Managing Wetland Complexity in the Anthropocene:

The Upo Wetland

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Abstract

Wetland loss continues to be one of the major drivers of global environmental change and, despite the plethora of studies conducted, the ecological condition of this ecosystem has not dramatically improved. Most wetland degradation is caused by human activities seeking profit-maximization that result in a general disregard for the complex properties of wetlands. This thesis analyzes management of Upo Wetland in Korea from a policy perspective, including the socio-ecological implications of wetland complexity. The theoretical framework is drawn from a literature review and the management policy literature.

I first identify a theoretical framework for policy analysis that includes ecological, economic, and institutional wetland complexity dimensions. In the section on ecological complexity, I introduce and consider difficulties in explicitly understanding the nature of wetland. In the section on economic complexity, I address the theoretical misconceptions about managing wetland complexity under the current economic paradigm. The fundamental issue of the current economic system stems from the rejection of its subordinated relation with ecosystems and the limitations to market valuation approaches when dealing with nature. The socio-ecological implications to wetland institutions, including command and control, community-based, and market-based institution, are analyzed as well as their effectiveness in solving wetland ecosystem degradation at different scales.

Based on these three dimensions of wetland ecosystems, I argue that the ecological complexity of Upo wetland reveals a limited understanding of the breath and span of wetland ecological functions. Although Upo Wetland is inextricably connected to other wetlands in Korea (Mokpo, Sajipo, and Jokjibul), it also has profound connections to other environments, such as the Topyeong Stream and Nakdong River. The economic complexity of the Upo Wetland

is likely to aggravate difficulties in management despite providing a large number of ecosystem goods and services (ES), including regulating ES (flooding and purifying contaminated water), supporting ES (habitat function), provisioning ES (water supply), and cultural ES (the "Upo Wetland Ecosystem Pavilion"). However, the local government of Changnyeong County mainly promotes policies related to industrial development, mainly considering provisioning ES. The Upo Wetland was designated as an internationally Ramsar wetland site in 1998 and regulated under the Wetland Conservation Act (WCA) from the Korean Ministry of the Environment (MoE), with the overarching goal of preserving high diversity (regulating ES) and habitat ecological functions (supporting ES). Government policy assigns the entire task of managing the Upo Wetland to local institutions of the Nakdong River Basin Environmental Office and Changnyeong County, while requiring them to interact across all social levels. However, local residents continue to engage in fishing and agricultural practices not considered in the current policy. This study highlights the need for an integrated institutional approach to manage the Upo Wetland, adequately and holistically considering ecological, economic, and social complexities.

RÉSUMÉ

La perte des milieux humides continue d'être parmi les moteurs des changements environnementaux globaux, et, malgré la panoplie de recherches conduites sur l'état de ces écosystèmes, leur condition écologique ne semble pas s'améliorer. La dégradation de zones humides est surtout causée par des activités humaines alignées avec la création et augmentation des profits, résultant dans un mépris généralisé envers les propriétés complexes des milieux humides. Par conséquent, ce mémoire de maîtrise vise à analyser le milieu humide Upo d'un point de vue de politiques de gestion qui inclut les conséquences socio-écologiques de la complexité des milieux humides. Le cadre théorique choisi se base sur une revue de la littérature générale et de celle de la gestion des politiques.

D'abord, j'identifie le cadre théorique pour l'analyse des politiques qui inclue la complexité écologique, économique et institutionnelle des milieux humides. En ce qui concerne la complexité écologique, j'introduis et je considère les difficultés à comprendre explicitement la nature des milieux humides. Pour expliquer la complexité économique, j'aborde les problèmes de compréhension théoriques présents dans la gestion de la complexité des milieux humides basée sur le paradigme économique actuel. Le problème fondamental de ce system économique provient du rejet de sa propre dépendance et subordination envers les écosystèmes, et de la tendance à se limiter aux méthodes de valorisation monétaire lorsqu'il s'agit de protéger la nature. Les effets socio-écologiques des institutions dans ces zones humides, qui incluent « command and control », la gestion communautaire, et les institutions axées sur le marché, sont analysés, ainsi que leur efficacité dans la réduction de la dégradation de ces écosystèmes à différentes échelles.

En se basant sur ces trois dimensions des écosystèmes humides, la complexité écologique du milieu humide Upo démontre la présence d'une compréhension limitée de la portée et de la durée des fonctions écologiques de zones humides. Bien que le milieu humide Upo soit inextricablement connecté à d'autres zones humides en Corée (Mokpo, Sajipo, et Jokjibul), il répercute aussi sur d'autres environnements, comme le ruisseau de Topyeong et la rivière Nakdong. La complexité économique du milieu humide de Upo est susceptible d'aggraver les obstacles en gestion, malgré la provision de la part de ces écosystèmes d'un grand nombre de bénéfices comme la régulation de services écosystémiques, SE, (régulation des inondations et purification d'eau), la stabilisation de ces services (soutien de fonctions d'habitat), l'approvisionnement des SE (approvisionnement d'eau) et présence de SE culturels (le Pavillon du milieu humide Upo). Cependant, le gouvernement local du comté de Changnyeong favorise surtout des politiques de développement industriel qui considèrent que l'approvisionnement des services écosystémiques. La zone humide Upo fut désignée comme un site humide international Ramsar en 1998, et elle est régulée sous la Loi de la conservation des milieux humides (WCA) du ministère de l'environnement de la Corée du Sud, visant à préserver une grande diversité (régulation des SE) et les fonctions écologiques liée à l'habitat (stabilisation de SE). Les politiques gouvernementales attribuent l'ensemble de tâches de gestion du milieu humide Upo aux institutions locales du bureau environnemental du bassin de la rivière Nakdong et au compté Changnyeong, alors que les politiques leur exigent d'interagir à tous les niveaux sociaux. Cependant, les résidents locaux continuent à s'engager dans des activités comme la pêche et l'agriculture, qui ne sont pas visées par les politiques actuelles. Cette étude souligne la nécessité d'intégrer une approche institutionnelle pour gérer le milieu humide Upo, si l'on considère les complexités écologiques, économiques et sociales.

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Introduction

Wetland loss is a global issue and a challenge to humanity. In the past few decades, high-profile governmental and academic studies have considered various approaches to managing human activities, toward the goal of balancing between wetland health and human well-being (Hassan et al., 2005; Jogo and Hassan, 2010). For example, the international Ramsar Convention, ratified by 168 countries, encourages the "wise use of wetlands" as a measure for managing both wetland and human well-being. This international Convention receives significant financial support from the United Nations General Assembly every three years - US$5.5 million from 2013 to 2014 - and has apportioned US$8.6 million in collateral expenses from the Small Grants Fund for Wetland Classification and Wise Use (SGF) in 109 different countries for 237 projects from 1991 to 2010 (Ramsar, 2007).

Such research has led to an increased understanding of the socio-ecological complexity of wetlands in policy decision-making (Hassan et al., 2005). In spite of this great research effort, however, the status of wetland ecosystems has not improved at a rate equivalent to the number of wetland research projects put into place (Turner et al., 2000). The major cause of wetland loss is tampering with ecosystems for human benefit (Turner, 1991) - mainly profit driven interventions (Costanza et al., 1998). This results in a disregard for the socio-ecological complexity of the wetland ecosystem from an anthropocentric perspective which seeks to prioritize human profit-maximization from limited ecosystems.

Ecosystems are complex systems exhibiting properties at the ecological, economic, and social dimensions. They maintain and develop spatial and temporal interactions between biotic and abiotic components, while providing limited resources for human benefit (Christensen et al., 1996). Schumpeter (1954: 41) describes the ideal understanding of this complexity as a ''vision

of this kind not only must precede historically the emergence of analytic effort in any field, but also may reenter the history of every established science each time somebody teaches us to see things in a light of which the source is not to be found in the facts, methods, and results of the preexisting state of the science.'' This is called the "pre-analytical vision" of ecological economics (Costanza, 2000). From this point of view, ecosystems should be managed to regulate human impacts while providing well-being for all species dependent on it (Holling and Meffe, 1996). Aldo Leopold (1966: 262) condenses the understanding of ecosystem management into a single sentence: "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise."

Aim and Objectives

This thesis aims at analyzing Korea's Upo Wetland management from a policy perspective that incorporates the socio-ecological implications of wetland complexity.

In Part 1 ("Ecological Complexity"), I describe the source and characteristics of wetlands' ecological complexity, considering the difficulty of explicitly understanding wetland ecological complexity as well as obstacles surrounding the standardization of ecological information when responding to specific objectives. In Part 2 ("Economic Complexity"), I address theoretical misconceptions about managing wetland complexity under the current economic paradigm. One fundamental issue of the economic system today stems from the rejection of its subordination to ecosystems and the inherent limitations of market value approaches. This ongoing view promotes market-oriented economic policy reform to govern wetlands, which only focuses on specific types of ecosystem benefits.

In Part 3 ("Institutional Complexity"), issues of wetland management by the institutional approach are presented. Socio-ecological implications of institutions, including command and

control, community-based, and market-based institutions, are analyzed as well as their effectiveness in solving wetland ecosystem degradation at different scales.

Based on these three dimensions of wetland ecosystems, I will present the case study of Korea's Upo Wetland, focusing on ecological, economic, and institutional complexities.

Finally, the discussion section introduces policy recommendations for managing the complexity of the Upo Wetland. This will help to build for Upo Wetland an integrated institutional approach balancing ecological, economic, and social needs.

Chapter 1. Theoretical Framework: Dimensions of wetland complexity

Part 1. Ecological Complexity: Understanding of the inherent complexity

Wetlands are lands covered by, or periodically saturated with water, which gives them both the terrestrial (uplands) and aquatic functions of ecosystems (Turner, 1991; Keddy, 2010). Wetlands maintain and develop their processes with biotic and abiotic components, and are characterized by the various rates of exchange between biogeochemical processes (Mitsch and Gosselink, 1993; Keddy, 2010). Ecosystem functions are a consequence of one or more processes of biotic and abiotic components interacting, such as flood control, ground water recharge, and nutrient retention. The National Research Council (1995) stated that wetland ecosystems perform extensive functions for both terrestrial and aquatic ecosystems, within and beyond their boundaries, and act as sources of raw materials and sinks of pollution.

The inherent ecological complexity of wetlands is increased by the many sources of information and constant changes in our understanding of wetlands. This is because of the difficulty involved in the explicit understanding wetland ecological complexity as well as the standardization of ecological information responding to specific objectives. Therefore, high-profile studies on wetland ecosystems mainly focus on a single objective (ecosystem protection) at the expense of disregarding the inherent properties of wetland systems (Yashiro et al., 2013). For example, there are many studies on biogeochemistry that focus on an understanding of wetland complexity, especially in water (Josselyn et al., 1994; Reid and Brooks, 2000; Steyaert et al., 2007), biodiversity (Gibbs, 2000), birds (Johnson, 2001) and plants (Soons, 2006).

The ecological complexity of wetlands is characterized by nonlinear dynamic functions as well as uncertainty about the characteristics of wetlands arising from the different contexts of understanding and disciplinarity (Mitsch and Gosselink, 1993; Turner et al., 2000). The

fundamental source of the complexities of wetland ecosystems, according to Schneider and Sagan (2005), is explained by the fact that ecosystems convert the energy from the sun (low entropy) to matter (high levels of entropy). In addition, Aylward and Barbier (1992) highlighted that ecosystem processes stem from the inter-relationships between variables such as the diversity of matter and space, as well as the continuous supply of energy from the sun over time. Since these variables engage in complex interactions stemming from the flow of energy from the sun (Odum, 1968), Harris (2007) and Liu et al. (2007) stress that ecosystems are nonlinear equilibrium dynamic systems. Their explanation is driven by adaptive (feedbacks) and dynamic (cross-scale) interactions of ecosystem components. In other words, the dynamic yet complex ecological systems determine the level of absolute unpredictability from regularity against simple systems (Parrott, 2010). The complexity and unpredictability of ecosystems allows for adaptability; they adjust their processes as a function of the changing and unpredictable variables state. However, this developed flexibility allows quantitative changes to the ecosystem from its original state to an alternative one without losing its qualitative characteristics, including changes due to human interactions - this feature has been described as “ecosystem resilience” (Holling, 1973). For example, wetlands are resilient to invasive species by stabilizing structures and functions such as habitats for endemic species (Hansson et al., 2005). This resilience can mitigate ecological crises by buffering changes in nutrient level, flood cycles and trophic interactions (Holling, 2001). Adding to the understanding of wetland resilience, Holling (2001: 396) introduces the concept of panarchy as, "…a representation of a hierarchical as a nested set of adaptive cycles."

Definitions and classifications, attributed to understand the ecological complexity of wetlands, are also incomplete. The international Ramsar Convention (Article 1.1) broadly

defines wetlands as "…areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres." The Ramsar Convention contributes to the sustainable development of wetlands through the conservation and sustainable use of wetlands and their resources. This is to promote the preservation of wetlands in collaboration with 168 nations. Moreover, numerous sites protected by the Ramsar List of Wetlands of International Importance mainly focus on waterfowl in that they "may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands in terms of ecology, botany, zoology, limnology or hydrology" (Article 2.1). Another definition of wetlands places greater emphasis on biology, mainly because wildlife biologists and botanists initially recognized the significant contribution of wetland ecosystems to human societies (Turner, 1991). The Ramsar Convention (1971) classifies 42 main types of wetland systems into three categories: a) marine and coastal, b) inland, and c) human-made. Furthermore, at the national level, studies aimed at conserving national fish and wildlife species since the 1950s follow the definition of wetlands according to the U.S. Fish and Wildlife Service (FWS) (Tiner, 1999). Following the FWS definition, Cowardin and Golet (1995) developed a hierarchical wetland classification. This classification system of wetland types into a) system, b) subsystem and c) class is rarely based on the uncertainty of wetland functions (Tiner, 1999). It is dependent on the spatial and temporal scale of the wetland habitat. Despite these many approaches to understand wetland ecosystems, there still is insufficient information to manage wetland ecosystems from a complexity perspective (Finlayson and Rea, 1999; Hahn et al., 2006).

Ecological complexity, therefore, increases the intricacy of managing wetlands due to their inherent complexity, including different and often conflicting understandings of wetlands. In summary, to recognize complex properties of wetland functions, processes, and components, there are various approaches, including energy flow analysis, species diversity approaches and different classification systems, that must be integrated in order to have a better understanding of wetland ecosystems.

Part 2. Economic Complexity: Limits to implementing economic approaches in ecological management

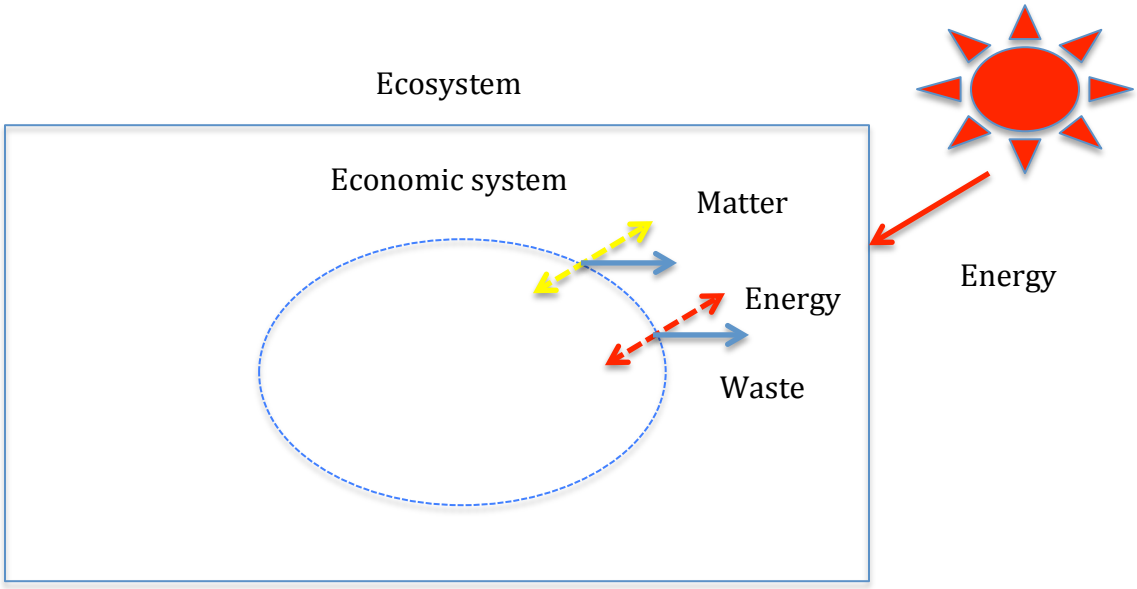
Ecological management has been recently included in policy-making by focusing on the importance of ecosystem functions to human well-being (De Groot, 1987; Turner and Carpenter, 1999). Due to a realization of the impact of managing ecosystem functions through a strictly monetary lens, the multidisciplinary concept of ecosystem goods and services (ES) is adopted in ecological management (Daily, 1997; Costanza et al., 1998). Van den Belt et al. (2011: 36) define ES as follows: "ES have ethical, spiritual, cultural, and bio-centric values that directly or indirectly support or enhance the well-being of humans and other species." The definition of ES that is most is widely accepted is that of the Millennium Ecosystem Assessment (MA, 2005), which defines ES as "the benefits people obtain from ecosystems." In addition, the MA (2005) identifies ES as consisting of the following services: provisioning ES (fish and agricultural products), regulating ES (flood control and water purification), cultural ES (recreations and religious benefits), and supporting ES (nutrient cycling).

