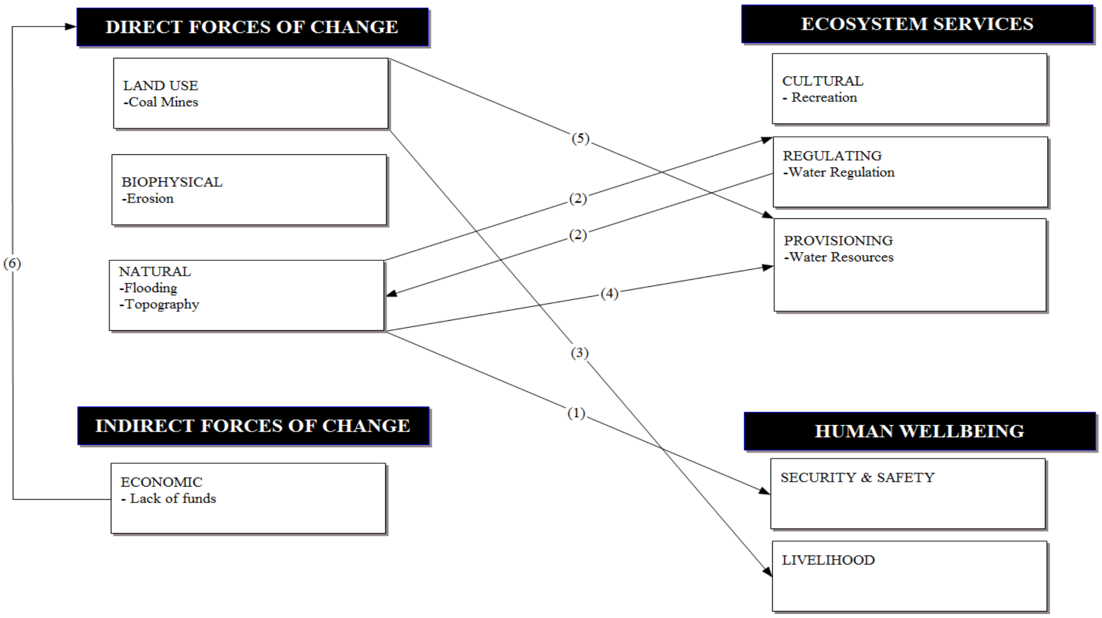
SBP 2


DIRECT FORCES OF CHANGE
LAND USE
-Coal Mines
CHEMICAL
-Acid Runoff
BIOPHYSICAL
-Erosion
NATURAL
-Flooding
PLANTING TREES
INDIRECT FORCES OF CHANGE
ECONOMIC
CULTURE
INSTITUTIONAL & LEGAL FRAMEWORK
ECOSYSTEM SERVICES
CULTURAL
- Recreation
PROVISIONING
-Water
-Wildlife
-Crop Production
-Soil
...
SUPPORTING
-Wildlife Habitat
HUMAN WELLBEING
SECURITY
LIVELIHOOD
(1)
(2)
(3)
(3)
(3)
(4)
(4)
(5)
(6)

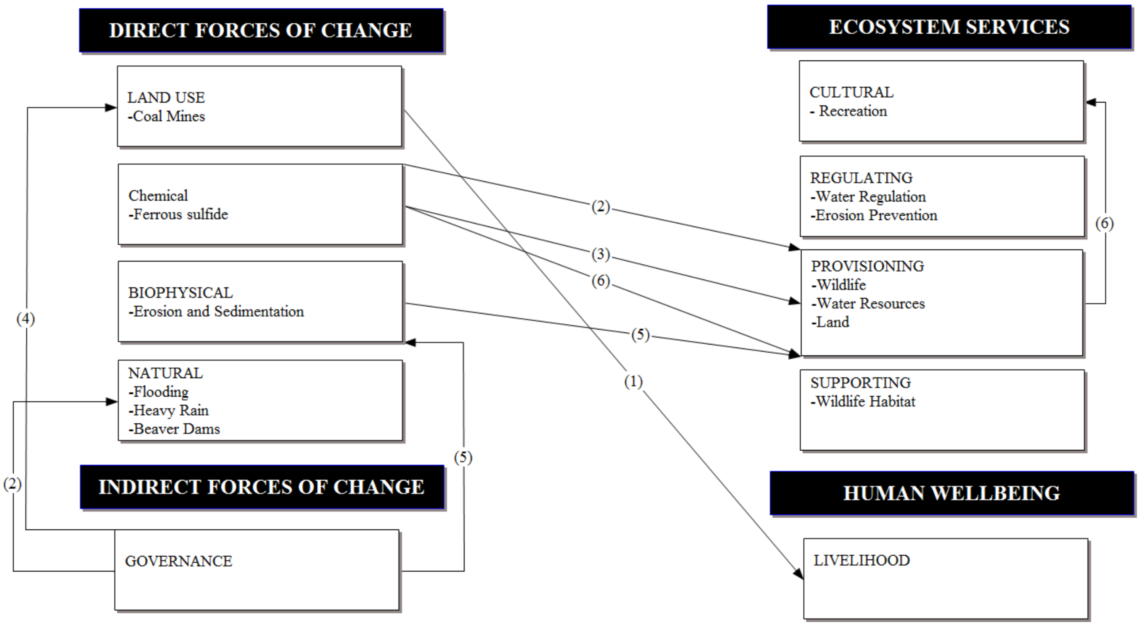
SBP 3


DIRECT FORCES OF CHANGE
LAND USE
-Coal Mines
-Agriculture
BIOPHYSICAL
-Erosion
INVASIVE SPECIES
INDIRECT FORCES OF CHANGE
GOVERNANCE
CULTURE
INSTITUTIONAL & LEGAL FRAMEWORK
ECOSYSTEM SERVICES
CULTURAL
- Recreation
REGULATING
-Water Regulation
-Water Purification
PROVISIONING
-Water Resources
-Crop Production
HUMAN WELLBEING
SOCIAL RELATIONS
LIVELIHOOD
(1)
(2)
(3)
(4)
(5)
(6)

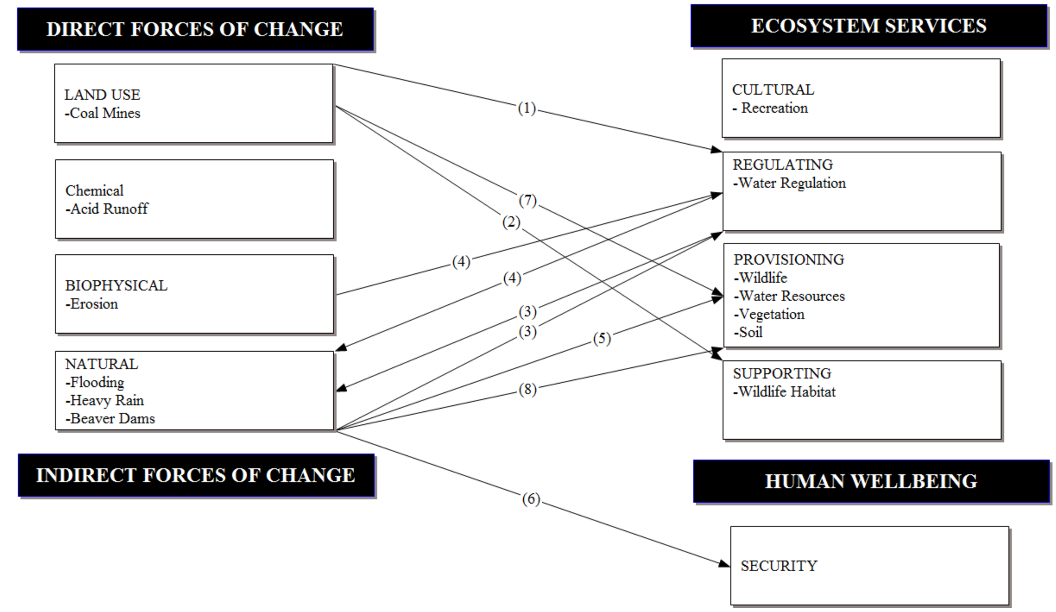
SBP 4


DIRECT FORCES OF CHANGE
LAND USE
-Coal Mines
BIOPHYSICAL
-Erosion
NATURAL
-Flooding
-Topography
INDIRECT FORCES OF CHANGE
ECONOMIC
- Lack of funds
ECOSYSTEM SERVICES
CULTURAL
- Recreation
REGULATING
-Water Regulation
PROVISIONING
-Water Resources
HUMAN WELLBEING
SECURITY & SAFETY
LIVELIHOOD
(1)
(2)
(2)
(3)
(4)
(5)
(6)

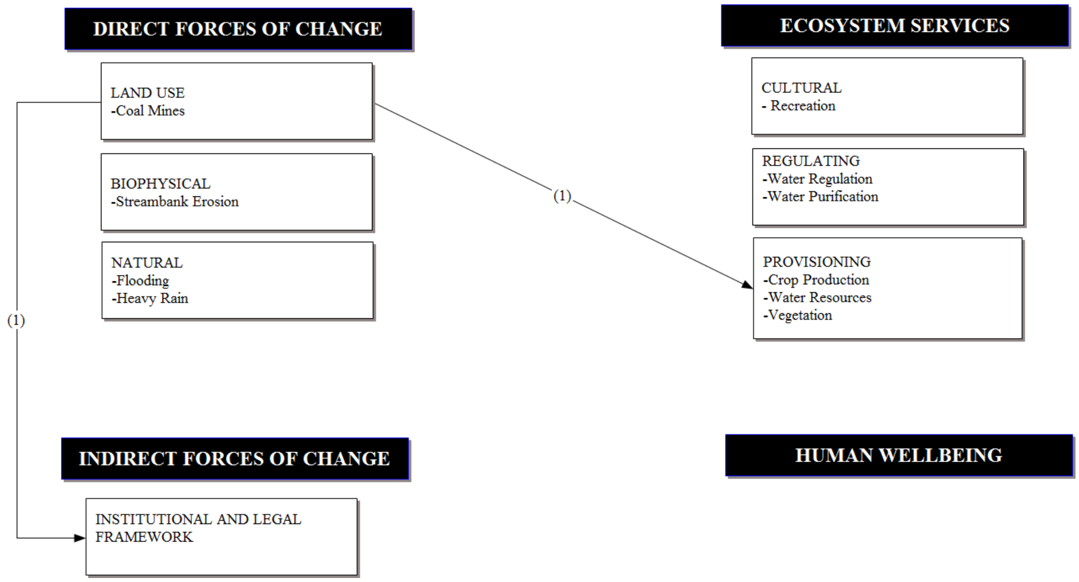
SBP 5


DIRECT FORCES OF CHANGE
LAND USE
-Coal Mines
Chemical
-Ferrous sulfide
BIOPHYSICAL
-Erosion and Sedimentation
NATURAL
-Flooding
-Heavy Rain
-Beaver Dams
INDIRECT FORCES OF CHANGE
GOVERNANCE
ECOSYSTEM SERVICES
CULTURAL
- Recreation
REGULATING
-Water Regulation
-Erosion Prevention
PROVISIONING
-Wildlife
-Water Resources
-Land
SUPPORTING
-Wildlife Habitat
HUMAN WELLBEING
LIVELIHOOD
(1)
(2)
(3)
(4)
(5)
(6)
(2)
(5)
(6)
(4)