Provisioning ES are directly linked to human well-being; they are mainly the source of tangible goods within the economic system. Regulating ES are important for human well-being due to the functional capacity of maintaining and developing a variety of ES (MA, 2005). Supporting ES directly and/or indirectly relate with other ES for human well-being through ecological process. Lastly, cultural ES are vitally important intangible properties that arise from diverse perceptions, depending on the cultural context. The widespread recent trend of wetland loss has resulted from insufficient consideration for wetland ES in ecological management (Russi et al., 2012). This is because there are theoretical misconceptions about managing ES under the current economic paradigm (Costanza et al., 1998).

Two factors of wetlands' economic complexity characterize the challenging relationship between economics and ecology in the context of wetland management. Firstly, the economic system disregards the fundamental limits of energy and matter flows from ecosystems to human societies (Daly and Farley, 2010). It requires the constant growth of the economic system for fulfilling human needs within a limited ecosystem. Secondly, the economic system has the inherent limitation of market value approaches to managing wetland ES. Economic approaches consider ecological management as either focusing on only tangible forms of ecosystem benefits or individual preferences despite its impact on others' well-being. This ongoing view promotes market-oriented economic policy reform in governing wetlands, which only focuses on a few specific types of ES. Mainstream economic approaches to managing wetlands disregard tradeoffs among ES.

Daly and Farley (2010) provide an alternate perspective of the fundamental issue of the current economic system that understands energy and matter flows between systems, which in turn support the economic subsystem (figure 1.1). The authors illustrate the ecosystem as a closed system of matter with a limited rate of energy flow from the sun so that it is able to supply limited energy and matter to the sub-ordinated economic system (Daly and Farley, 2010). In other words, human well-being is subordinated to the ecosystem that is limited in supplying a finite source of monetary value, continually producing irretrievable waste through a one-way path (Daly and Farley, 2010; van den Belt et al., 2011). This biophysical condition renders it impossible to support an endless demand from ever increasing economic growth (Daly and Farley, 2010). Therefore, this system places limits upon an otherwise endless tendency of economic growth in supplying the market system resources from the ecosystem just to satisfy human wants (Daly and Farley, 2010).

Figure 1.1. The economic system as part of the ecosystem (Adopted from Daly and Farley, 2010)



Another fundamental issue is that wetland loss still takes place mainly due to the limited capacity of economic valuation to address the multi-dimensional ES derived from wetland. Van den Belt and others (2011) illustrate that valuation of ecosystem benefits is a human effort to balance between human well-being and fundamental life-supporting systems. Wilson and Carpenter (1999: 773) define economic values derived from ecosystems as "the amount of money a person is willing to give up in order to get a thing, or the amount of money required to give up that thing." There have been efforts to evaluate the benefits from complex wetland functions in the use and nonuse terms (Barbier, 1994; Costanza et al., 1998) of direct use (mostly marketable ES such as provisioning ES), indirect use (mostly nonmarketable ES such as regulating, supporting ES) and nonuse values (neither direct nor indirect use of wetland ES such as cultural ES).

Market-based valuation of ES assumes a marginal efficiency approach, namely the marginal costs should equal the marginal benefits of consuming ES (Wilson and Carpenter, 1999; Daly and Farley, 2010). Valuation of ES only focuses on marketable forms with marginal values and/or prices of ecosystem output (Barbier et al., 1997; Wilson and Carpenter 1999; Turner et al., 2000; van den Belt et al., 2011). In other words, a market system is blind to the wide range of ecosystems values. For example, the total economic value of the Nigerian Hadejia-Nguru wetlands comprised only marketable goods (provisioning ES): a) agricultural products (Naira 250-280million/year), b) fishing (Naira 45 million/year) and c) fuel wood (Naira 14million/year), leaving aside the nonmarketable goods of ecosystem functions, such as flood control and water purification (Kimmage and Adams, 1990).

While this ES valuation approach focuses heavily on marketable forms, the nature of most ecosystem benefits is not inherently marketable (Daly and Farley, 2010). Therefore, monetary valuation is not applicable to the full range of ecosystem benefits which contribute to society's well-being, but only considers individual demands (Barbier et al., 1997). Van den Belt and others (2011:36) also state the danger of monetary-oriented valuation this way: "Perhaps no amount of money justifies destroying a mangrove forest essential to the survival of an endangered species. Either way, valuation measures are only meaningful within established boundaries, which can only be established by moral and ethical values; not by economics only."

Appropriate ES management requires an integrated economic approach that asserts use values (direct values, indirect values) as well as non-use values (intrinsic value, bequest, option, existence value) (Barbier et al., 1997; van den Belt et al., 2011). However, this seems difficult to accomplish given the limited capacity of economic valuation to include multi-dimensional ES only in monetary terms (Chee, 2004; Costanza et al., 1998). Therefore, it leads to an

anthropocentric conceptualization of trade-offs among ES accompanied by a narrow understanding of economic value from a marginalist perspective (Holling and Meffe, 1996; Limburg et al., 2002; Rodríguez et al., 2006; Polasky et al., 2011). Rodríguez and others (2006: 28) define trade-offs between ES this way: " Trade-offs occur when the provision of one ES is reduced as a consequence of increased use of another ES." For example, wetland destruction in the Midwest USA is due to the increase in agricultural outputs from provisioning ES (Rodríguez et al., 2006) at the expense of other services such as regulating, cultural, and supporting ES.

In understanding wetlands' economic complexity, one fundamental issue of the current economic system disregards the fundamental limits to energy and matter flows from ecosystems to fulfill human needs, because the economic system objects to a subordinated relation to the ecosystem (Daly and Farley, 2010). Another fundamental issue is that the economic system does not provide a means to value intangible ES and promotes individual preferences over collective and other-regarding preferences. It leads to limiting monetary valuation of wetland ES when dealing with ecological management. This valuation narrative generates trade-offs between valuation forms and among ES by focusing on the specific types of ES (mainly provisioning ES) that will help meet market needs.

Part 3. Institutional Complexity: Socio-ecological implications of institutions

The environmental issues of wetlands have been aggravated mainly by the economic system's misuse of ES (Costanza et al., 1998). This section will identify the socio-ecological implications of wetland institutions and how they manage, address and solve environmental issues. To reduce the negative impacts of managing ES, the degree of rivalry and excludability will be used to comprehend the characteristics of ES in light of the cross-societal institutions developed to manage wetland ES.

Vatn (2005: 207) defines institutions as "the conventions, norms and formally sanctioned rules of a society. They provide expectations, stability and meaning essential to human existence and coordination. Institutions regularize life, support values and protect and produce interests. Institutions influence choice both by acting as constraints, as facilitators, and as defining what is relevant or proper behavior." There are various forms of formal and informal institutions (Ostrom, 1990), many of which adopt policies to implement environmental (or other socio-economic) strategies. The international convention of Ramsar (2007: 15) defines policy as "a collection of principles which indicate intended and acceptable activity or direction for an organization or government." Policies are the most widely recognized legal form of document to solve public environmental issues with multi-level stakeholders' participation in a decision making process (Ostrom, 1990; Ramsar, 2007), and require a wide range of social interventions to encompass diversity of variables, such as knowledge and culture, in the policy process.

However, the majority of wetland policies are framed according to mainstream economics, rather than focusing on the multi-disciplinary aspects of the socio-ecological complexity of wetlands (Daly and Farley, 2010). This involves high stakes due to the alarming rate of wetland loss, with increasing institutional approaches rooted in various value systems and

knowledge of wetland decision-making processes. Escobar (2006) also states that there is broad range of ecological institutions that have not been formalized.

To understand how institutions manage environmental issues using different rules for pursuing specific objectives at different scales, three types of institutions will be explained: 1) command and control, 2) community-based approaches, and 3) market-based approaches. A summary of each of the institutional regimes, including their major elements of rights and characteristics, is provided in Table 1.1.

In the 1970s and 1980s, environmental issues had been mostly driven by traditional regulation from governments in the form of command and control regimes (Ekins, 1999). This institutional approach is an inefficient system to manage the full range of ecosystems because it aims to offer a more stable production for human benefit through managing natural resource systems (Driesen, 1998). This is accomplished by either removing or reducing the internal and external variables of ecosystems, such as simplifying ecological dynamics in order to better serve human well-being (Holling and Meffe, 1996; Ludwig, 2001). As such, it tends to oversimplify the characteristics of a given ecosystem (Ekins, 1999; Berkes, 2004). However, simplifying ecological variables for socio-ecological efficiency leads to unexpected results (Holling and Meffe, 1996).

After the last two decades with priority given to command and control, community-based institutions have emerged as a new approach to manage natural resources. Community-based approaches recognize the complex character of the socio-ecological systems of wetlands (Berkes, 2004). These approaches help to achieve the institutional goal of wetland protection while including local communities in the process of management (Armitage, 2005). In fact, community-based approaches have successfully managed issues of community-owned ES

because the community is structured between their own knowledge, conservation practices and traditional customs (Ostrom, 1990). Therefore, community-based approaches encourage cross-scale social interactions while acquiring the knowledge of the ecological complexity of ecosystems and its relational properties within society, by trial and error over time (Ostrom, 1990).

Building on the community-based approach, co-management strategies play an active role in environmental issues by taking into consideration the complex nature of the ecosystem, both at horizontal and vertical levels. Co-management balances the power and knowledge of various stakeholders at different scales: individual, community, national and international (Berkes, 2004). In addition, the concept of adaptive co-management is introduced to further understand the learning process, emphasizing bottom-up management approaches in a co-evolutionary process (Berkes, 2004).

Although community-based regimes realize the importance of community involvement in the decision-making process, these approaches are also in favor of unifying valuation across actors as a means to an easier management of ES. According to Armitage (2005), institutions based on the community need to not only adopt but also preserve diverse values to manage ES, depending on time and social scales such as knowledge, customs, politics, livelihoods and so on.

Finally, environmental policy has continued its upward trend to adopt a monetary value approach to conserve nature (Daily and Ellison, 2002; Grieg-Gran et al., 2005; Pascual et al., 2010), because money serves as a major substitute of ES for the state of human well-being. As such, market-based institutions have been building trust and developing environmental tools for conserving ecosystems under environmental policy (Gómez -Baggethun and Ruiz-Pérez, 2011). Market-based approaches largely comply with economic systems to allocate ES through cost-

benefit analysis (CBA). This approach values ES in terms of opportunity costs and aims at maximizing profit while minimizing expenses. CBA is primarily based upon economic efficiency in managing ES, and relies heavily upon individual preferences (Grieg-Gran et al., 2005; Fisher et al., 2008). This tends to generate distributional issues between so-called ES suppliers and/or consumers in our society. In this system, payments for ES increase landowners' participation, to conserve ES through compensation (Pagiola et al., 2005; Fisher et al., 2008).

Table 1.1. Summary of major elements of rights and characteristics in different levels of existing institutions.

Society level	Rights	Characteristics
Command and Control	Central government	• Traditional regulation by government • System simplification • Risk and cost high
Community-based approached	Collective Community	• Upward trend • Cross-scale social interaction • Trial and error over time
Market-based approaches	Individuals	• Individual decision value • Cost-effective • Distributional issues • Positive and negative externalities

To manage wetland ES in light of cross-societal institutions, ES can be classified by the degree of rivalry and excludability: 1) rivalry and excludability; 2) non-rivalry and excludability; 3) rivalry and non-excludability; 4) non-rivalry and non-excludability. A rival good and service, such as an apple or a fish, eliminates all benefits for others once consumed by an individual

(Brown et al., 2007). On the contrary, the benefit of a non-rival ES is not diminished when consumed, but when it reaches congestion level it will then turn it into a rival ES (Brown et al., 2007) - an example is birdwatching. The benefits of the goods and services are then appropriated by the owner or person who has the legal right over it. This person then sets the required conditions for consumption within social institutions (Brown et al., 2007). Discussing rivalry and excludability, Daly and Farley (2010) state: "Excludability is not a property of the resource *per se*, but rather of the regime that controls access to the resource." Excludability is the main point of the market system, to efficiently produce and allocate goods and services for generating human benefits (Daly and Farley, 2010).

Most ES have been degraded not only because of insufficient excludability but also due to the unconditionally prioritized single force of the market system. This excludable right is a means of internalizing the externalities by relational activity of ES. The nature of most ecosystem resources is particularly considered insofar as it is free in nonmarketable form so that it alters others' welfare by individual contributions that are not planned yet known as externalities (Daly and Farley, 2010). These externalities remain a challenge in valuing properties of ecosystems in monetary terms. By realizing difficulties in managing the characteristics of ES, a market system decenters its constraints to provide efficient benefits in the economic system by property rights (Daly and Farley, 2010). The extensive usage of goods and services is restricted by the authority of owners, which is called property rights (Alchian, 1987). Property rights are likely to be various agreed upon relationships within contexts such as history, culture and law, characterized by the distribution of rights to get benefits from ecosystems, depending on spatial and temporal scale (Berkes et al., 2000). ES thus emerge into the range of property rights that are the cross-societal means to control the greater beneficial or harmful

impact upon decisions made by interacting between people while exercising their rights (Demsetz, 1967). There are various ways of managing ES with property rights, depending on the degree of the rivalry and excludability in the context of their ecological and social implications.

There are four property rights of goods and services defined by the degree of the rivalry and excludability:

1) Private property rights (rivalry and excludability),

2) Common property rights (non-rivalry and excludability),

3) Open access property rights (rivalry and non-excludability), and

4) Public property rights (non-rivalry and non-excludability).

Private property rights (rivalry and excludability) have the exclusive authority for a mutual agreement to use rivalry goods and services, made between the owner and consumer (Alchian, 1987). This right meets the requirement of the market system by supplying benefits along with the costs of rivalry goods and services. However, it restricts human well-being to get benefits even from marketable goods due to its priority of receiving benefits in the context of market forces.

Common property rights (non-rivalry and excludability) have the community-based authority to exclude the use of goods and services by consumers without authority. Although these goods and services are not reduced in the capacity of goods and services by consumption (non-rivalry) such as information, common property rights are efficient in allocating benefits of goods and services upon excludability in the market system (Daly and Farley, 2010). Open access property rights (rivalry and non-excludability) face the difficulties of conserving rivalry goods and services that are overused within non-excludability, such as fish. Public property rights (non-rivalry and non-excludability) have no excludable right of acquiring benefits of non-

rivalry goods and services. Unless all individuals agree to pay for non-rival and non-excludable ES, the market system will no longer be efficient in managing public ES.