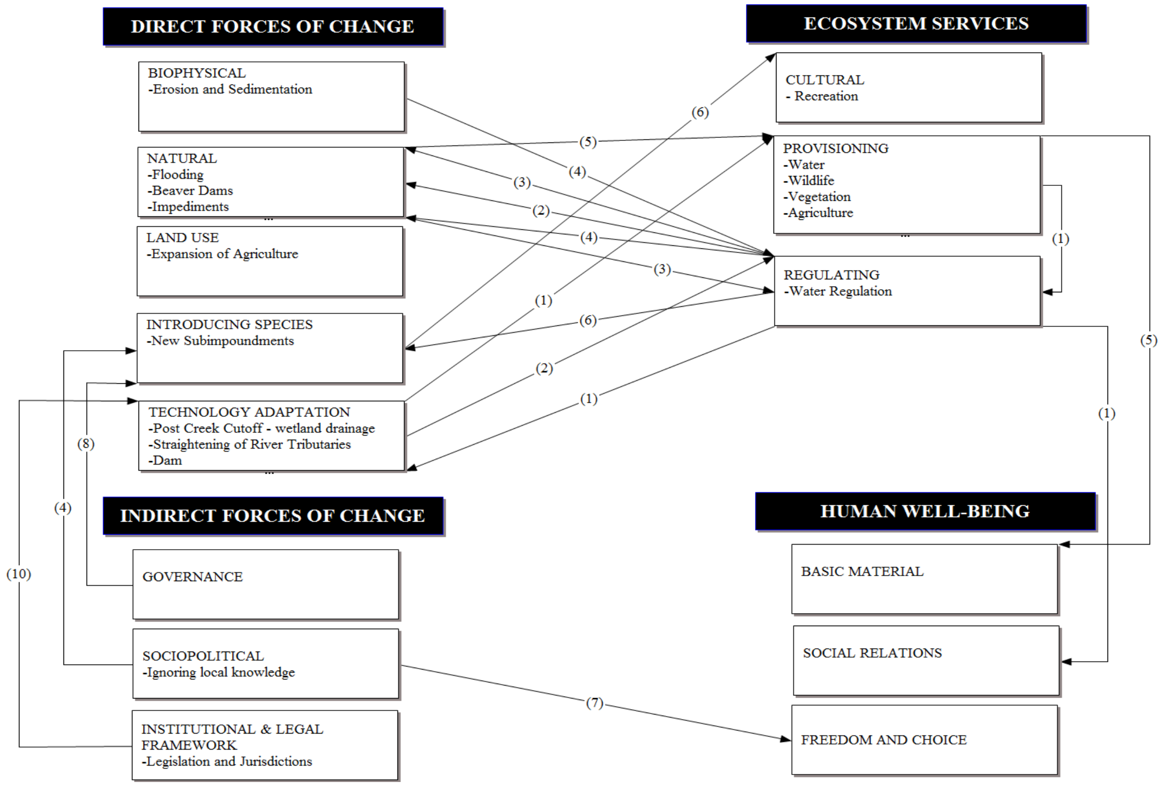
SBP 6


DIRECT FORCES OF CHANGE
LAND USE
-Coal Mines
Chemical
-Acid Runoff
BIOPHYSICAL
-Erosion
NATURAL
-Flooding
-Heavy Rain
-Beaver Dams
INDIRECT FORCES OF CHANGE
ECOSYSTEM SERVICES
CULTURAL
- Recreation
REGULATING
-Water Regulation
PROVISIONING
-Wildlife
-Water Resources
-Vegetation
-Soil
SUPPORTING
-Wildlife Habitat
HUMAN WELLBEING
SECURITY
(1)
(7)
(2)
(4)
(4)
(3)
(3)
(5)
(8)
(6)

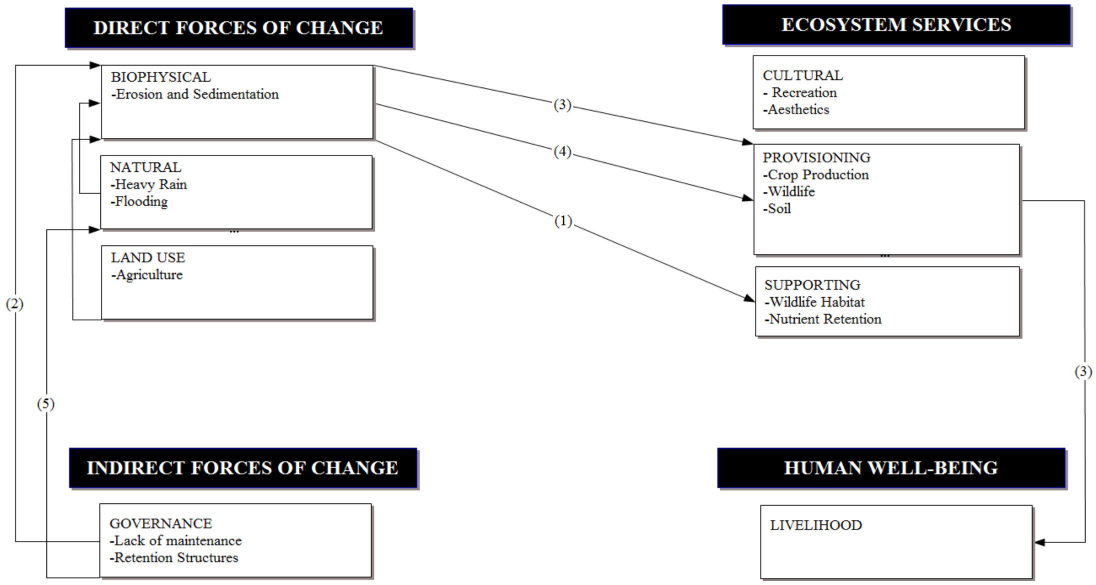
SBP 7


DIRECT FORCES OF CHANGE
LAND USE
-Coal Mines
BIOPHYSICAL
-Streambank Erosion
NATURAL
-Flooding
-Heavy Rain
INDIRECT FORCES OF CHANGE
INSTITUTIONAL AND LEGAL FRAMEWORK
ECOSYSTEM SERVICES
CULTURAL
- Recreation
REGULATING
-Water Regulation
-Water Purification
PROVISIONING
-Crop Production
-Water Resources
-Vegetation
HUMAN WELLBEING
(1)
(1)

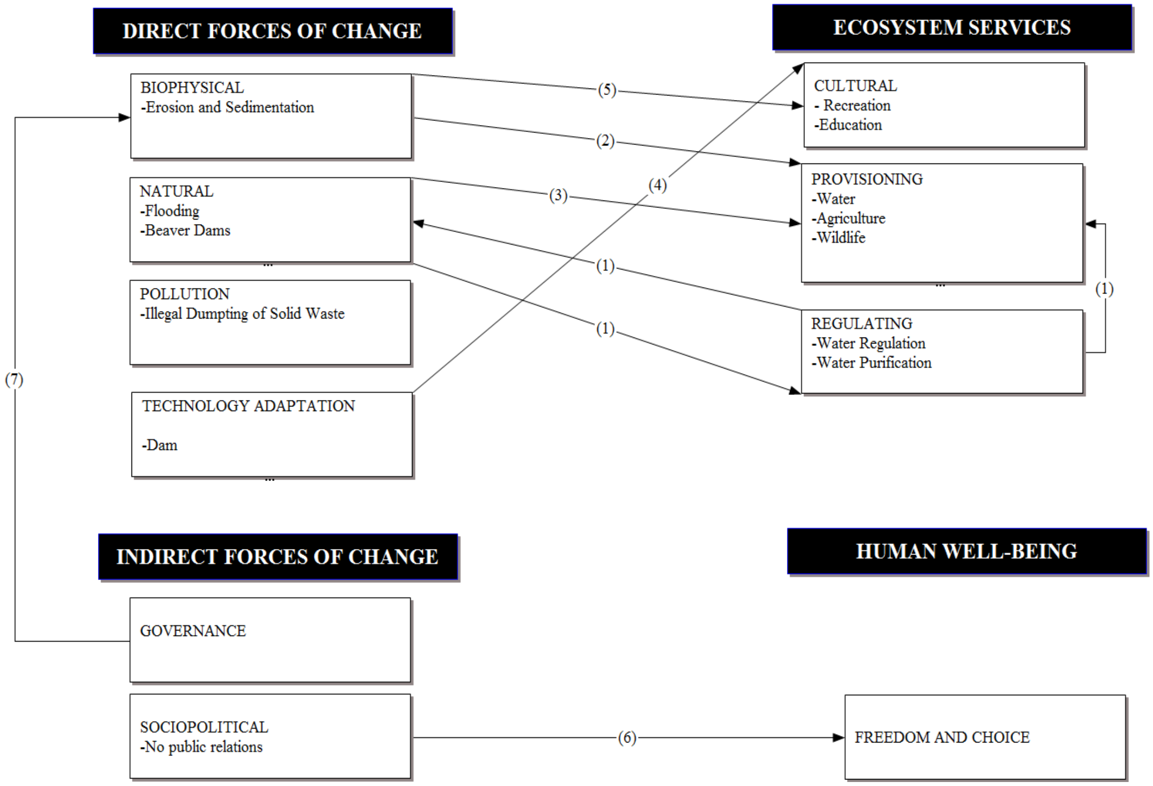
CJVP1


DIRECT FORCES OF CHANGE
BIOPHYSICAL
-Erosion and Sedimentation
NATURAL
-Flooding
-Beaver Dams
-Impediments
...
LAND USE
-Expansion of Agriculture
INTRODUCING SPECIES
-New Subimpoundments
TECHNOLOGY ADAPTATION
-Post Creek Cutoff - wetland drainage
-Straightening of River Tributaries
-Dam
...
INDIRECT FORCES OF CHANGE
GOVERNANCE
SOCIOPOLITICAL
-Ignoring local knowledge
INSTITUTIONAL & LEGAL FRAMEWORK
-Legislation and Jurisdictions
ECOSYSTEM SERVICES
CULTURAL
- Recreation
PROVISIONING
-Water
-Wildlife
-Vegetation
-Agriculture
...
REGULATING
-Water Regulation
HUMAN WELL-BEING
BASIC MATERIAL
SOCIAL RELATIONS
FREEDOM AND CHOICE
(6)
(5)
(4)
(3)
(2)
(4)
(3)
(1)
(6)
(2)
(1)
(1)
(5)
(1)
(8)
(4)
(10)
(7)

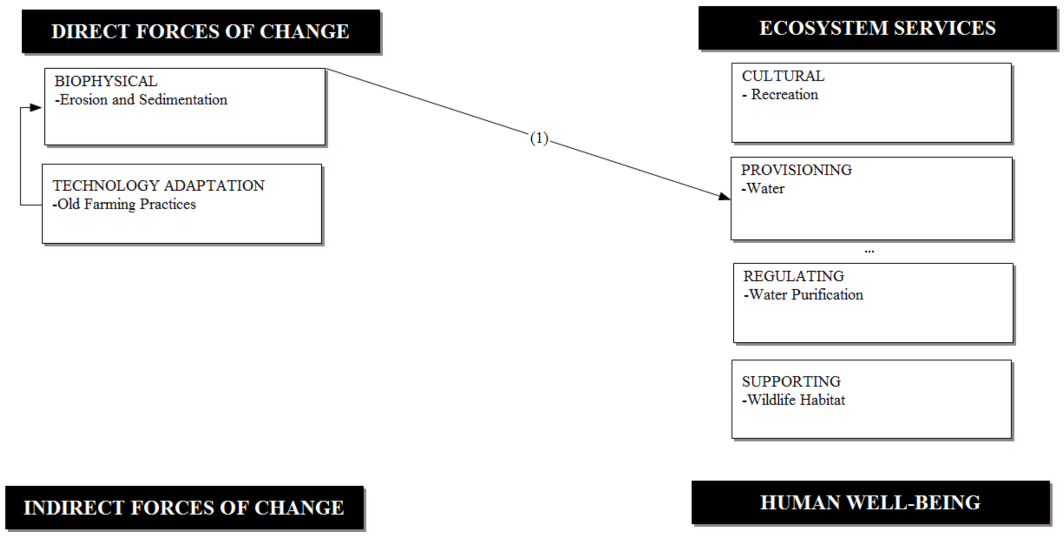
CJVP2


DIRECT FORCES OF CHANGE
ECOSYSTEM SERVICES
BIOPHYSICAL
-Erosion and Sedimentation
NATURAL
-Heavy Rain
-Flooding
LAND USE
-Agriculture
CULTURAL
- Recreation
-Aesthetics
PROVISIONING
-Crop Production
-Wildlife
-Soil
SUPPORTING
-Wildlife Habitat
-Nutrient Retention
(1)
(2)
(3)
(4)
(5)
(3)
INDIRECT FORCES OF CHANGE
GOVERNANCE
-Lack of maintenance
-Retention Structures
HUMAN WELL-BEING
LIVELIHOOD