In general, the goods and services of wetlands are categorized as open access (rivalry and non-excludability such as fish) and/or public property (non-rivalry and non-excludability such as water purification). Therefore, wetlands have been deteriorated due to the insufficient excludability of goods and services through property rights, despite the inappropriate generation of goods and services with private property (Turner et al., 2000). Due to the fact that most ES fall into nobody's property, they have no right to exclude another's benefits. As a result, wetland ES have been mostly allocated its right to the private sector. This is likely an institutional issue, following market force as priority in managing wetland ES. For example, a fisherman manages his wetland by exercising private property rights through fish farming as a livelihood, although it is authorized as open access property for fisheries. Therefore, the present economic system is efficient in allocating ES under equilibrium conditions when, and only when, the marginal benefit equals the marginal cost. It is safe to iterate that the economic system is limited in covering most ES, granted it does not usually have property right to exclude the acquisition of benefits from non-rivalry goods and services. As a result, wetland ES have been mainly managed by the narrow requirement of the economic system, using private property rights.

Hardin (1968), in "The Tragedy of the Commons," set the stage for the environmental policy to manage natural resources (the pasture) with the concept of property rights (private property instead of open access property) for human well-being (individual priority over community benefits from cattle). With the coming of market failure, McCay and Jentoft (1998: 21) stressed this issue of managing non-excludability ES (open access property of the pasture) by

ill-defined property rights with a market-based institution: “The rational decisions of each individual accumulate to create an irrational dilemma for the group, and freedom becomes tragic.”

Ostrom (1990) also stated the difficulties of managing ES with institutions by suggesting the new concept of a “common pool” due to the complex features of socio-ecological systems. The well-being of individuals unites to form the individual, community, national, and international human well-being. The national well-being does not necessarily reflect every citizen's well-being. However, under the neoclassical economic paradigm, economic rights focus on the individual's benefits. This could have either positive or negative consequences. In other words, individuals abridge their own property rights with the intention to use goods and services to achieve self-centered individual well-being. If multi-level institutions manage ES together and share services with equal rights, this will not only provide better economic benefit from ES for individual gains, but it will also prevent environmental issues from the misuse of ES in the economic system. Furthermore, this multi-dimensional institution in society would manage goods and services, both marketable and nonmarketable. Therefore, this new policy institution is likely to meet each level of stakeholders’ desires and interact to achieve their ultimate goals in respecting the nature of ES. Above all, it must be remembered that environmental issues are complex due to diverse stakeholders’ combined interests and various other values in order to establish a common criterion in the decision-making process.

Chapter 2. Result: Case study of the Upo Wetland

Overview of the Case Study

The Upo Wetland is a naturally formed ecosystem that has undergone a long history with the people of Korea. It has maintained its ecological integrity with water flowing in from the Topyeong Stream (토평천) and Nakdong River. The main water supply of the Upo Wetland is the Topyeong steam, which runs from Mt. Hwawang (화왕산), while intermittent water comes from Nakdong River when it is over-flooded by the summer's heavy rains. As a freshwater wetland, the Upo Wetland extends between the northeastern and the southeastern regions of Gyeongsangnam Province (경상남도) near the Nakdong River. The largest inland wetland in South Korea, Upo comprises the four wetlands known as Upo, Mokpo (목포) (located at the northern part of the Upo), Sajipo (사지포) (located at the northeastern part of the Upo) and Jokjibul (쪽지벌) (located at the southwestern part of the Upo). It is located on 128°25' east and 35°33' north (Changnyeong County, 2008). Therefore, the whole region is representatively called the Upo Wetland, with four different administrative sectors:

- The Upo Wetland (1,278, 285 m^2): Daedae-ri, Yueo-myeon, Changnyeong County, Gyeongsangnam Province, Korea
- The Mokpo Wetland (530,284 m^2): An-ri, Ibang-myeon, Changnyeong County, Gyeongsangnam Province, Korea
- The Sajipo Wetland (364,731 m^2): Jumae-ri, Daehap-myeon, Changnyeong County, Gyeongsangnam Province, Korea
- The Jokjibul Wetland (139,626 m^2): Okcheon-ri, Ibang-myeon, Changnyeong County, Gyeongsangnam Province, Korea

The Upo (우포) Wetland (also called the Woopo Wetland) has long coexisted with people who settled along the Nakdong River (낙동강). During the period of Japanese colonization, the names of the Upo, Mokpo and Sajipo wetlands were imposed by the Japanese Governor-General of Korea, and data has been recorded using these names (Changnyeong County, 2008). However, local people have continued to refer to each of these wetlands using different names, particularly through descriptive terms reflecting the region's natural shape and features. Upo (牛浦) Wetland, and its surrounding landscapes of Upo, Somok (소목), and Mt. Woohang (우방산), are noted for collectively resembling the features of a cow. Therefore, the Upo Wetland is called Cow Field, Mokpo Wetland is called Tree Field, and Sajipo Wetland is known as Sand Field (Jokjibul has retained its name) (Changnyeong County, 2008). Generations of successful farming in the Upo Wetland are reflected in the common expression, "There is plenty of food when there is noise in summer on wetland." In addition, as a demonstration of the region's abundant importance across centuries, archaeologists have found a variety of artifacts on the site, including the remains of a wooden boat, and stone pestles. These have raised the Upo Wetland's significance as a historical site in addition to its ecological and social value (Changnyeong County, 2008) (Table 2.1).

Table 2.1. Summary of the property, size and jurisdiction on each wetland (Adopted from Changnyeong County, 2008)

	Upo wetland	**Upo Wetland "Cow field"**	**Mokpo Wetland ("Tree field")**	**Sajipo Wetland ("Sand field")**	**Jokjibul Wetland**
Property	The largest inland wetland in Korea	The biggest wetland among the four wetlands	Supplying firewood since the Korean war	Having much more sand than the other four wetlands	Named in Korean, without using Chinese characters like the others. The smallest of the four wetlands
Size	2.31 km^2	1.28 km^2	0.53 km^2	0.36 km^2	0.14 km^2
	4 administrative districts (Yueo-myeon, Ebangmyeon, Daehabmyeon and Daejimyeon) for Changnyeong County				
County	Yueo-myeon , Changnyeong Country	Daedaeri and Sejinri of Yueo-myeon, Changnyeong Country	Anri of Ebangmyeon, Changnyeong Country	Jumaeri of Daehabmyeon, Changnyeong Country	Okchunri of Daejimyeon, Changnyeong Country
Province	Gyeongsang-nam Province	Gyeongsang-nam Province	Gyeongsang-nam Province	Gyeongsang-nam Province	Gyeongsang-nam Province
Region	Korea	Korea	Korea	Korea	Korea

Wetland is a critical feature of Korea's complex socio-ecological system. The number of wetlands in Korea is relatively small due to the location of the peninsula atop stable terrain, which has provided little in the way of major geological events required for forming wetlands.

Across the western and eastern parts of the country, wetlands are marked by distinctive characteristics brought about by their proximity on three sides to the Eastern, Western and Southern seas. Depending on location, wetlands may be exposed to various air pressure gaps occurring between the land and the ocean, resulting in a natural cycle of climate events such as monsoons and typhoons. During the summer, wetlands are greatly affected by the resulting concentrated season of heavy rain.

The features of wetlands have broadly affected Korean society in the areas that surround them. Since the beginning of civilization, human beings have always found benefits to commonwealth in close proximity to water (Brown and Garver, 2009). Wetlands supply various advantages for human well-being, in the form of farming opportunities, residential amenities, and industrial uses.

In recent history, however, wetlands in Korea have been reclaimed for expanding land development, particularly in the form of farming fields, because 70% of the country's geographical area (approximately 220,258 km^2) is composed of mountains (Ministry of Environment, 2014). The country's wetlands have provided a continuous supply of water resulting from seasonally concentrated rains.

Korea wetlands are endangered in both ecological as well as social terms, particularly by wetland use in the name of economic development. Wetland loss ranges from small areas to whole sections of the Upo Wetland, resulting from different levels of anthropocentric interference, such as the construction of dikes, drainage channels, pumping stations, and roads and buildings around the wetland environment, as well as the conversion of wetland to farmland (Changnyeong County, 2008). In 1930, the Upo Wetland was reduced by 60% by constructing a levee on its east side to minimize flood damage (Changnyeong County, 2008). Later, the greater

part of Korean wetlands, including the Upo Wetland, were turned into farmland following a project to widen farming capabilities, in order to increase local income and speed industrial development following independence from Japan (Changnyeong County, 2008). In the 1980s, massive reclamation projects were sanctioned under the National Master Plan for Land Reclamation, an impulse that has continued under successive indiscriminate projects promoting development through management (Moores, 2006).

Upo Wetland has largely avoided this more recent economic trend of national development. This could be the result of its mountainous location - terrain undesirable for profit-driven development. The central government's policy reforms in the wake of the Upo Wetland's designation by the international institution of the Ramsar Convention (1971) as needing preservation, and an increasing awareness on the part of citizens of the need to preserve wetland, have also played a part in the sparing of the Upo Wetland from major development. It seems dangerous, however, to underestimate potential threats to the Upo Wetland in the light of its socio-ecological complexity - even considering the noted increase of resident bird species from 67 to 160 between 1998 and 2007 due to the destruction surrounding other principal habitats (Kang et al., 2007; Changnyeong County, 2008). There is also a conflict with local individuals regarding conservation policy decisions that they feel run afoul of individuals' rights to profit from Upo Wetland management. This conflict suggests that local farmers are less likely to cooperate with the government's initiatives to preserve the Upo Wetland, occasionally even committing illegal acts targeting Upo Wetland policies. Therefore, it is critical to reform this unequal policy management not only for human well-being but also in the fundamental service of supporting the Upo Wetland's ecosystem, before we exceed our capacity to deal with such issues through institutional management.

Historical consideration

Korea has seen the deepening of long-held ideological conflicts between traditional values and the profit-driven concerns of a modernized capitalist society, an ideological drift that has been central to Korean life since the Joseon Dynasty (1832-1910) (Chung and Kirkby, 2002). The first king of the Joseon Dynasty, Yi Seong-gye (이성계) believed that three principles were central to national government: foreign, cultural, and economic policies.

On the one hand, in foreign policy, the Joseon Dynasty established close relations with China in order to pursue practical interests through economic and cultural partnerships between nations. On the other hand, that era's approach to government enforced a national isolation policy by fixating on the potential threat to the existence of the nation posed by external capitalist countries who, it was feared, would drag Korea into economic crisis. Although researchers have argued that the policy of isolation was implemented in order to bolster and centralize the political power of the king and his closest supporters, it led to Korea becoming independent based on traditional values. In cultural policy, Confucianism has remained deeply rooted in Korean society since this period. Additionally, economic policy aimed to stabilize public well-being with the "agriculture-first" principle. This policy reformed a land system previously designed according to the hierarchy of feudalism. Consequently, the foundation of a rapidly developing national economy was grounded in an initiative to increase agriculture by boosting the number of crops per unit of area while expanding land reclamation projects, building up water facilities (thousands of reservoirs), improving seeds, and honing agricultural technique. However, this self-sufficient nation faced the paradoxical challenge posed by its success in modern industrial societies: namely, how to preserve its traditional identity.

The first modern ideology was coercively implemented in Korea after the Japanese invasion in 1910, which followed a run on the exploitable resources not available in Japan that were required to meet the demands of that country's industrial growth. During the subsequent colonial period (1910-1945), Japanese leaders designed a colonial and industrialization policy that took place over three phases, each steadily encroaching upon Korean institutions: the primary stage (1910-1919), the secondary stage (1919-1931), and the tertiary stage (1931-1945).

The primary stage (1910-1919) was designed to strengthen Japanese colonial rule by bolstering military force. At that time, an event of singular importance was the land survey project that was enacted in order to strip land ownership from Koreans. This land survey resulted in 40% of the country's farmland being taken from Koreans, given by the first king of the Joseon Dynasty, who owned non-registered land under the direction of the Oriental Development Company.

During the second stage (1919-1931), Japanese leaders changed their approach to colonizing Korea despite announcing an appeasement policy. Leaders began severely exploiting the land of the Korean peninsula as a resource supplier for maximizing economic growth in lopsided favour of Japanese interests. This process demanded the agricultural system be reshaped to meet the needs of mass production, which required the homogenization of agricultural crops and landholders. The traditional, sustainable approach to farming that had previously been practiced in Korea was deemed not competitive enough in market terms to quickly produce large agricultural yields brought about through the exploitation of cheap labour. However, the consumption of agricultural products by Koreans was almost half as much as that by the Japanese, despite the increase in crops such as rice and millet (Chung and Kirkby, 2002).

The tertiary stage (1931-1945) brought with it changes to the variety of primary industries on the Korean peninsula. In their desire to continue expanding their continental domain, Japanese leaders founded military supply manufacturers in the northern part of Korea due to its close proximity to the Chinese border. However, this development eventually outpaced itself, leading to an insufficient system of rapid growth that the Korean infrastructure could not support; consequently, Japanese leaders began looking to modernize that very infrastructure.

All three of these phases were critical in the founding of Korea's modernized industrialization. Although colonial exploitation policies were a cruel period for Koreans, the Japanese colonial era built the foundation of Korea's future industrial development.

In 1945, Korea regained independence from Japan. As the Japanese colonial period came to an end with that nation's loss in the Second World War, another colonial period began, based in economics. The benefactors of colonial hegemony in Korea shifted from Japan to the Soviet Union, China and the United States. This chaotic term led to the Korean War, which ended with the nation split in half along the 38th parallel between North and South Korea. This split reflected the fundamentally opposed socio-economic systems of capitalism and socialism. Eventually, North Korea was oriented around Soviet socialism while the southern part of Korea was dominated by American capitalism. During this time period, South Korea was governed by its first president, Rhee Syngman (이승만) (1948-1960).

To recover from the Korean War, South Korea complied fully with directions from the United States while attempting to develop its own identity. For example, according to Chung and Kirkby (2002), monetary support from foreign countries totalled some $270 million per year, not including military spending, toward the reconstruction of Korea's economic system. However,

the hidden motive for this help was to expand the USA's economic agenda for the globalization of Korea.

The historically important era known as the Yusin period (1963-1979), led by dictator Park Junghee (박정희), established the national target of achieving economic growth through a five-year plan. He also implemented a rural community development plan known as the Saemaeul Movement (새마을 운동) (Figure 2.1) to support national industrial growth while reducing the gap between rich and poor. Government selectively supported local communities, encouraging a self-regulating system driven by spontaneous cooperation while developing its own spirit of self-reliance. This helped fan the flames of the national drive toward modernization, a movement that many Koreans hoped would allow them to join the ranks of developed nations while actively driving local development as well.

Figure 2.1. Symbol of Saemaeul Movement (새마을 운동) with its memorial stamp

Although this modernization program was successful in overcoming Korea's absolute poverty, it resulted in deepening the chasm between rich and poor during the period of the long-term seizure of power by one man. Additionally, the principal benefits were to the small group of powerful individuals who had fully supported the government in its industrial development.

Chung and Kirkby (2002) also note that the state transferred economic power to rich conglomerates, called Chaebol (재벌) in Korea, for developing export-oriented national industries under Chaebol management.

The five-year plan for economic growth was grounded in a series of strong economic policies organized at the national level every five years. This "Miracle on the Han River" regime accomplished successful economic growth in the short-term by increasing demand, lowering labour costs, cultivating constant financial aid from foreign countries, and widening government-sponsored exports. Although the government aimed first with this regime to promote fiscal independence for the Korean economy, they were totally dependent on an influx of foreign capital for economic growth. This approach to modernization exposed serious contradictions inherent in Korean society, namely a deepening reliance on foreign aid and the widening gap between economic classes. For example, the fourth five-year plan for economic growth (1977-1981) was plagued by adverse effects to the plan's direction in the form of high commodities prices and a shortage of supplies. The greater consequence of this series of economic approaches was to leave Korea highly vulnerable to globalization in the market economy while also threatened in terms of its national identity.

Since the 1980s, the government has sought a stable economy as the keystone of an economic approach, aiming to minimize the side effects of growth-oriented economic policy. To accomplish this, Korean governments have imposed state intervention in the market system by means of economic liberalization, industry rationalization, and agricultural policy. In particular, this shifted the goal of the agricultural structure from self-sufficiency and staples to farmer income growth. However, this new economic stabilization policy has been reformed as a result

of outside intervention following the principles of the global economic system, and once more increasing dependence on foreign capital.

This history of Korea is critical to analyze management of Upo Wetland from a policy perspective by having an explicit recognition of the socio-ecological implications on wetland complexity.