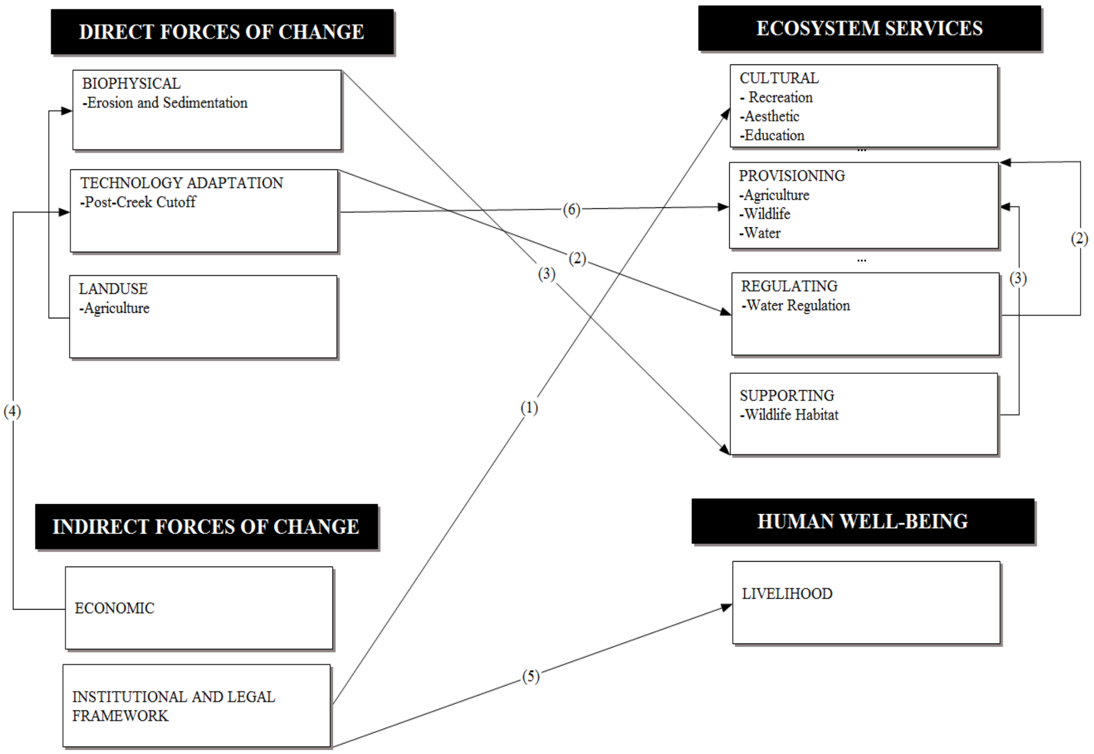
CJVP3


DIRECT FORCES OF CHANGE
ECOSYSTEM SERVICES
BIOPHYSICAL
-Erosion and Sedimentation
NATURAL
-Flooding
-Beaver Dams
POLLUTION
-Illegal Dumpting of Solid Waste
TECHNOLOGY ADAPTATION
-Dam
CULTURAL
- Recreation
-Education
PROVISIONING
-Water
-Agriculture
-Wildlife
REGULATING
-Water Regulation
-Water Purification
(5)
(2)
(3)
(4)
(1)
(1)
(1)
(7)
INDIRECT FORCES OF CHANGE
GOVERNANCE
SOCIOPOLITICAL
-No public relations
(6)
HUMAN WELL-BEING
FREEDOM AND CHOICE

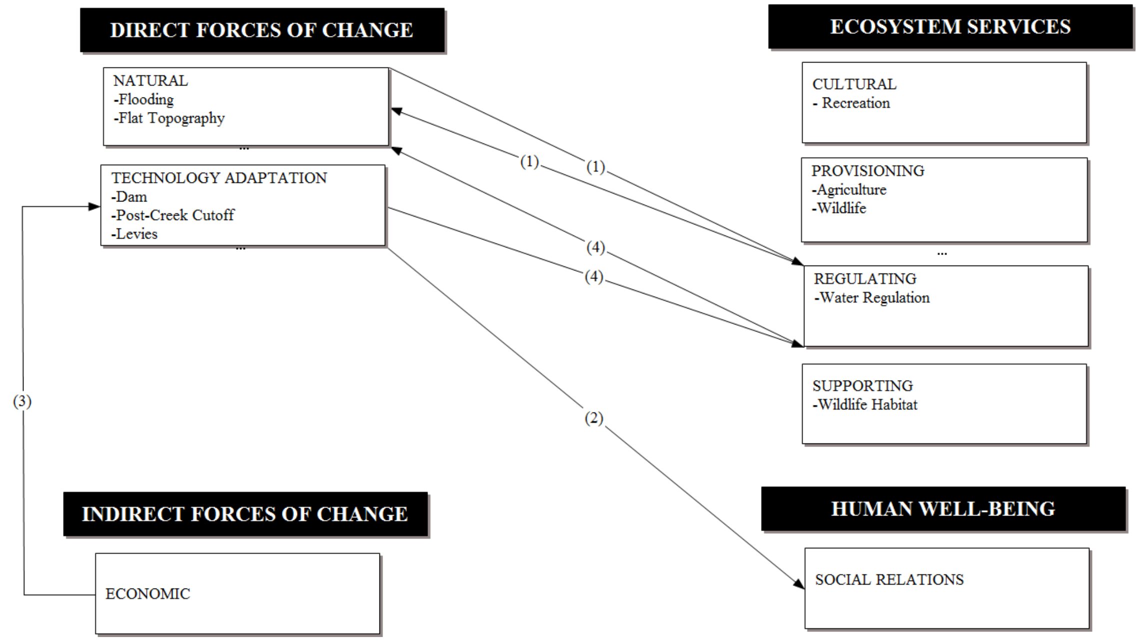
CJVP4


DIRECT FORCES OF CHANGE
BIOPHYSICAL
-Erosion and Sedimentation
TECHNOLOGY ADAPTATION
-Old Farming Practices
(1)
ECOSYSTEM SERVICES
CULTURAL
- Recreation
PROVISIONING
-Water
...
REGULATING
-Water Purification
SUPPORTING
-Wildlife Habitat
INDIRECT FORCES OF CHANGE
HUMAN WELL-BEING