Methodology

The theoretical framework of this study is drawn from a general literature review, in order to analyze the management policy of the Upo wetland case study. The collected information on the management policy was taken mainly from the Changnyeong County Office, the Gyeongsangnam Province Development Institute, the Korea Environmental Institute, the Nakdong River Basin Environmental Office, and the Ministry of Environment in Korea. Additional data was sourced from the Ramsar Convention, South Korea's National Statistics Office, and Water Supply and Drainage Office.

Part 1. Ecological complexity of the Upo Wetland

Ecological complexity presents complex factors of wetland management by the inherent complex properties of ecological systems, including a different understanding of ecosystems that appears between one field and the next. This circumstance has been in part to blame for the steadily increasing rate of wetland loss that has continued in spite of the high profile of scientific studies on wetlands. This results in focusing on the specific objective of protecting the whole interactive ecosystem by disregarding the inherent properties of wetland ecosystems. A case study of the Upo Wetland also seems like it will inevitably follow this general trend of research. Although the Upo Wetland has been recognized for such features as its distinctive functional linkages with surrounding areas of wetlands and farmland, most Korean government and university researchers have simplified the complex functioning of the Upo Wetland by focusing on protecting specific species, either for their ecological importance or for the development of eco-tourism. There is no single authentic source on the ecological state of the Upo Wetland. However, it is necessary to point out this stream of studies has been supplied and implemented in the management of the Upo Wetland for the purpose of sustaining human well-being with the ecosystem. Due to insufficient information about the nature of the Upo Wetland and the inherent complexity of wetlands, coupled with systematic approach and definition and classification of wetlands on the international and national level, it is understood that wetlands are complex to manage, due to their ecological complexity.

The Upo Wetland has distinctive functional features owing to its linkages with Mokpo, Sajipo and Jokjibul Wetlands as a whole, and also its connections to the surrounding farmland, the Nakdong River and other local elements. This suggests much deeper implications bound up in the management of the complex properties of the Upo Wetland.

A complex wetland system is likely to maintain and develop its ecological functioning within its capacity by adjusting to internal and external impacts. Concise descriptions of ecological complexity begin by introducing the distinctive role played by water in the Upo Wetland ecosystem. Water is the major source of maintaining and developing this role, one based in the connections between different ecosystems and the Upo Wetland. There are various ecological functions that water serves in wetlands, such as providing a habitat for diverse species with various nutrients for species including humans and a storage area for fresh water with a filtering to balance the water quantity and quality between ecosystems (Changnyeong County, 2013). Therefore, a consideration of ecological interrelationships between wetlands through water supports an understanding of wetlands as complex ecological systems. The international convention of Ramsar (1971) also recognizes the importance of water function by defining wetlands on the basis of a water depth not exceeding six metres at low tide of marine water.

The Upo Wetland, in particular, identifies the ecological function of its water as being to maintain and develop its systems through access to water flow from the surrounding environment. The diverse levels of its water supply result either from natural cycles of seasonal changes or catastrophic cycles of climate change (Changnyeong County, 2013). The majority of the water maintaining the level of the Upo Wetland comes from the Topyeong Stream (Changnyeong County, 2013). In addition, water level fluctuation occurs as a result of the Upo Wetland's connection to the Nakdong River, whose level shifts during the summer season. When the Nakdong River increases by a depth of more than 7 to 8 metres as a result of concentrated heavy rain, this increases the water level of the Upo Wetland by more than 4 to 5 metres (Changnyeong County, 2013). Such a change to water level between ecosystems significantly affects the natural cycle of the Upo Wetland, because water delivers water resources such as

nutrients, animals, and other valuable biological properties. Due to anthropocene climate change, dramatic water flow has radically limited wetland functions stemming from the alteration to the length and intensity of the monsoon and typhoon seasons (Moores, 2006). However, demand for water from wetlands shows no signs of diminishing, despite the dwindling supply of water available from the wetlands caused mainly by the drainage of water for agricultural use.

The diversity of wetland plants demonstrates the important role of water in the functioning of the Upo Wetland. Due to the flooding season in South Korea, increasing water levels in the Upo Wetland stimulate productiveness in a diverse range of plants, both land and aquatic species. Some plants have adjusted to become suited to the particular water level of the Upo Wetland through systematic processes. Wetland plants diversify according to the amount of photosynthesis to which they may expose themselves, which itself depends on water levels. When the water level increases, the water gets murkier by spreading suspended solids and floating plants (Changnyeong County, 2008). This affects the availability of sunlight for absorption by water plants, which require it for photosynthesis (Changnyeong County, 2013). After the water level has been stabilized, water plants and phytoplankton undergo the photosynthetic process while increasing the amount of oxygen in the Upo Wetland's water (Changnyeong County, 2013). Therefore, during the flooding period, the Upo Wetland maintains and develops its system with a broad range of plants. The process of the Upo Wetland plants depends on the water level. Its flora varies, boasting over 50% to 60% diversity of hydrophytes and 10% of the total number of plants in Korea (Changnyeong County, 2013). The government (Changnyeong County, 2008) classifies this diverse range of the Upo Wetland plants into four types dependent on the water level (Table 2.2):

- plants at the water's edge;

- plants with leaves above the water;
- plants under the water;
- plants floating on the water.

At the international level, the Upo Wetland has adopted the Ramsar criteria following its designation as an internationally important wetland on the Ramsar list in 1998. That list classified the Upo Wetland as a floodplain wetland, and defined wetlands (Ramsar 1971). The Upo Wetland also meets the requirements of Article 2.2 of the Ramsar convention (1971), namely that it boasts "international significance in terms of ecology, botany, zoology, limnology or hydrology, [as well as] international importance to waterfowl at any season."

Additionally, it is included within the Ramsar list of internationally important wetlands. As a result, the Upo Wetland falls under the following Ramsar criteria:

- 1b (the site is one of the largest inland wetlands in South Korea and boasts well-preserved native species on site),
- 2b (the site maintains a broad range of biodiversity from rare to
- common species in biological and genetic context),
- 3b (the site provides cultural services), and
- 4b (the site functions as an important fish habitat by providing food and spawning places).

At the National level, South Korea divides wetlands into inland and coastal wetlands under the Wetlands Conservation Act of 1999. The Upo Wetland belongs to the category of inland wetland, and is also classified as a riverine wetland due to its formation and location near the Nakdong River. The largest area of inland wetland is a rice-filled area in South Korea, despite its having functional constraints as ecosystem.

However, these functional properties of understanding inherent complexity of Upo Wetland have been reduced to the simplest form of ecological function in the focusing on preservation of such as specific species in the Upo Wetland. Since 2000, over tens of thousands of migratory birds have reached the Upo Wetland due to the destruction surrounding other principal habitats, such as Eulsukdo (을숙도) in Nakdong River (Kang et al., 2007). Therefore, the international Ramsar Convention recognized the value of the Upo Wetland in 1998 by registering it as an internationally important wetland for its important role in preserving a biodiversity habitat especially for migratory birds. In addition, this habitat is particularly important because of the location of the Upo Wetland in the intermediate route between East Asia and Australia, and also because it provides a clear four seasons per year for supporting habitual functions beneficial to migrating fowl. For example, winter and summer migratory birds come to the Upo Wetland for survival in order to escape intense environments (Changnyeong County, 2013). Therefore, the Upo Wetland is able to provide shelter that meets the seasonal needs of migratory birds flying between North and South (Table 2.2).

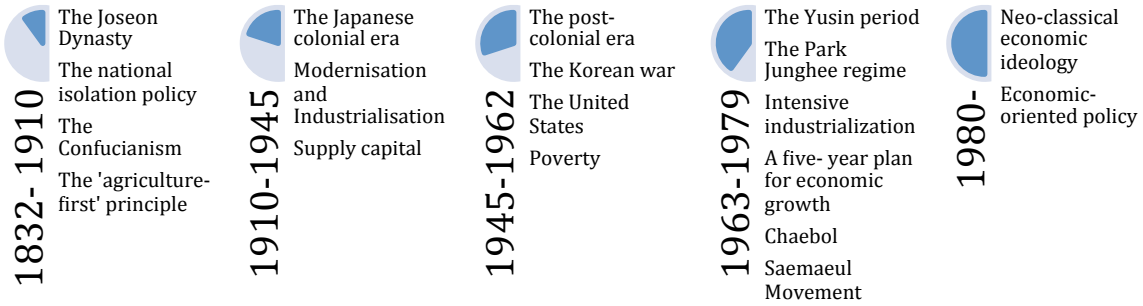
Table 2.2. Summary of the species, including endangered and rare species, of the Upo Wetland (Adopted from Gyeongsangnam Province Development Institute, 1997 and Changnyeong County, 2013).

Including endangered, threatened and rare species Total Number of species 342								
Species	Birds	Fish	Mammals	Reptiles	Amphibians	Mollusks	Plants	Arthropod
Number	62	28	12	7	5	5	168	55
Detail	Winter (25), Summer (16), Throughout the year (21)	Native and/or Invasive	-	-	-	-	Plants at the water's edge, with leaves above the water, under the water, and floating on the water	-
	Anas falcata and Anas Formosa, Platalea, and etc.	Snake head ("Tyrant of freshwater"), Crucian carp, Catfish, and etc.	-	Turtles (Reeves' turtle, Muljarus japonicus, and etc.	-	-	Prickly lotus (Gasiyeon, Thorn lotus, and etc.	Diving beetle, Water Strider, Gaeajaebi, Horn dragonfly, and etc.

Part 2. Economic complexity of the Upo Wetland

Environmental issues have gradually increased in importance to the point that they are, today, recognized as integral matters that must be managed and addressed in a variety of different fields. In Korea, this shift has been derived from the historical transition of the era of industrial development. During the Joseon Dynasty period (1832-1910), the king upheld a national isolation policy intended to protect a self-sufficient economy from interference by foreign forces. Since introducing industrialization during the Japanese colonial period (1910-1945), the Korean government has unconditionally pushed for national development, mainly in the service of economic growth.

Figure 2.2. An outline of key events, characteristics and facts of Korea history since the Joseon Dynasty.



Within an anthropocentric milieu, there are difficulties with integrating an economic approach in ecological management due to the disciplinary differences with current ecological and economic paradigms - the economic system denies subordination to the ecosystem, instead promoting limitless growth to fulfil anthropocentric benefits (Daly and Farley, 2010). In addition, there is a limited economic value for ES within the market system. Therefore, this leads to trade-

offs among ES, with a focus on the specific types of ES (mainly provisioning ES) that meet the needs of the economic system.

ES have been underestimated in their value in wetland management, despite playing a vital role to humans. There are two fundamental reasons for this; incomplete information regarding ES, due in part to ecological complexity, and the effects of the market system in the Anthropocene. The market system does not provide a means by which to conceive such an intangible factor as ES in monetary terms—particularly due to its ambiguous borders—thereby leaving it impossible to value and therefore absent from most cost-benefit analysis. However, the Korea Environmental Institute (2008) has estimated the entirety of ES in monetary value per unit area of inland wetlands among Han, Yeongsan, and Seomjin River (Table 2.3).

Table 2.3. Categorization of the monetary value (dollar/ha) of inland wetlands among the Han, Yeongsan, and Seomjin River, by each ES with specific wetland function (Adopted monetary data from the Korea Environmental Institute, 2008).

ES	Function		Han River (dollar/ha)	Yeongsan River (dollar/ha)	Seomjin River (dollar/ha)
Regulating ES	Water purification		380,421	48,363	310,953
Supporting ES	Habitat	Commercial fish	411,818	52,355	336,656
		Non-commercial species	229,796	29,214	187,833
Cultural ES	Leisure or aesthetic		25,363	3,225	20,732
Provisioning	Marine production		460,577	58,554	376,471

ES	Function	Han River (dollar/ha)	Yeongsan River (dollar/ha)	Seomjin River (dollar/ha)
ES				
Related with the whole ES	Indirect uses	123	16	100
	Non-usuable value	565,326	71,870	462,091

Ecosystem Services (ES) provided by the Upo Wetland are classified into regulating, supporting, provisioning, and cultural ES, all of which contribute to human well-being.

The first of the ES provided by the Upo Wetland is regulatory services, composed of systematic biological processes that have an impact upon both the inner life of the ecosystem and the external geography and environments. These services help regulate the health and condition of the wetland. The role of regulating services varies with the scale of internal and external impacts upon the wetland transition. These services result in either maintaining or developing the Upo ecosystem, with benefits like providing a highly suitable condition for some species at certain stages of life. Therefore, they maintain and develop the ecosystem in various circumstances, supplying human society not only with regulating services but also with other valuables. The Upo Wetland provides such regulating ES as flood control, water storage, water purification, and others. These services play an important role in the Upo Wetland's bio-geophysical characteristics, bearing distinct properties due to the variance in seasonal differences that result from being its surrounded on three sides by sea. The locale generates concentrated heavy rain, which causes intense flooding from the Nakdong River as well as water shortages to local communities. This seasonally concentrated flooding plays an important role in the rich

biodiversity that the wetland provides among its regulating ES. A high diversity of ecological characters supports other ES and vice versa. For example, the high diversity of plant species (regulating ES), such as reeds, cattails, and irises, in the Upo Wetland purify water (regulating ES) contaminated from human use. Accordingly, these processes benefit water and food supplies (provisioning ES) while providing supporting and cultural ES. This array of benefits pays dividends to the whole ecosystem, including human society, with which it is interconnected. Were it not for flooding, the Upo Wetland would be dramatically reduced in its area - which would result in reducing an entire and integral set of ES, which would have the consequence of threatening human well-being (Changnyeong County, 2008).

However, despite the highly valuable services generated as a result of summer flooding, the extent of that flooding has been severely decreased by projects such as construction on the upper region of the Nakdong River. Having less flooding reduces regulating services and leads to an overall decrease in the array of ES (supporting, cultural, and provisioning ES) that support human well-being. In addition, the contamination of the Upo Wetland is mostly the result of unconditional pursuit of anthropocentric benefits (Changnyeong County, 2008). This has led to a reduction of the scope of the Upo Wetland. The quality of water has deteriorated despite an increasing need for water from Changnyeong County (Changnyeong County, 2013). This is mainly due to an increasing amount of chemical fertilizers and other agricultural chemicals used in surrounding farms, though it also relates to the number of livestock being raised on those farms, as well as environmental pollutants emitted by facilities engaged in industrial development. Changnyeong County tried to ameliorate this issue by extending sewage facilities toward a length of 242,533m in 2011 (Water Supply and Drainage Office, 2011). However, this effort is different from considering the fundamental causes of water issues, disregarding the

regulating services provided by the purification of wastewater in the Upo Wetland. Contaminated water travels along the Nakdong River and passes through it into the Upo Wetland. Therefore, the regulating ES of the Upo Wetland are critical not only for their single function of direct benefit to the wetland itself, but also because they are interconnected with other ES that serve the whole surrounding ecosystem.

The second set of valuable ES provided by the Upo Wetland is supporting services -those services that support the functioning of other services. Supporting services help with regulating services by means of maintaining a functioning habitat on the Upo Wetland, which provides as safe habitat for fish, and a place for aquatic birds to spawn and nurture their young. In particular, many migratory birds feed on the diverse plants in the Upo Wetland in winter. However, as with regulating services, support services face the same challenges of being beyond the scope of measurement within the market system. Therefore, they remain likely to be overlooked as important criteria to be managed in the Upo Wetland.

Thirdly, provisioning ES are those by which the Upo Wetland is directly beneficial for human well-being. These ES reveal tangible benefits such as clean water that meets the needs of human consumption. Therefore, it involves an excludable right to consume without permission. Provisioning ES are mainly estimable in monetary terms, but some forms of provisioning ES — such as fish and water—are hard to regulate the consumption of, despite their being in tangible form. This problem exists simply because nature has ambiguous boundaries, which would be used to exclude the consumption of others. Provisioning services benefit farmers, who compose 42% of the total Changnyeong County population, and call upon the provisioning services of the Upo Wetland to conduct their agriculture, forestry and fishery industries (South Korea's National Statistics Office, 2011). The region's main agricultural crops are rice, wheat, barley, and

miscellaneous grains. Provisioning Ecosystem Services must be given careful consideration in the management of the Upo Wetland because the majority of Changnyeong County's policies are driven by the pursuit of economic interest. National statistics data note that the fourth highest economic benefit in Changnyeong County resulted from the agricultural industry, which yielded 32,701 tons of rice from a cultivation area of 6,505ha (South Korea's National Statistics Office, 2013).

Cultural ES have likewise provided essential socio-economic benefits for the local community since the beginning of the Upo Wetland. Without the Upo Wetland, present-day society in nearby communities would have been very different. Cultural services provided by the Upo Wetland are closely related to the local community: they appear in the forms of recreation, tourism, education, religion and related institutions. Although such benefits are intangible, they must be considered as important ES to be managed, bringing with them the possibility of providing economic benefits to the local community by enacting exclusionary policies that prohibit other consumers from enjoying them except at a price. However, most communities related to the Upo Wetland do not have the right to such policies, as central government maintains control. According to the report of the Upo Wetland management office, in 2011 Upo had 103,000 visitors, who spent $115,385 to enter the park - in return, the wetland provided superb natural scenery (Changnyeong County, 2013).

According to the national statistics office in 2011, the economic activity rate of Changnyeong County is about 62.5% and its estimated Gross Regional Domestic Product (GRDP) accounted for $1.6 billion through 17 economic activities. These include agriculture, forestry and fishery, mining, water supply, and leisure related service industries, among others. The fourth-highest contributor to the GRDP is the agriculture, forestry and fishery industry,

amounting to roughly $180 million in 2011 (South Korea's National Statistics Office, 2011). On the one hand, the County spent nearly $2 million out of its general accounts for environmental protection (South Korea's National Statistics Office, 2011). In 2011, the province had special funds of about $36 million to spend on improvements to water quality (South Korea's National Statistics Office, 2011). On the other hand, despite these efforts and expenditures to protect the environment, 2011 national statistics data show that between 2009 and 2011, Changnyeong County has been mainly promoting industrial development in the region, according to local policy.

Part 3. Institutional Complexity

Formation and Development of Korean Environmental Policy

Environmental problems are greatly bound up with previously unresolved problems. The consequence of this is eventually likely to reach a point of crisis that threatens life on earth from the small to the large scale. Since Japan colonized Korea as a material supplier for their industrial growth, Korea has participated in neo-classical economics to achieve remarkable progress. Such growth has involved indefinite consumption of natural resources and the generation of waste requiring disposal.

Until the period of the Joseon Dynasty, Korea's environment was well-retained and stable, with an agricultural culture embedded in a geography of naturally occurring energy and resources. For example, Koreans used natural fertilizer instead of commercial fertilizer, and oxen to plow the soil instead of agricultural machines (Chung and Kirkby, 2002). It was only with the Japanese invasion and that country's colonial insistence on speeding production and resource extraction that the first industrial approaches to agriculture were introduced in Korea (Chung and Kirkby, 2002). The consequence of industrialization is that soil, and therefore regulating and supporting ES, was radically impacted by the introduction of chemical fertilizers and pesticides (Chung and Kirkby, 2002). Additionally, for the purpose of military and industrial expansion, Japanese destroyed almost 72% of the Korean mountains through extraction of raw materials such as minerals and timber (Chung and Kirkby, 2002). Although the industrial infrastructure was founded during Japanese colonization, environmental destruction has only accelerated.

After its period of independence from Japan, Korea moved into a new colonial era of neo-classical economics with a Japanese industrial foundation, which led to the rise of a conglomerate operating in heavy and chemical industry. Because of their political power,

Chaebol essentially ruled the nation in a neoliberal competition state (Chung and Kirkby, 2002). At the same time, central regulation supported growth in export-oriented industries, ranging from heavy industry to chemical manufacture. The large amount of fossil fuels involved in the operations of those industries resulted in acid rain and pollution becoming widespread among the nation's rivers and coasts (Chung and Kirkby, 2002). The quality of the air and water drastically deteriorated as a result of this indiscriminate economic-oriented development.

Along with continuous economic growth, self-regulated communities adopted to reduce the income gap between industrial and agricultural population by increasing agricultural production through the use of unregulated chemicals. This trend accelerated environmental pollution and generated financial difficulties for local farmers, who became dependent on those agricultural chemicals (Chung and Kirkby, 2002). In addition, Chung and Kirkby (2002) note that industrial-oriented development—namely the construction of 14 multi-purpose dams and the use of inefficient energy sources like coal and oil—resulted in a decrease in ES offered by water and air.

Although there was market-oriented regulation, and the "polluter pays" principle encouraged the public to understand having a functioning and healthy environment as a right, the government continued to disregard public rights in the interests of economic growth. The environment was simply not considered as a priority in Korean national policy (Chung and Kirkby, 2002). Therefore, the state of environmental pollution in Korea reflects the history of an economic-dominated ideology that believed exploiting natural resources was its chief priority.

Korea's first environmental policy was announced by a central government in 1963 (Table 2.4). Despite having heard continuous public concern on the subject of environmental pollution, the government neglected the seriousness of this matter in its zeal to focus on

industrial development. As public concern became more intense and widespread over time, the government enacted environmental policies promoting continuous industrial development driven by tremendous energy consumption (Changnyeong County, 2013). In particular, during the Yusin period, national policy considered public well-being irrelevant at the same time as it was enshrining industrial development that was destroying the environment (Chung and Kirkby, 2002).

After a long period of military dictatorship, a new era of Korean democratic government started strengthening its institutions in order to attempt to mitigate environmental contamination. However, the government avoided changing policy in any way that would hinder economic growth, while at the same time undervaluing not only environmental preservation but also public well-being. The state placed emphasis on increasing economic growth rather than on promoting public prosperity in a manner that coincided with reduced environmental deterioration (Chung and Kirkby, 2002). The continuing privileging of economic gains is reflected in the process of formation, development, and management of environmental policy which occurred as part of a top-down regulation imposed by the state.

First, the integrity of the issue of environmental policy has likely been distorted through the confirmation process leading from the Economic Ministers' Meeting to the President such as the four-river project. Second, environmental policy regimes are enacted by various ministries, each with their own authorities and different policies and approaches to policy. This increases the complexity of managing environmental issues and likewise increases confusion by transferring responsibilities from the central government to private individuals. This policy infrastructure encourages both private individuals and government to abandon environmental responsibility toward consumers despite the large proportion of environmental problems

generated from industrial development. Finally, the issue of environmental policy is a source of pressure from other countries with an increasing awareness of the importance of regulating pollution such as the yellow-dust storm phenomenon between China and Korea. However, the fundamental purpose of Korea's environmental shifts has been to expand economic-oriented relations featuring environmental intervention in policy and institutions. Therefore, environmental management is mainly determined by the economic-orientation of the state of Korea.

The principle of economic-growth-first is deeply ingrained in global society. At the pace at which Korea pursues this trend, it seems as though little stands between the nation's industrial growth and the destruction not only of the environment but also human existence. However, international forces have been influential in establishing and modifying formal policies such as the mandate for the independence of the Korean Ministry of Environment (MoE) when responding to their objectives such as economic benefits. With that change, the government acknowledged the importance of solving environmental issues, at least in forms of marketable resources such as water, and based on marketable approaches such as the Effluent Charge System, the Waste Disposal Deposit System, and the Environment Improvement Charge system. However, the consequence of this regime - in the form of economic penalties, subsidies, and incentives - has been insufficient to reduce environmental problems in Korea.

Table 2.4. Summary of the formation and development of Korean environmental policy, including wetland policy (Adopted from Chung and Kirkby, 2002 and Changnyeong County, 2013)

In 1933, designated as a natural monument number 15 under the cultural policy of protecting law for historical site by Japanese In 1962, Upo wetland designated as migratory birds' nesting ground In 1963, the Pollution Prevention Act 1977-1979, the Environmental Preservation Act & the Marine Pollution Prevention Act The Environmental Preservation Act; Environmental standards- Emission charge system Environmental monitoring Emission standards and control Various administrative sanctions for violations Environmental Impact Assessment (EIA) The Solid Waste Management Act - The beginning of the 1990s, replaced the Environmental Preservation Act to subdivision into; The Environmental Policy Foundation Act The Air Environment Preservation Act The Water Environment Preservation Act The Noise and Vibration Control Act The Hazardous Chemical Substances Control Act The Environment Pollution Damage Dispute Co-ordination Act In 1980, the introduction of the Office of Environment (OoE) as a sub-cabinet agency of the Ministry of Public Health and Social affairs - In 1990, replacement of the Office of Environment (OoE) with the Ministry of Environment (MoE) In 1987, the introduction of the Long Term (1987-2001) Comprehensive Plan for Environmental Preservation

- In 1991-1996, replacement of the Long Term Plan with a medium-term plan

In 1990, Declaration of Environmental Conservation (1990)

In 1992, National Environmental Policy (1992)

In 1988-1997, Environmental Management Act

In 1993, Upo wetland designated as ecosystem monitoring area

In 1997, Upo wetland designated as Ecological Conservation Area

In 1998, Upo wetland registered as internationally important wetland list for ecosystem protection and view preservation by the Ministry

In 1999, Wetland Conservation Act

- In 2002, the National Ecological Network Strategy

Institutional complexity of the Upo Wetland

With limited ecological and economic state management of wetland ES, there are various approaches to deal with the complexity of wetlands at different levels of society. There are institutions with command and control, community-based, and market-based approaches to solve environmental issues, each with different rules for pursuing determined objectives on different scales of society. However, the issues of management practices are highly focused on either single or specific wetland ES, with gaps between different groups concerned with different socio-ecological values of wetland ES. To reduce the negative impacts of this, the characteristics of ES and the cross-societal means of property rights are considered in respect of the socio-ecological implications on wetland ES management, on national, community, and individual levels.

Wetlands in Korea, covering an area of around 336.610 km^2, are formally managed by two central governments and one local government: inland wetlands by the Ministry of Environment (MoE) (117.126 km^2) (MoE, 2014), coastal wetlands by the Ministry of Land, Transport and Maritime Affairs (212.850 km^2) (MoE, 2014), and three individual wetlands by a

surrounding local government (6.634 km^2) (Changnyeong County, 2008). Along with international concerns, the inland Upo Wetland (hydrated area 2.31 km^2, 8.54 km^2 total area) is managed by the central government of MoE in cooperation with the local government, Nakdong River Basin Environmental Office, and Changnyeong County (Changnyeong County, 2013). However, the state has specified the main stakeholders managing the Upo Wetland as three private activists, three private organizations, and the local government of Changnyeong County, all done in an effort to decentralize the responsibility from MoE (Changnyeong County, 2013).

On a national level, the Ministry of Environment (MoE) has rooted its authority over wetlands management in the pursuit of economic benefit. The Upo Wetland reveals one of the country's environmental policy directions. Since Korea initiated a narrow perspective of wetland policy in 1962 based on preserving single species of migratory birds (Changnyeong County, 2011), there was a push to cultivate the area surrounding the Upo Wetland to increase agricultural production for developing Japanese industries in the 1960s (Changnyeong County, 2011). Then, government, through its arm of the Agricultural Development Corporation, conducted massive land conversion on the Upo Wetland, to accomplish national industrial development in 1978 (Changnyeong County, 2011). In 1993, the Upo Wetland was designated as an ecosystem-monitoring area during the construction of a waste disposal site on the Ibang-myeon (Changnyeong County, 2011). In 1998, the Upo Wetland achieved an internationally important position to its inclusion on the Ramsar Convention's list, and the drive to protect its ecological and scenic values (cultural ES) was encouraged by international pressure. Since 1999, wetland management has been expanded under the legal policy framework of the Wetland Conservation Act (WCA). The Upo Wetland management complies with this regulation by designating a wetland protection area, a surrounding wetland management area, and a wetland

improvement area. The WCA contributes to the promotion of international cooperation by efficiently conserving and managing wetland, cultivating biodiversity conservation, and reflecting international agreements on wetland management.

The central government agency MoE has developed the Upo Wetland policy using the process of a top-down regulation, command and control institution. It aims at promoting efficient wetland preservation in the midst of international economic pressure. Since being registered on the Internationally Important Ramsar wetlands list in 1998, the Upo Wetland has seen its management developed in the form of a central policy. In order to efficiently manage it, the MoE has planned to purchase the privately-owned Upo reservoir, and regulated pesticide use on the reservoir to preserve regulating services of high biodiversity and water purification. The MoE allowed local government to spend $80 million to buy 1,458,492m^2 of private property for conversion to public property in the area of Upo Wetland reservoir (MoE, 2014).

However, this state centered-regime opposed individual local farmers without considering them in the policy-making process. For example, MoE allows only thirteen local farmers to fish in the wetland. To reduce local farmers' strong opposition, central government has allowed the local government to apply an environmental ranger system to monitor disruptive activity from local residents by imposing a penalty on such things as fishing or agricultural pesticide disposal. In addition, the central government has pursued the local government to establish "the Upo Wetland Ecosystem Pavilion" in order to raise awareness of the value of wetlands, especially among locals.

At the community level, there have always been strong movements in community organizations throughout the history of Korea (Chung and Kirkby, 2002). Korean environmental management is also grounded in community participation in an agricultural-based lifestyle, in

Confucianism, and especially in the regional development plans put in place during the Yusin regime (Chung and Kirkby, 2002). Since a nation historically curtailed of their privileges tends to suffer equally under military dictatorship (Chung and Kirkby, 2002), communities have developed since the shift to democracy eager to guide governmental decisions and encourage individual participation. Although the MoE still holds primary authority over management of the Upo Wetland, the wetland is mainly administered by local governments, including the Nakdong River Basin Environment Office and Changnyeong County (Changnyeong County, 2011). Central government has passed its regulating power down to the Nakdong River Basin Environment Office, in order to generalize administration of the Upo Wetland.

In accordance with the Wetlands Conservation Act, the Nakdong River Basin Enivronment Office governs a restricted and prohibited area of approximately 3,101,430m^2 in order to prevent accelerating the destruction of the Upo Wetland, while also regulating safety concerns brought about by the increasing number of visitors attracted by cultural tourism (Changnyeong County, 2011). Areas have been registered for the Sajipo (512,649.4m^2), Upo (1,878,916.2m^2), Mokpo (556,996.6m^2), and Jokjibul (152,867.9m^2) wetlands (Nakdong River Basin Environmental Office, 2013). In addition, local government makes it a rule to promote sustainable use within the area under the Wetland Conservation Act, and monitors the whole area of the Upo Wetland throughout all four seasons of the year (Changnyeong County, 2011).

The other local government to whom the management of the Upo Wetland was passed down from the MoE is Changnyeong County, which is in charge of purchasing private property, and employing guards to prevent illegal fishing. As a result of this local management arrangement, the Upo Wetland was the only wetland charging fines for illegal activity, such as fishing within the wetland conservation area, between 2003 and 2007 in Korea. Also, this local

government grasps the importance of the region's wetland conservation areas, and has encouraged recognition of the national importance of wetland conservation for its wide variety of values, especially the cultural ES of Upo Wetland. Therefore, this local government operates "the Upo Wetland Ecosystem Pavilion" in order to increase awareness of the cultural ES of Upo Wetland.

On the one hand, community-based organizations have not had as great an impact as they've wished on wetland policy decisions, despite many boasting an array of expertise and on-site experience in wetland management. This limited impact is a direct result of being neglected by central government (Changnyeong County, 2011). In addition, attempts to enforce wetland management policies have faced challenges resulting from the conflicting interests of different government departments such as the MoE, the Ministry of Construction and Transportation, and the Korean Forest Service. On the other hand, however, the Upo Wetland is designated as important by the Ramsar list in to preserve its expansive ecological value, which has consequently put the international Ramsar Convention into partnership with the MoE and Korean environmental movement organizations, despite opposition by local residents who see wetlands preservation as in contrary to their monetary interests (Changnyeong County, 2013).

At the individual level, local residents have existed within the ecosystem of the Upo Wetland alongside all the salient events of Korean history. The Upo Wetland is closely interwoven with details of local life and has long been associated both with supporting local livelihoods and with maintaining local individuals' identities within the context of their place of residence. However, the MoE (2014) noted that local individuals residing in the area surrounding the mouth of the river are succeeding economically not through development of the Upo Wetland but rather through agriculture. Therefore, they have attempted to induce local residents to

become supportive of wetland management and to recognize its monetary benefits, such as institutional compensation and the economic effects deriving from eco-tourism.