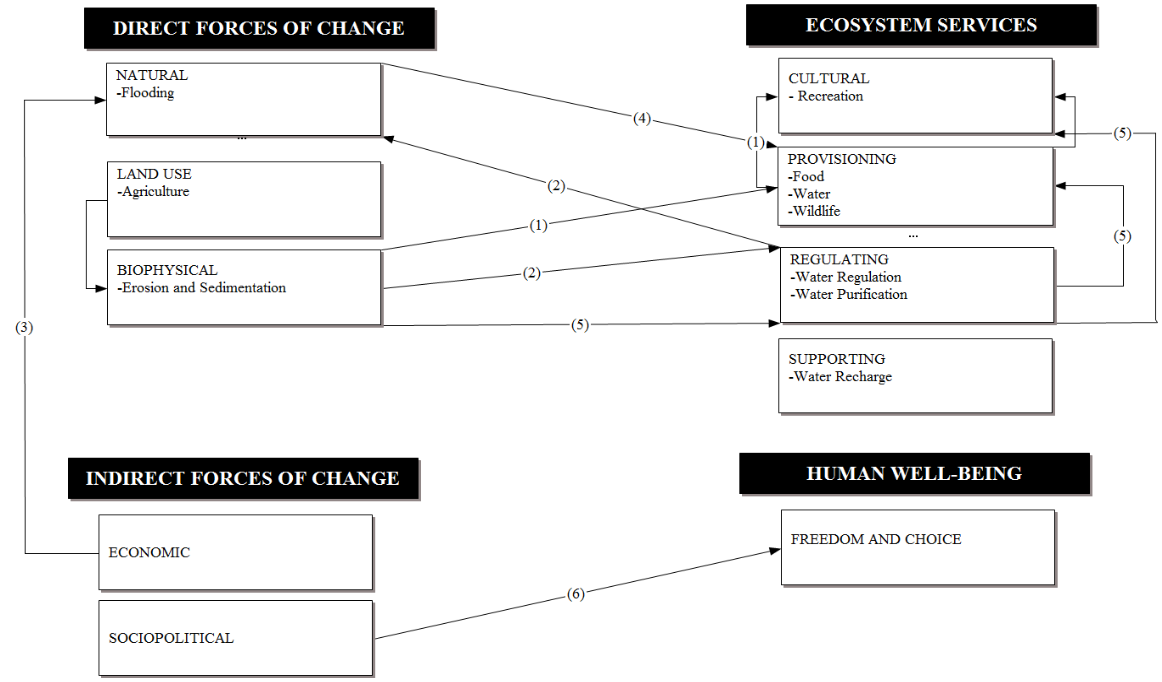
CJVP5


DIRECT FORCES OF CHANGE
BIOPHYSICAL
-Erosion and Sedimentation
TECHNOLOGY ADAPTATION
-Post-Creek Cutoff
LANDUSE
-Agriculture
(4)
(6)
(2)
(3)
(1)
(5)
ECOSYSTEM SERVICES
CULTURAL
- Recreation
-Aesthetic
-Education
...
PROVISIONING
-Agriculture
-Wildlife
-Water
...
REGULATING
-Water Regulation
SUPPORTING
-Wildlife Habitat
(2)
(3)
INDIRECT FORCES OF CHANGE
ECONOMIC
INSTITUTIONAL AND LEGAL FRAMEWORK
HUMAN WELL-BEING
LIVELIHOOD

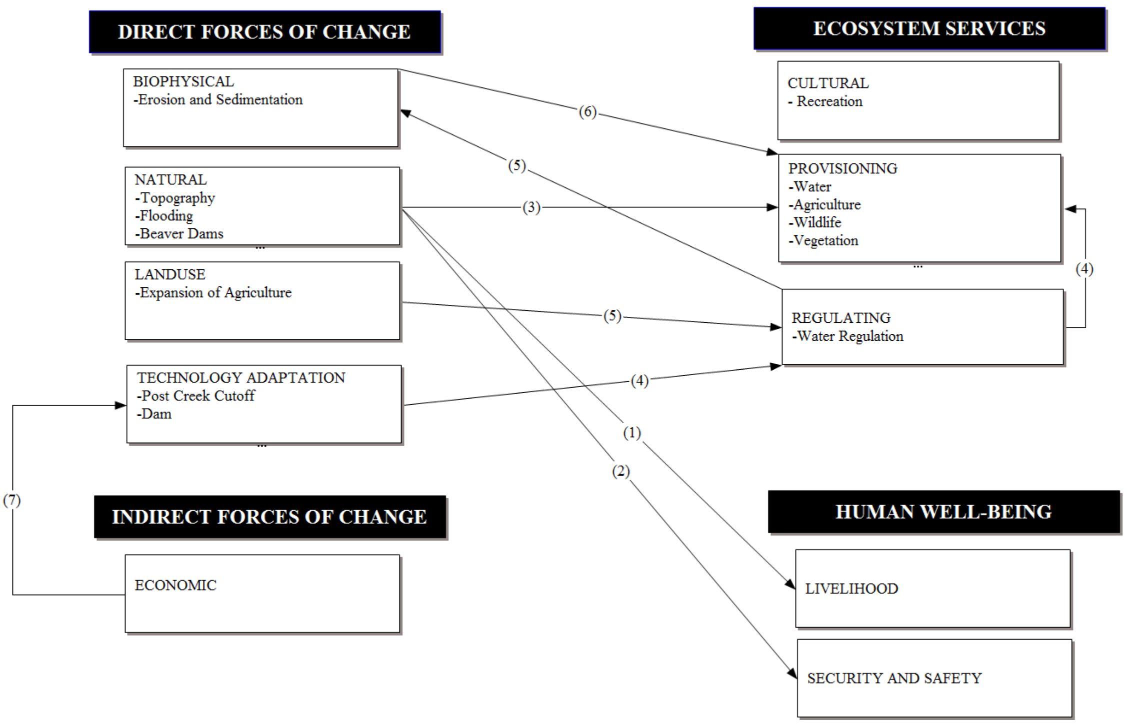
CJVP6


DIRECT FORCES OF CHANGE
NATURAL
-Flooding
-Flat Topography
...
TECHNOLOGY ADAPTATION
-Dam
-Post-Creek Cutoff
-Levies
...
INDIRECT FORCES OF CHANGE
ECONOMIC
ECOSYSTEM SERVICES
CULTURAL
- Recreation
PROVISIONING
-Agriculture
-Wildlife
...
REGULATING
-Water Regulation
SUPPORTING
-Wildlife Habitat
HUMAN WELL-BEING
SOCIAL RELATIONS
(1)
(1)
(4)
(4)
(2)
(3)

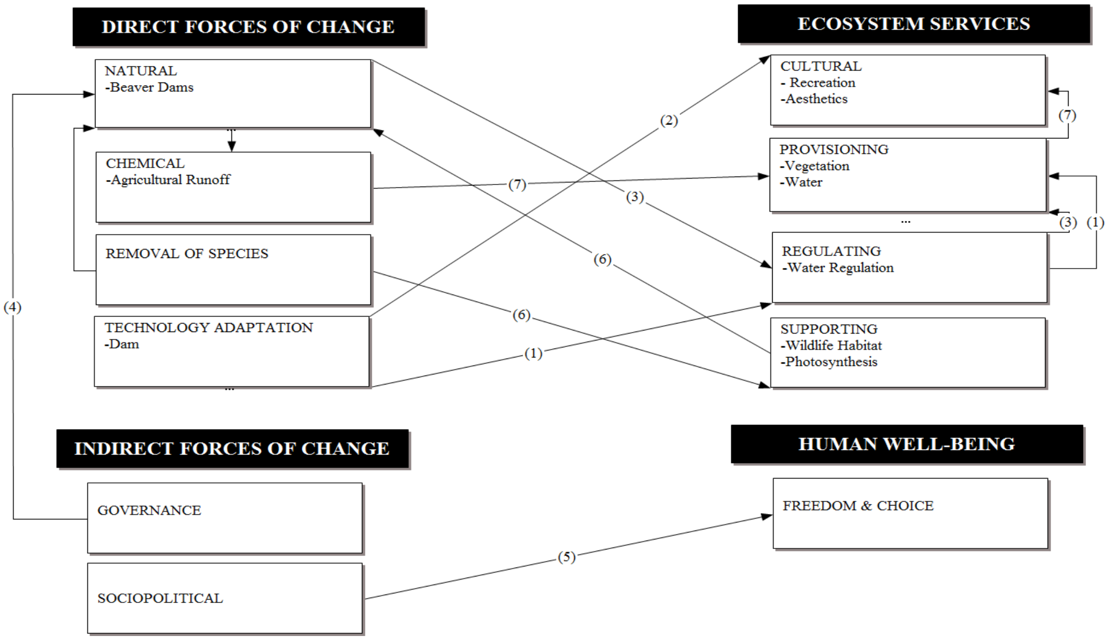
CJVP7


DIRECT FORCES OF CHANGE
NATURAL
-Flooding
...
LAND USE
-Agriculture
BIOPHYSICAL
-Erosion and Sedimentation
INDIRECT FORCES OF CHANGE
ECONOMIC
SOCIOPOLITICAL
ECOSYSTEM SERVICES
CULTURAL
- Recreation
PROVISIONING
-Food
-Water
-Wildlife
...
REGULATING
-Water Regulation
-Water Purification
SUPPORTING
-Water Recharge
HUMAN WELL-BEING
FREEDOM AND CHOICE
(4)
(1)
(2)
(1)
(2)
(5)
(5)
(5)
(3)
(6)

CJVP8


DIRECT FORCES OF CHANGE
BIOPHYSICAL
-Erosion and Sedimentation
NATURAL
-Topography
-Flooding
-Beaver Dams
...
LANDUSE
-Expansion of Agriculture
TECHNOLOGY ADAPTATION
-Post Creek Cutoff
-Dam
...
INDIRECT FORCES OF CHANGE
ECONOMIC
ECOSYSTEM SERVICES
CULTURAL
- Recreation
PROVISIONING
-Water
-Agriculture
-Wildlife
-Vegetation
...
REGULATING
-Water Regulation
HUMAN WELL-BEING
LIVELIHOOD
SECURITY AND SAFETY
(1)
(2)
(3)
(4)
(4)
(5)
(5)
(6)
(7)