In spite of these policies, some local residents continue to engage in indiscriminate fishing and agricultural practices that do not comply with the policy (Changnyeong County, 2011). Although one of the legal considerations is improving the quality of local residents' lives under the WCA (MoE, 2013), the right to maintain a clean supply of ES on the Upo Wetland has been impeded by interference from central government. The reality is that central government through MoE debilitates ES by means of abusing its privilege of prohibiting subsistence levels. Although most of the Upo Wetland is privately owned by locals, except its reservoirs, livelihood rights derived from ES are hindered in order to comply with both community (cultural ES such as eco-tourism) and national (regulating and supporting ES such as water quality and biodiversity) demands for of wetland management. This threat to local farmers' and fishers' livelihoods results in an exacerbation of existing prejudices toward the MoE, community government (Changnyeong County), and toward the international Ramsar Convention.

The inclusion of local residents in management decisions remains critical in order to foster an atmosphere of coexistence that will reflect widely on other social levels. With that in mind, local residents are important stakeholders in efficiently managing the Upo Wetland through the accumulation of their experience and knowledge.

Since the beginning of the Upo Wetland, it has supplied a wide range of benefits (ES) to human well-being such as the high biodiversity by nature of its shallow water and the seasonal impact of summer flooding (Changnyeong County, 2008). Although nothing much has changed in its situation, its existence has been gradually more seriously threatened by several factors, such as shifting values of ES function in management. Upo Wetland management is tied closely

with the concerns and lifestyles of local residents because changes to the wetland affect their lives directly. However, its socio-ecological importance has also been expanded to reflect the interests of community, national, and international groups. For example, the Ramsar Convention has its own criteria with which to decide whether a wetland is internationally important enough to be included on its list. The Upo Wetland satisfies these criteria in 1998 due to its nationally unique geography, its place as a stop for more than 20,000 migratory birds, its usefulness as a habitat for fish, and other reasons. Yet for local residents considering the region on an individual level, the value of the Upo Wetland seems different from that which it holds from an international perspective, largely because it, in its proximity to human habitat, has been a part of their geography and traditions throughout history and for the entirety of their lives.

Chapter 3. Discussion and alternative policy approaches

Part 1. Discussion

Over the past decades, ecological management has been included in policymaking as it focuses on the importance of ecosystem functions to human well-being (De Groot, 1987; Turner and Carpenter, 1999). However, the complexity of environmental issues makes it difficult to establish a common criterion in decision-making processes, due to the complex properties of wetlands and diverse stakeholders' combined interests and various value-articulating institutions (Vatn, 2005). Therefore, a new environmental policy institution is required to meet each level of stakeholders' desires and interact to achieve their ultimate goals with respect to the nature of ES. However, most wetland research projects have only attempted to respond to the socio-ecological complexity of wetlands by focusing on either ecological, economic, or institutional complexity in isolation.

Despite many approaches to understand wetland ecosystems, there still is insufficient information to manage wetland ecosystems from a complexity perspective (Finlayson and Rea, 1999; Hahn et al., 2006). This is due to an increase in the understanding of ecological complexity not only by its' inherent nature but also by its' characteristics depending on the different contexts of understanding and knowledge forms. There are various approaches to understanding wetland ecosystem complexity, from species diversity to energy flow analysis of wetlands, as will be seen in what follows.

Some approaches focus solely on single objectives within determined fields such as hydrological processes to establish the mechanistic modeling of wetland complexity (Golden et al., 2014), and the genetic diversity of aquatic plants to assess the impact on ecological wetland restoration (Oudot-Canaff et al., 2013). In the same vein, other approaches focus on several

objectives such as hydrogeomorphic processes and vegetation responses to assess the level of human impact on ecological wetlands (Kotze et al., 2012), and the abundance and diversity of the bird and macroinvertebrate communities to assess the ecological integrity of wetlands (Getachew et al., 2012). Still other approaches are a systemic accounting of wetland complexity. For instance, Chen et al. (2011) adopt cosmic exergy as a thermodynamic metric to assess the purifying wastewater function (Regulating ES) of wetlands. Li et al. (2013) apply spatial resilience to assess wetland function in ecological sensitivity, water quality, and vegetation cover in order to categorize wetland governance. Kim et al. (2006) develop a classification and mapping system of Korea wetlands, by adapting international criteria of wetland classifications and mapping systems to wetland characteristics in Korea.

These narrow approaches are weak in understanding the complexity of wetland ecosystems that increases the intricacy of managing wetlands not only due to their inherent complexity but also due to different and often conflicting understandings of wetland ecosystems. The primary issue is that high-profile studies on wetlands have mainly disregarded the inherent properties of wetland ecosystems, by focusing on single objectives to protect the whole ecosystem (Yashiro et al., 2013).

Second, wetland loss still takes place mainly due to the irreconcilable differences between ecological and economic fields. Economic complexity disregards the fundamental limits to energy and matter flow from ecosystems, to satisfy an ever-increasing growth of the economic system for fulfilling limitless human needs (Daly and Farley, 2010). Arrow et al. (1995) describes these finite ecosystem functions producing goods and services for economic growth in terms of the limited “carrying capacity” of socio-ecological systems. Furthermore, Daly (1985) finds this biophysical limit to be one of the major flaws of standard neoclassical economics for

growing economic systems. In addition, Daly identifies failure to place limits on economic growth by insufficient accounting for future generations, animals, the paradox between individual income and happiness, and the various individual impacts such as culture and education upon the economic system, which are called "ethicosocial limits" (Daly, 1985).

Ecological management places a large emphasis on an economic approach which either focuses on only tangible forms of ecosystem benefits or individual preferences despite its impact on others' well-being (Costanza et al., 1998). Economic valuation has a limited capacity to address the multi-dimensional benefits derived from wetlands as it only focuses on marketable forms (marginal values and/or prices) of ecosystem output (Barbier et al., 1997; Wilson and Carpenter 1999; Turner et al., 2000; van den Belt et al., 2011). In other words, a market system is blind to the wide range of ecosystem values. Despite acknowledging this narrow perspective of economic value, there are various approaches that allocate value to ES for either marketable or nonmarketable benefits of wetlands. The narrow perspective leads to an anthropocentric conceptualization of trade-offs among ES followed by a narrow understanding of economic value from a marginalist approach (Holling and Meffe, 1996; Limburg et al., 2002; Rodríguez et al., 2006; Polasky et al., 2011).

For example, Sathirathai (1998) and Barbier and Strand (1998) focused on evaluating the economic loss of provisioning ES by human needs, despite acknowledging the habitat functions of breeding and nurseries for fisheries (Supporting ES). Sathirathai (1998) values the economic loss of mangrove provisioning ES (shellfish and demersal fish) by deforestation in Surat Thani Province in the Gulf of Thailand, through the Ellis-Fisher-Freeman model from US$0.33 to $11.10 per km^2. Barbier and Strand (1998) estimates the loss of provisioning ES (shrimp fishery) in a declining marginal area (km^2/ year) of mangroves by over-exploited fisheries in the Laguna

de Términos of Campeche through a comparative statistical analysis and arrives to a cost of about US$140,000 km^2 per year. There are those focusing on single regulating ES but also disregarding bundled wetland ES such as Grossmann (2012), who adopts the indirect method of a cost-minimization model to value shadow price of phosphate and nitrogen nutrient retention (regulating ES). In addition, Cardoch et al. (2000) apply an avoided economic cost analysis for estimating wastewater treatment functions (regulating ES) between dissolved air flotation (DAF, about $208,000/year) and wetland treatment (about $63,000/year). Furthermore, Ming et al. (2007) calculate the flood mitigation function of wetland soils (Regulating ES) by quantitative analysis, and van Roon (2012) finds the importance of managing peat wetlands due to the regulation of ES (Biodiversity and Carbon sequestration). Leauthaud et al. (2013) understand that the process of water depletion impacts water availability (Provisioning ES) for residents' livelihoods, and for the local food production system responsible for their well-being. Dobbie (2013) finds the need of wetland management for both provisioning ES (freshwater) and cultural ES (aesthetic benefit).

Third, the alarming rate of wetland loss increases institutional approaches rooted in various value systems and knowledge of wetland decision-making processes. However, the majority of wetland policy is framed according to mainstream economics, rather than focusing on the multi-disciplinary aspects of socio-ecological complexity of wetlands (Costanza et al., 1998). There are three types of institutions used to know how existing institutions manage environmental issues using different rules for pursuing specific objectives. Case studies of wetland ES management identify the issues of management practices by focusing on either a single ES, or a particular social scale.

For example, Yi and Nam (2008) suggest designating forest wetlands at Sinbul Mountain in Korea as a wetland conservation area by means of a command and control institution, to conserve the ecological value of wetland plants. Thompson et al. (2003) implement community-based fisheries management (CBFM) - including a government agency of the Development of Fisheries (DOF), five NGOs, and an international research center of WorldFish Center - to improve fishery participation for sustainable management of provisioning ES (fisheries) in the Bangladesh floodplain. Setlhogile et al. (2011) apply a total economic valuation approach to estimate a single direct value (tourism, cultural ES) and indirect value (groundwater recharge, regulating ES), through the community-based natural resource management (CBNRM), and Namaalwa et al. (2013) suggest the sustainable use of provisioning (water and land use for agriculture), regulating (biodiversity), and supporting Namatala wetland ES by community-based institution, in order to have horizontal and vertical incorporations with different socio-ecological values between national ministries, local governments, and local communities in Uganda. Heberling et al. (2010) supply incentives to agricultural producers for wetland restoration and creation, in order to reduce nutrient runoff within water quality trading (WQT) programs. Mombo et al. (2014) apply payment for ES (PES) to sustainably manage wetland regulation, and provisioning of ES of water from the deforestation produced by rural communities in catchment forests in Tanzania. In addition, Fernandez (1999) suggests providing economic incentives to protect and restore the supporting and regulating ES (biodiversity) of wetlands, within the Habitat Conservation Plan and Wetland Mitigation Bank policies.

Part 2. Alternative policy approaches

Policy management of the Upo Wetland is analyzed to comply with the socio-ecological implications of wetland complexity, understood as ecological, economic, and institutional complexity. The complexity of managing wetlands increases not only due to the lack of explicit understanding of the inherent characteristics of wetland ecosystems, but also due to human interventions in wetland management within the anthropocentric milieu. To comply with the socio-ecological implications of managing wetland complexity, the analysis of Upo Wetland policy management introduces "a nested institutional approach" (Yashiro et al., 2013), managing a bundle of ES through institutional cooperation.

There is a lack of explicit understanding of the inherent complexity of the Upo Wetland. It has distinctive ecological functions linkages with other wetlands (Mokpo, Sajipo, and Jokjibul wetland) as a whole and with a wide range of connections to other environments, such as water flowing from the Topyeong Stream and Nakdong River. In addition, there are different understandings of inherent complexity of the Upo Wetland which appear between one field and the next, such as those simplifying the complex functions of the Upo Wetland ecosystem by focusing on water, plants, and specific species. Although there is insufficient data to explain the ecological state of the Upo Wetland with regard to the ecological complexity of the ecosystem, the Korean government considers the Upo Wetland as being a well-preserved ecosystem only in terms of its high biodiversity (including endangered species), and its natural monuments (Changnyeong County, 2013).

Along with such ecological complexity, social complexity remains likely to aggravate difficulties in wetland management because the majority of prior policies were economic-growth-based, founded on misconceptions about a fundamental interrelation between ecosystems

and economic systems (Daly and Farley, 2010). Such approaches are likely to miss the fundamental problems involved in attempting to maintain and develop economic systems on the backs of ecosystems, and in turn will tend to simplify the view of a number of complex wetland ES by trade-offs among ES (Polasky et al., 2011). MA (2005) underlines that these benefits come in the form of the previously defined ES. However, a bundle of ES, including provisioning, regulating, cultural, and supporting ES, have had their value underestimated in wetland management despite playing a vital role to ecosystems as well as to humans. It is due in part to ecological complexity, and also the effects of the market system within the anthropocene limits of economic value.

A historical transition in Korea has been taking place throughout the era of industrial development since the Joseon Dynasty period (1982-1910). The Upo Wetland has provided large numbers of benefits to human society while balancing the need to maintain and develop its complex ecological system. With concentrated heavy rain, regulating ES of Upo Wetland decrease the extent of summer flooding and contaminated water along the Nakdong River, while reducing water shortage problems for the local community. Supporting ES of Upo Wetland provide habitat function to support high biodiversity of the Upo Wetland ecosystem (regulating ES), including migratory birds and endangered species. Provisioning ES of Upo Wetland include water supply to farmers, who compose 42% of the total Chanyoung County population, conducting agriculture industries of rice, which is its fourth highest economic benefit (South Korea's National Statistic Office, 2011). Lastly, cultural ES of Upo wetland appear in the forms of recreation, tourism, and education with the "Upo Wetland Ecosystem Pavilion". However, the local government of Changnyeong County mainly promotes most policies in industrial development with trade-offs among ES driven by the pursuit of economic interest with

ecological complexity. For example, despite efforts and expenditures of about $36 million to protect the regulating and provisioning ES of Upo Wetland for improving water quality in 2011, local policy makers are planning to increase the economic activity in the Upo Wetland by promoting provisioning ES through agriculture (South Korea's National Statistic Office, 2011).

However, these have the common issues of management practice, focusing on either single or specific wetland ES, with gaps between different groups concerned with different socio-ecological values within wetland ES. To maintain human well-being, people manage the ecological complexity of an ecosystem across a complex social system of institutions. This view classifies society into different levels on the national, community, and individual level.

Following economy-oriented national development in the internationalist economic context, Korea's environmental problems, including wetland destructions, have been growing rapidly even as citizen awareness has been increasing, and even as the Upo Wetland was being designated as internationally important Ramsar wetland list in 1998 (Ramsar, 2007). Accordingly, the Korean Ministry of the Environment (MoE) promotes the initiation of environmental policy reform, calling primarily for the regulation of the Upo Wetland under the 1999 Wetland Conservation Art (WCA) policy. The WCA aims at preserving the high diversity (regulating ES) and habitat (supporting ES) among its ecological functions, especially for migratory birds (MoE, 2014). The state focuses on managing regulating and supporting ES as a means of maintaining the national value of biodiversity (regulating ES) and the international value of habitat (supporting ES). However, the MoE indicates that the main causes of contaminated Upo Wetland ES are individual activities resulting in problematic effects. For example, local residents damage the biological balance of the wetland (regulating ES) by depleting the fish stock (provisioning ES) and by introducing agricultural by-products, which

contaminate wetland water. This approach focuses on such individual and comparatively minor harms, at the cost of refusing to demand accountability from national policy decision-makers who have continued to prioritize industrial development. To accomplish these aims while maintaining its economic-growth-oriented policy, the MoE relies on local governments to induce voluntary participation from local residents, which means they're relying on sites of neglected community management where all-around expertise and on-site experience are both sufficient (Moores, 2006). The state assigns to local institutions the entire task of the Upo Wetland management, while requiring them to interact across social levels.

One of the local government bodies is the Nakdong River Basin Environmental Office which reports on the ecological state of the Upo Wetland to the central government and the public. In addition, they designate the scope of the total restricted and prohibited area of the Upo Wetland under the WCA in order to prevent the accelerated destruction of the Upo Wetland, while raising safety concerns resulting from the increasing number of eco-tourists among local residents. Furthermore, the Nakdong River Basin Environmental Office makes general rules to promote sustainable use of ES in areas where preservation initiatives are less effective.

The other subordinate government is that of Changnyeong County, which is in charge of specific tasks related to the direct administration of the Upo Wetland. It receives support from the central government in order to purchase a privately owned reservoir and add it to the store of public property, in order to reduce the effect of local farmers' agricultural activities on regulating and supporting ES. To strengthen its stand against individual meddling, the Changnyeong County local government employs guards against illegal fishing and provides monetary benefits such as compensation as incentives to reduce private harvesting activities in the Upo Wetland. Despite all these efforts, illegal activities by local residents have continued unabated. Therefore,

the Changnyeong County coordinates local policies intended to encourage cultural ES with the MoE-supported Upo Wetland Ecosystem Pavilion, which aims at widening knowledge of the value of a bundle of Upo Wetland ES, by educating not only visitors but also local residents through eco-tourism.

Local residents continue to engage in indiscriminate fishing and agricultural practices to support their livelihoods with provisioning ES that do not comply with the policy. It is because the right to maintain ES on the Upo Wetland has been impeded by interference from central and local governments as well as the environmental organizations. For example, the MoE (2014) has attempted to induce local residents to become supportive of wetland management through monetary benefits such as institutional compensations and subsidies, because they noted that local individuals are gaining their economic benefits to live not mainly through the Upo Wetland ES but rather though agricultural benefits. Although most of the Upo Wetland is privately owned by locals, except its reservoirs, livelihood rights derived from ES are hindered in order to comply with both community and national demands of wetland management. It remains critical to include local residents in management decisions, in order to foster an atmosphere of coexistence that will reflect equal relationship widely on social levels.

Part 2.1. Policy analysis of the Upo Wetland

Armitage (2007) supports multi-level institutions to manage complex environmental issues in socio-ecological forms with community-based management, which build up resilient systems to manage environmental problems through interacting between formal and informal institutions to pursue the optimal objective, depending on the scale of society. Yashiro et al. (2013) develop “a nested institutional approach” to the management of a bundle of ES by multi-

level institutions, ranging from individual to state level, depending on the degree of rivalry and excludability. This approach strives to reduce the anthropocentric view, which mainly pursues economic growth, in order to manage the complex properties of environmental issues across multilateral institutions. Yashiro et al. (2013) propose managing ES with coordinated cross-social institutions by the degree of the rivalry and excludability in respect of each complexity, with their interactive relation between ecosystem and human well-being (Table 3.1 and Figure 3.1). This approach is a multi-level approach to managing a bundle of ES through institutional cooperation. In such an institutional approach, the public property of regulating and supporting ES is managed by command and control institution considered to be of low rivalry and low excludability (Yashiro et al., 2013). This is supported by Durigon et al. (2012), who purport that the national level of command and control policy is likely to protect the low rivalry and low excludability of public properties of wetland ES instead of market-based approach (economic incentives) through comparing the degree of wetland protection, depending on the level of market economies between eighteen nations. The common property of cultural ES is managed by a community-based institution considered to have somewhere in between high and low rivalry and excludability (Yashiro et al., 2013). Armitage (2007) also recognizes the social-ecological complexity of managing common properties of ES through the cross-social institutions of a community-based approach. In addition, the open access property of provisioning ES is managed by a market-based institution considered as having high rivalry and low excludability, and the private property of provisioning ES is managed by a market-based institution considered as having high rivalry and high excludability (Yashiro et al., 2013).

Firstly, regulating and supporting ES are fundamental capacities of a complex system that maintains and develops its functions. This functional capacity is unlikely to change unless the

degree of impacts affecting it exceeds the acceptable levels of the ecosystem. However, the public property of regulating and supporting ES is considered to have insufficient authorization to consuming these functions by others, due to being intangible form of ES with ambiguous boundaries. Accordingly, it is important to eradicate destructive activities, especially those enacted by the market system to supply the benefits of the ecosystem to society. A command and control institution tightens regulation on the complementary consumption of public property of regulating and supporting ES with high excludability.

Secondly, cultural ES, such as aesthetic views and eco-tourism, are the consequence of the history of local community life, maintaining interactions with regulating, supporting, and provisioning ES. Although cultural ES offer intangible benefits like regulating and supporting ES do, they maintain a higher degree of exclusivity than regulating and supporting ES, because cultural ES are closely related to local communities who access benefits of these ES - meaning they tend to be regulated by local communities with the excludable rights to consume the benefits by others. Therefore, community-based management varies to consume the common property of cultural ES in different areas, which have their own cultural identities.

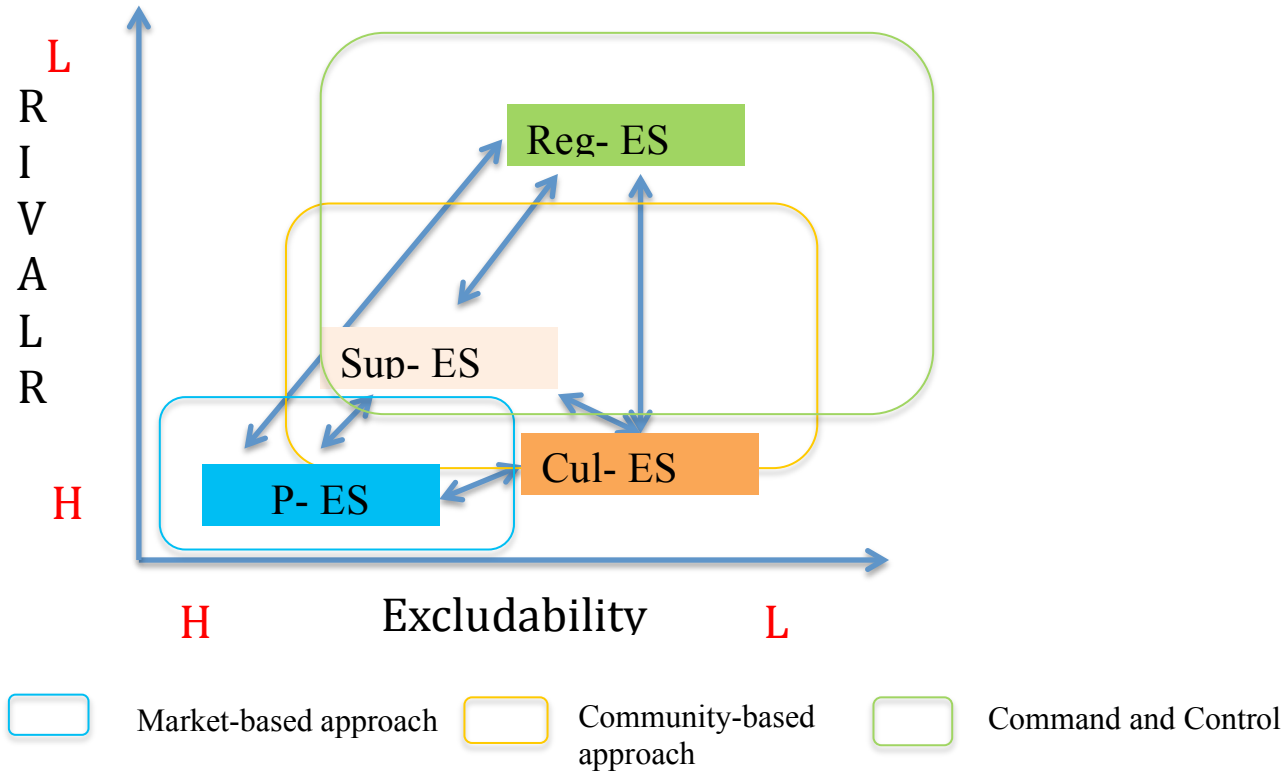
Finally, provisioning ES are inherently tangible goods and as such offer high rivalry in the consumption of their benefits. Therefore, provisioning ES benefit the market by generating profits through economic processes and, as a result, the transferable economic value of provisioning ES is predominantly managed by market-based approaches merging high rivalry and high excludability. There are open access and private property varieties of provisioning ES. Open access property of provisioning ES has low excludability with high rivalry properties - it has been devastated by economic-oriented wetland management policies intended to increase marketable benefits. In addition, high rivalry provisioning ES has the high excludability

properties of private property managed by a market-based approach. Therefore, the open access property of provisioning ES is managed with the private property of provisioning ES, to exclude imprudent consumption, not according to an anthropocentric nature perspective but in line with socio-ecological integrity. In addition, in order to supply provisioning ES, it is necessary to maintain regulating, supporting and cultural ES because the entire range of ES are intermingled with each other, maintaining and developing the whole ecosystem fuelled by energy from the sun.

Table 3.1. Arranging ES and existing institutions with property rights by the degree of rivalry and excludability based on a nested institutional approach (Adopted from Yashiro et al., 2013)

Public property: Regulating and supporting ES- Low rivalry and Low excludability- Command and Control institution
Common property: Cultural ES- Intermediate rivalry and excludability- Community-based institution
Provisioning ES: - Open access property- High rivalry and Low excludability- Market-based approach - Private property- High rivalry and High excludability- Market-based approach

Figure 3.1. Multi-level approach to manage a bundle of ES through institutional cooperation by the level of excludability along the X axis, and the level of rivalry along the Y axis (Adopted from Yashiro et al., 2013).



According to analysis of the Upo Wetland's management, wetland policy applies "a nested institutional approach" (Yashiro et al., 2013) to manage a bundle of ES by arranging existing institutions to respect socio-ecological complexity. Considered from the perspective of this approach, the Upo Wetland management misses several points about how existing institutions manage a bundle of ES in socio-ecological complexity.

First, the MoE has failed to implement a command and control institution, instead shifting its responsibilities to local governments to have them manage regulating and supporting ES on public properties in its place. Second, community-based institutions fail to follow the national policy for regulating and supporting ES. Although the Upo Wetland generates cultural

ES embedded in such forms as eco-tourism, education, scenic views, and religious activities, the community-based institutions of Changnyeong County devaluate the cultural ES of the Upo Wetland, leaving them weighed down by the demands of national development. Additionally, local communities, including local governments, have no common property rights to manage cultural ES through a community-based policy. Although local governments have sufficient capacity to form links across different levels of society, in policy-making processes they tend to by overlooked as the main stakeholders who are often local community bodies such as NGOs with local residents (Moores, 2006). Therefore, local governments limit wider sharing of knowledge in the management of the Upo Wetland. In particular, local governments are missing local individuals' participation in policy decision-making, meaning a wide range of knowledge is absent that would result in private entities opposing wetland policy that they feel infringes on their private rights. Finally, individual citizens living near the Upo Wetland are impeded in exercising their right to exclude others' consumption of high rivalry provisioning ES, to maintain their livelihood on private properties, because of an unreasonable prohibition on private activities in the Upo Wetland and insufficiently well-planned infrastructure, to implement a market-based approach. As a result, locals argue for their rights to have access to provisioning ES despite an oppositional government policy on preserving regulating, supporting, and cultural ES.

Environmental problems are greatly bound up with previously unresolved problems (Vatn, 2005). The consequence of this is eventually likely to reach a point of crisis that threatens life on earth from the small to the large scale. A policy recommendation for the Upo Wetland, based on the principle of "a nested institutional approach" (Yashiro et al., 2013) is meant to meet the needs of many groups across social strata, all of which can benefit from the proper management of the Upo Wetland, by maintaining a bundle of ES through the level of existing

institutions based on degree of rivalry and excludability.

First, on the state level, Upo Wetland policy has to reform the purpose of management by promoting the well-being of the people instead of focusing on economic growth. In order to balance national development between economic terms and human well-being, the relation with the international Ramsar Convention would aid to reform Upo Wetland policy since the Wetland has been recognized as internationally important in 1998. Second, the MoE must exercise its central right to regulate the low rivalry and low excludability of regulating and supporting ES, defining the Upo Wetland's ES as public property instead of shifting its responsibility to local governments and individuals. Although the state still has absolute authority over local governments, to which responsibility is shifted, the state has experienced difficulties in managing the Upo Wetland due to interruptions caused by the various competing interests of several divisions of policy departments. Therefore, the state needs to reclaim its authority from local governments to the MoE, for the purpose of expanding public ownership of reservoirs, in order to efficiently manage regulating and supporting ES. For example, the MoE requires the central right presently held by the government of Changnyeong County to control illegal acts by local residents with a command and control institution. Furthermore, the state urges the Nakdong River Basin Environmental Office to build up a cooperative system that reflects all relevant social levels, which would considerably extend the reach of the Upo Wetland management, designating the scope of the total restricted and prohibited area of the Upo Wetland under the WCA in order to prevent the accelerated destruction of the Upo Wetland. This would result in the unhindered right of ordinary citizens and community level institutions to participate in the management of a bundle of Upo Wetland ES.

The community-based institutions of the Upo Wetland claim to have an excludable

right on the common property for efficiently managing cultural ES through different levels of institutions, in order to improve institutional cooperation as well as cultural identity through local economic development. In this model, local governments explore management plans for cultural ES by collecting extensive opinions from the local community as well as non-government organizations. In particular, the Nakdong River Basin Environmental Office establishes clear-cut lines of authority over, and responsibility for, the wetland by collecting opinions from members of all levels of society who are related with such decisions, developing cultural ES alongside common property rights such as determining the processes of restricted and prohibited area in the Upo Wetland, in order to raise safety concerns resulting from the increasing number of eco-tourists (cultural ES) among local residents.

The other local government is Changnyeong County. Changnyeong County has authority from the MoE to invigorate eco-tourism with "the Upo Wetland Ecosystem Pavilion" raising awareness of Upo's cultural ES. However, it needs to transfer the prohibiting rights of command and control management to the MoE and exert a market-based approach on the individual level in order to reduce individual illegal activities in the restricted and prohibited area.

Lastly, on the individual level, individuals make rational decisions on private property for provisioning ES with market-based approaches in order to balance economic benefits within the complex system of the Upo Wetland. The Upo Wetland is likely to be managed with market-based approaches, monetarily benefiting private property through institutional compensation and incentives. In order to this, individuals require the authority to participate in policy decision-making to protect their rights while holding the equal right to cooperate in the formation of wetland policy. The consequence of this is would likely be reduced protests and illegal activities, leading to a wetland managed by local residents through

participation in the process of wetland policy-making with different levels of stakeholders.

Chapter 4. Conclusions

The policy management of the Upo Wetland must be analyzed in terms of ecological, economic, and institutional complexity.

Due to ecological complexity, a lack of explicit understanding in describing the inherent nature of wetland characteristics leads to a mismanagement of wetlands. The analysis of wetlands as complex systems requires a different context to understand the nature of wetland, coupled with a systems approach and a re-definition and classification of wetlands at the international and national level that overcomes disciplinary silo thinking. This implies that focusing on specific objectives to protect a whole ecosystem will inevitably disregard the inherent properties of wetland ecosystems.

Based on the ecological complexity dimension of wetland ecosystems, the Upo Wetland reveals our limited comprehension of the breath and span of wetland ecological functions. It has distinctive ecological function linkages to other wetlands (e.g. Mokpo, Sajipo, and Jokjibul wetland) and also to other environments by means of the water flowing from the Topyeong Stream and Nakdong River. However, current wetland classifications simplify this complexity, and tend to avoid integration of knowledge and approaches.

Definition & Classification of Upo Wetland

- On the international level: under the Ramsar list of internationally important wetland in 1998 as a floodplain;
- On the national level: under the Wetlands Conservation Act of 1999 as a riverine wetland.

In economic complexity, there are disciplinary differences between ecological and economic fields when dealing with management recommendations for ecosystems. It is because

the fundamental issues of the economic system objects to a subordinated relation to the ecosystem and does not place limits on the monetary valuation of wetlands. The current economic system disregards the fundamental limits on energy and matter flows from ecosystems to fulfill human needs. In addition, this system does not provide a means to value intangible goods and services, and promotes individual preferences over collective and other-regarding preferences. Such a valuation narrative generates trade-offs between valuation forms and among ES, by focusing on the specific types of ES (mainly provisioning ES) that will help meet market needs.

The economic complexity of the Upo Wetland remains likely to aggravate difficulties in management, despite the wetland's vital role in human life. There are regulating ES (flood control, water storage, water purification, and others), supporting ES (habitat function), provisioning ES (water and food supply), and cultural ES (recreation, tourism, education, religion and related institutions such as the "Upo Wetland Ecosystem Pavilion"). However, there are contradictions between the ecological and economic fields, when analyzing and accounting for trade-offs among ES.