CJVP9


DIRECT FORCES OF CHANGE
NATURAL
-Beaver Dams
CHEMICAL
-Agricultural Runoff
REMOVAL OF SPECIES
TECHNOLOGY ADAPTATION
-Dam
...
INDIRECT FORCES OF CHANGE
GOVERNANCE
SOCIOPOLITICAL
ECOSYSTEM SERVICES
CULTURAL
- Recreation
-Aesthetics
PROVISIONING
-Vegetation
-Water
...
REGULATING
-Water Regulation
SUPPORTING
-Wildlife Habitat
-Photosynthesis
HUMAN WELL-BEING
FREEDOM & CHOICE
(1)
(1)
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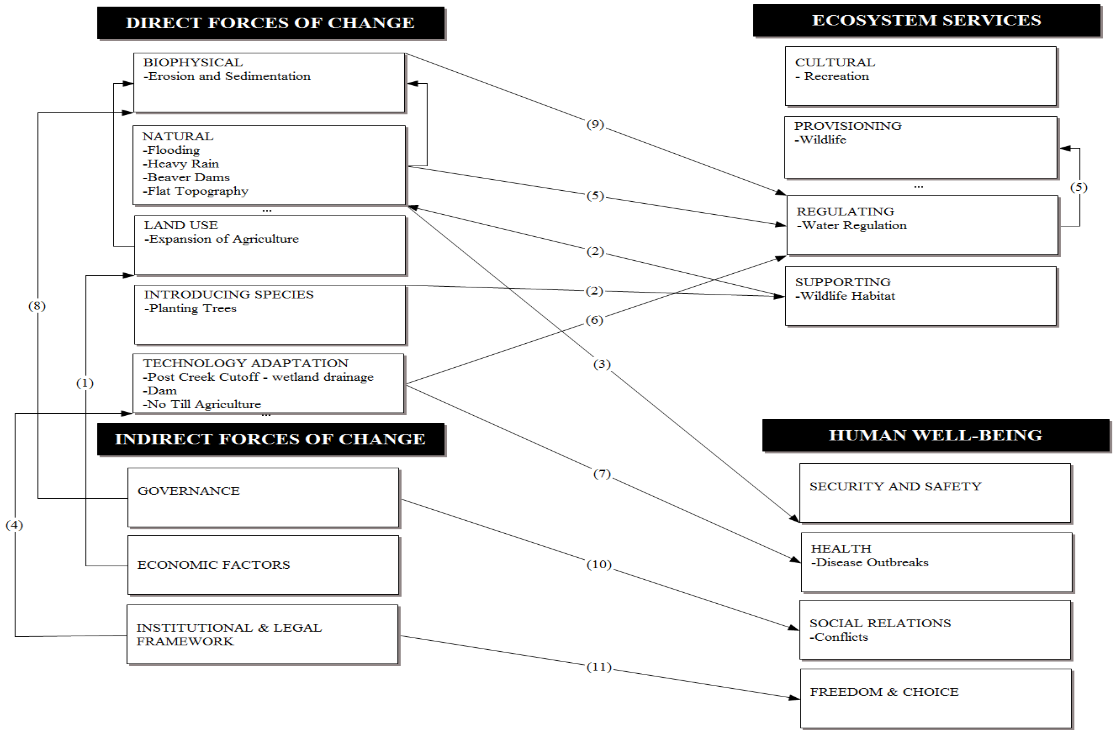
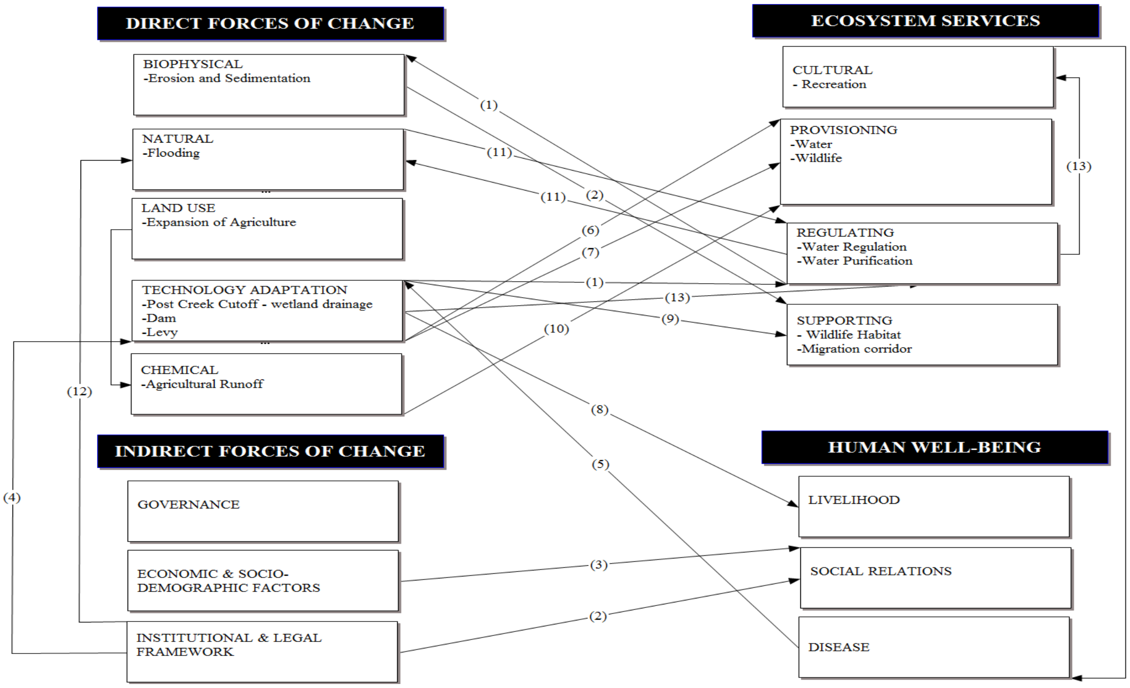
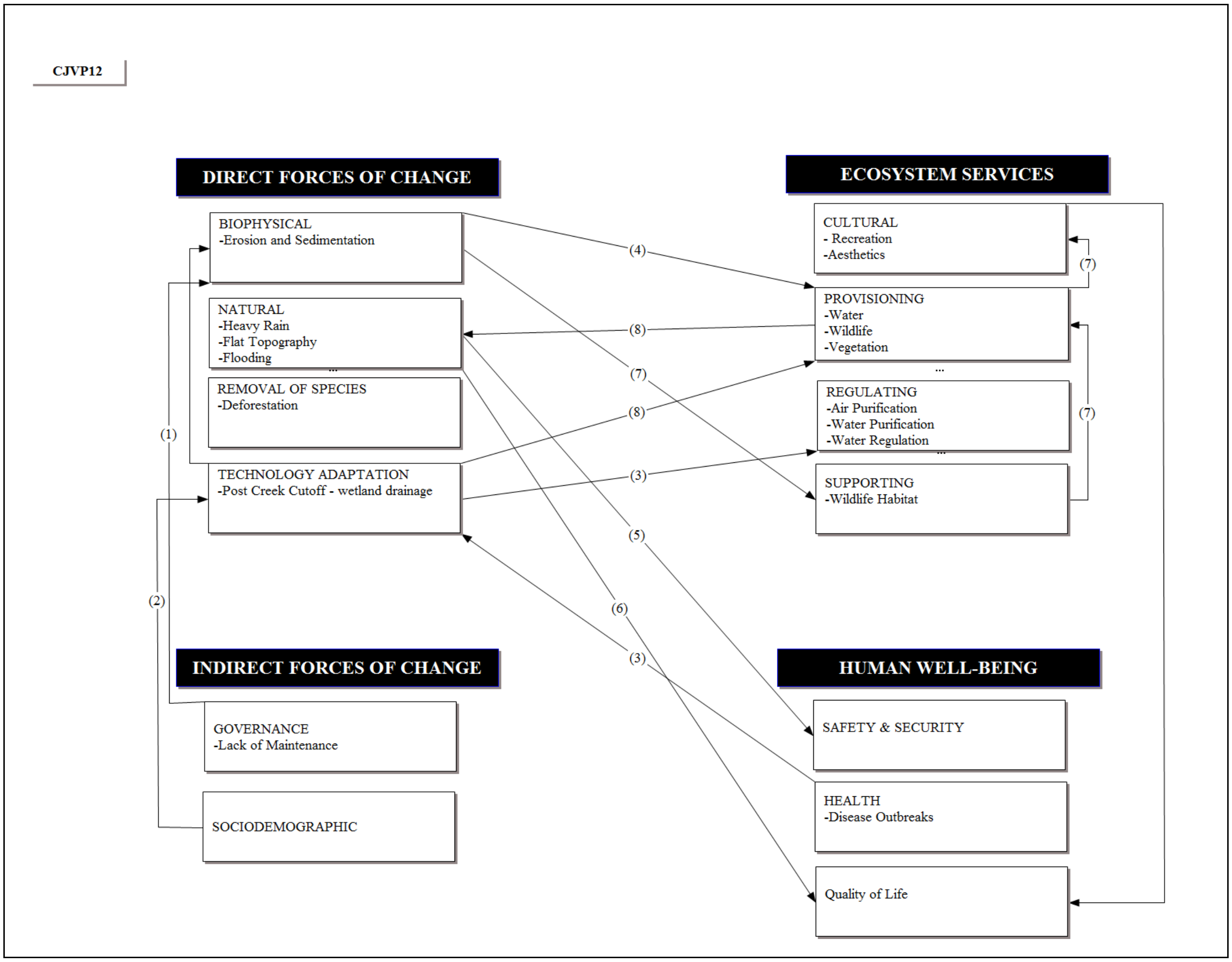
(6)
(7)
(7)

CJVP10



CJVP11




CJVP12
DIRECT FORCES OF CHANGE
BIOPHYSICAL
-Erosion and Sedimentation
NATURAL
-Heavy Rain
-Flat Topography
-Flooding
...
REMOVAL OF SPECIES
-Deforestation
TECHNOLOGY ADAPTATION
-Post Creek Cutoff - wetland drainage
INDIRECT FORCES OF CHANGE
GOVERNANCE
-Lack of Maintenance
SOCIODEMOGRAPHIC
ECOSYSTEM SERVICES
CULTURAL
- Recreation
-Aesthetics
PROVISIONING
-Water
-Wildlife
-Vegetation
...
REGULATING
-Air Purification
-Water Purification
-Water Regulation
...
SUPPORTING
-Wildlife Habitat
HUMAN WELL-BEING
SAFETY & SECURITY
HEALTH
-Disease Outbreaks
Quality of Life
(1)
(2)
(3)
(3)
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(8)