Contamination to the Upo Wetland:

- Reduction of the scope of the Upo Wetland
- Decreasing the extent of Upo Wetland flooding by construction on the upper region of the Nakdong River and by climate change from global warming
- Deteriorating the quantity and quality of provisioning water due to an increasing amount of chemical fertilizers and other agricultural chemicals used in surrounding farms, as well as from environmental pollutants emitted by facilities engaged in industrial development

- The majority of Changnyeong County's policies are driven by the pursuit of economic interest
- In 2011, the province had special funds of about $36 million to spend on improvements to water quality

In addition to this limited ecological and economic understanding of wetland complexity, there is an institutional complexity aimed at providing guidance to management practices, bridging the gap between different stakeholders concerned with various socio-ecological values. Institutions manage environmental issues using different rules for pursuing determined objectives at different scales of society, from command and control and community-based, to market-based institutions. However, management practices mainly focus on either single or specific types of wetland ES.

Although the Upo Wetland was designated an internationally Ramsar site in 1998 and regulated under the Wetland Conservation Art (WCA) by the Korean Ministry of the Environment (MoE), wetland institutions are not fully integrated and do not accomodate multiple stakeholders with plural rationalities. Current Upo Wetland institutions pay attention to the National, community and individual levels, but are fully integrated as seen below.

- At the national level, the Ministry of Environment (MoE):
    - Wetlands management in the pursuit of economic benefit
    - Top-down regulation, command and control institution
    - Purchased the privately-owned Upo reservoir, and regulated pesticide uses affecting the reservoir, to preserve regulating services of high biodiversity and water purification
    - Allows only thirteen local farmers to fish in the wetland

- Aims to reduce local farmers' strong opposition
- Allows the local government to apply an environmental ranger system, to monitor disruptive activity from local residents
- Pursued the local government to establish "the Upo Wetland Ecosystem Pavilion," in order to raise awareness of the value of wetlands, especially among locals

• At the community level, where the Upo Wetland is administered mainly by local governments, there is the Nakdong River Basin Environment Office and Changnyeong County:

- The Nakdong River Basin Enivronment Office:
  - Governs a restricted and prohibited area in order to prevent accelerating the destruction of the Upo Wetland, while also regulating safety concerns brought about by the increasing number of visitors attracted by cultural tourism
  - Makes rules to promote sustainable use within the area under the Wetland Conservation Act
  - Monitors the whole area of the Upo Wetland throughout all four seasons of the year
- Changnyeong County:
  - Purchasing private property
  - Employing guards at ordinary times to prevent illegal fishing
  - Operating "the Upo Wetland Ecosystem Pavilion" for increasing awareness of the cultural ES of Upo Wetland, for the MOE
- At the individual level, there are the local residents:

- They continue to engage in indiscriminate fishing and agricultural practices that do not comply with the policy
- Most of the Upo Wetland is privately owned by locals, except its reservoirs
- Livelihood rights derived from ES are hindered in order to comply with both community (cultural ES such as eco-tourism) and national (regulating and supporting ES such as water quality and biodiversity) demands for of wetland management

Environmental problems are greatly influenced by previously unresolved problems. The consequence of this is eventually likely to reach a point of no return for the existence of wetlands around the world. A policy recommendation for the Upo Wetland, based on the principle of "a nested institutional approach", is meant to meet the needs of many groups across social strata, all of which can benefit from the proper management of the Upo Wetland by maintaining a bundle of ES through devising and strengthening value-articulating institutions, based on the degrees of rivalry and excludability of all ES under management.

REFERENCES CITED

Alchian, A. A. 1987. Property rights. The New Palgrave: A dictionary of economics **3**: 1031-4.

Armitage, D. 2005. Adaptive capacity and community-based natural resource management. Environmental management **35**: 703-715.

Armitage, D. 2007. Governance and the commons in a multi-level world. International Journal of the Commons **2**: 7-32.

Arrow, K., Bolin, B., Costanza, R., Dasgupta, P., Folke, C., Holling, C. S., Pimentel, D., et al. 1995. Economic growth, carrying capacity, and the environment. Ecological Economics **15**: 91-95.

Aylward, B., and Barbier, E. B. 1992. Valuing environmental functions in developing countries. Biodiversity and Conservation **1**: 34-50.

Barbier, E. B. 1994. Valuing environmental functions: tropical wetlands. Land Economics 155-173.

Barbier, E. B., Acreman, M., and Knowler, D. 1997. Economic valuation of wetlands: a guide for policy makers and planners. Gland: Ramsar Convention Bureau.

Barbier, E. B., and Strand, I. 1998. Valuing mangrove-fishery linkages–A case study of Campeche, Mexico. Environmental and Resource Economics **12**: 151-166.

Berkes, F., Colding, J., and Folke, C. 2000. Rediscovery of traditional ecological knowledge as adaptive management. Ecological Applications **10**: 1251-1262.

Berkes, F. 2004. Rethinking community-based conservation. Conservation Biology **18**: 621-630.

Brown, T. C., Bergstrp, J. C., and Loomis, J. B. 2007. Defining, valuing, and providing ecosystem goods and services. Natural Resources 47, 329.

Brown, P., and Garver, G. 2009. Right relationship: Building a whole earth economy. Berrett-Koehler Publishers.

Cardoch, L., Day Jr, J. W., Rybczyk, J. M., and Kemp, G. P. 2000. An economic analysis of using wetlands for treatment of shrimp processing wastewater—a case study in Dulac, LA. Ecological Economics **33**: 93-101.

Changnyeong County. 2008. An introduction of Upo wetland: General State of Upo wetland, Value of Upo wetland, Time of Creation and Historical record of Upo wetland, Animals and Plants of Upo wetland, Upo wetland preservation management. Upo Wetland Ecological Park (online). http://www.upo.or.kr/01info (in Korean).

Changnyeong County. 2011. Upo Wetland Conservation Effort (Formal and Informal Institutions). Upo wetland Ecosystem Pavilion data (online). http://www.upo.or.kr/01info/04_01.asp (in Korean).

Changnyeong County. 2013. Changnyeong County statistics annual report: Statistical and Major indicators. An introduction of Changnyeong County (online). http://www.cng.go.kr/statistics/index.asp (in Korean).

Chee, Y. E. 2004. An ecological perspective on the valuation of ecosystem services. Biological Conservation **120**: 549-565.

Chen, Z. M., Chen, B., and Chen, G. Q. 2011. Cosmic exergy based ecological assessment for a wetland in Beijing. Ecological Modeling **222**: 322-329.

Christensen, N. L., Bartuska, A. M., Brown, J. H., Carpenter, S., D'Antonio, C., Francis, R., Woodmansee, R. G., et al. 1996. The report of the Ecological Society of America committee on the scientific basis for ecosystem management. Ecological Applications **6**: 665-691.

Chung, J.Y., and Kirkby, R. J. R. 2002. The political economy of development and environment in Korea. London: Routledge.

Costanza, R., d'Arge, R., De Groot, R., Farber, S., Grasso, M., Hannon, B., van den Belt, M., et al. 1998. The value of the world's ecosystem services and natural capital. Ecological Economics **25**: 3-15.

Costanza, R. 2000. Social goals and the valuation of ecosystem services. Ecosystems **3**: 4-10.

Cowardin, L. M., and Golet, F. C. 1995. US Fish and Wildlife Service 1979 wetland classification: A review. Vegetation **118**: 139-152.

Daily, G. (Ed.). 1997. Nature's services: societal dependence on natural ecosystems. Island Press.

Daily, G., and Ellison, K. 2002. The new economy of nature: the quest to make conservation profitable. Island Press.

Daly, H. E. 1985. The circular flow of exchange value and the linear throughput of matter-energy: a case of misplaced concreteness. Review of Social Economy **43**: 279-297.

Daly, H. E., and Farley, J. 2010. Ecological economics: principles and applications. Island Press.

Demsetz, H. 1967. Toward a theory of property rights. Law and Economics **1**: 341-353.

De Groot, R. S. 1987. Environmental functions as a unifying concept for ecology and economics. Environmentalist **7**:105-109.

Dobbie, M. F. 2013. Public aesthetic preferences to inform sustainable wetland management in Victoria, Australia. Landscape and Urban Planning **120**: 178-189.

Driesen, D. M. 1998. Is Emissions Trading an Economic Incentive Program: Replacing the Command and Control/Economic Incentive Dichotomy. Wash. & Lee L. Rev. 55, 289.

Durigon, D., Hickey, G. M., and Kosoy, N. 2012. Assessing national wetland policies' portrayal of wetlands: Public resources or private goods? Ocean & Coastal Management **58**: 36-46.

Ekins, P. 1999. European environmental taxes and charges: recent experience, issues and trends. Ecological Economics **31**: 39-62.

Escobar, A. 2006. Difference and Conflict in the Struggle Over Natural Resources: A political ecology framework. Development **49**: 6-13.

Fernandez, L. 1999. An analysis of economic incentives in wetlands policies addressing biodiversity. Science of the Total Environment **240**: 107-122.

Finlayson, C. M., and Rea, N. 1999. Reasons for the loss and degradation of Australian wetlands. Wetlands Ecology and Management **7**: 1-11.

Fisher, B., Turner, K., Zylstra, M., Brouwer, R., Groot, R. D., Farber, S., Balmford, A., et al. 2008. Ecosystem services and economic theory: integration for policy-relevant research. Ecological Applications **18**: 2050-2067.

Getachew, M., Ambelu, A., Tiku, S., Legesse, W., Adugna, A., and Kloos, H. 2012. Ecological assessment of Cheffa Wetland in the Borkena Valley, northeast Ethiopia: Macroinvertebrate and bird communities. Ecological Indicators **15**: 63-71.

Gibbs, J. P. 2000. Wetland loss and biodiversity conservation. Conservation Biology **14**: 314-317.

Golden, H. E., Lane, C. R., Amatya, D. M., Bandilla, K. W., Raanan Kiperwas, H., Knightes, C. D., and Ssegane, H. 2014. Hydrologic connectivity between geographically isolated wetlands and surface water systems: A review of select modeling methods. Environmental Modeling & Software **53**: 190-206.

Gómez-Baggethun, E., and Ruiz-Pérez, M. 2011. Economic valuation and the commodification of ecosystem services. Progress in Physical Geography **35**: 613-628.

Grieg-Gran, M., Porras, I., and Wunder, S. 2005. How can market mechanisms for forest environmental services help the poor? Preliminary lessons from Latin America. World Development **33**: 1511-1527.

Grossmann, M. 2012. Economic value of the nutrient retention function of restored floodplain wetlands in the Elbe River basin. Ecological Economics **83**: 108-117.

Gyeongsangnam Province Development Institute. 1997. A Study for Ecosystem Conservation of Upo-Mokpo Wetlands, Changnyeong County District, Korea. Changnyeong County: Gyeongsangnam Province Development Institute (in Korean).

Hahn, T., Olsson, P., Folke, C., and Johansson, K. 2006. Trust-building, knowledge generation and organizational innovations: the role of a bridging organization for adaptive comanagement of a wetland landscape around Kristianstad, Sweden. Human Ecology **34**: 573-592.

Hansson, L. A., Brönmark, C., Anders Nilsson, P., and Åbjörnsson, K. 2005. Conflicting demands on wetland ecosystem services: nutrient retention, biodiversity or both? Freshwater Biology **50**: 705-714.

Hardin, G. 1968. The tragedy of the commons. Science **162**: 1243-1248.

Harris, G. P. 2007. Seeking sustainability in an age of complexity. Cambridge: Cambridge University Press.

Hassan, R. M., Scholes, R., and Ash, N. (Eds.). 2005. Ecosystems and human well-being: current state and trends: findings of the Condition and Trends Working Group (Vol. 1). Island Press.

Heberling, M. T., García, J. H., and Thurston, H. W. 2010. Does encouraging the use of wetlands in water quality trading programs make economic sense? Ecological Economics **69**: 1988-1994.

Holling, C. S. 1973. Resilience and stability of ecological systems. Annual Review of Ecology and Systematics 1-23.

Holling, C. S., and Meffe, G. K. 1996. Command and control and the pathology of natural resource management. Conservation Biology **10**: 328-337.

Holling, C. S. 2001. Understanding the complexity of economic, ecological, and social systems. Ecosystems **4**: 390-405.

Jogo, W., and Hassan, R. 2010. Balancing the use of wetlands for economic well-

being and ecological security: The case of the Limpopo wetland in southern Africa. Ecological Economics **69**: 1569-1579.

Johnson, D. 2001. Habitat fragmentation effects on birds in grasslands and wetlands: a critique of our knowledge. Great Plains Research: A Journal of Natural and Social Sciences 568.

Josselyn, M. N., Mehta, A. J., Morris, J. T., Nuttle, W. K., Simenstad, C. A., and Swift, D. J. 1994. Scientific assessment of coastal wetland loss, restoration and management in Louisiana (p. 1-103). Coastal Education and Research Foundation.

Kang M-J, Kim C-S, and Oh K-H. 2007. Flora, actual vegetation map, and primary production of the vascular hydrophytes and hygrophytes in the Upo Wetland. Journal of the Korean Wetland Society **9**: 45–55.

Keddy, P. A. 2010. Wetland ecology: principles and conservation. Cambridge University Press.

Kimmage, K., and Adams, W. M. 1990. Small-scale farmer-managed irrigation in northern Nigeria. Geoforum **2**1: 435-443.

Kim, K. G., Park, M. Y., and Choi, H. S. 2006. Developing a wetland-type classification system in the Republic of Korea. Landscape and Ecological Engineering **2**: 93-110.

Korea Environmental Institute. 2008. UNDP/GEF Current state of wetland protection areas in Korea. Ministry of Environment (in Korean).

Kotze, D. C., Ellery, W. N., Macfarlane, D. M., and Jewitt, G. P. W. 2012. A rapid assessment method for coupling anthropogenic stressors and wetland ecological condition. Ecological Indicators **13**: 284-293.

Leauthaud, C., Duvail, S., Hamerlynck, O., Paul, J. L., Cochet, H., Nyunja, J., Grünberger, O., et al. 2013. Floods and livelihoods: The impact of changing water resources on wetland agro-ecological production systems in the Tana River Delta, Kenya. Global Environmental Change **23**: 252-263.

Leopold, A. 1966. A Sand County almanac: With other essays on conservation from Round River. Random House LLC.

Limburg, K.E., O'Neill, R.V., Costanza, R., and Farber, S. 2002. Complex systems and valuation. Special Issue: The Dynamics and Value of Ecosystem Services: integrating Economic and Ecologica Perspectives. Ecological Economics **41**: 409–420.

Liu, J., Dietz, T., Carpenter, S. R., Alberti, M., Folke, C., Moran, E., Taylor, W. W., et al. 2007. Complexity of coupled human and natural systems. Science **317**: 1513-1516.

Li, Y., Shi, Y., Qureshi, S., Bruns, A., and Zhu, X. 2013. Applying the concept of spatial resilience to socio-ecological systems in the urban wetland interface. Ecological Indicators.

Ludwig, D. 2001. The era of management is over. Ecosystems **4**: 758-764.

McCay, B. J., and Jentoft, S. 1998. Market or community failure? Critical perspectives on common property research. Human Organization **57**: 21-29.

Millennium Ecosystem Assessment (Ed.). 2005. Ecosystems and Human Well-Being: Our Human Planet: Summary for Decision Makers (Vol. 5). Island Press.

Ming, J., Xian-Guo, L., Lin-Shu, X., Li-juan, C., and Shouzheng, T. 2007. Flood

mitigation benefit of wetland soil—A case study in Momoge National Nature Reserve in China. Ecological Economics **61**: 217-223.

Ministry of Environment. 2013. Close examination of Wetlands protection area of Upo wetland (in Korean).

Ministry of Environment. 2014. The 2ND Wetlands conservation program from 2013 to 2017 (online). http:// www.me.go.kr (in Korean).

Mitsch, W. J., and Gosselink, J. G. 1993. Wetlands. New York: Van Nostrand Reinhold.

Mombo, F., Lusambo, L., Speelman, S., Buysse, J., Munishi, P., and Van Huylenbroeck, G. 2014. Scope for introducing payments for ecosystem services as a strategy to reduce deforestation in the Kilombero wetlands catchment area. Forest Policy and Economics **38**: 81-89.

Moores, N. I. A. L. 2006. South Korea's shorebirds: a review of abundance, distribution, threats and conservation status. Stilt **50**: 62-72.

Nakdong River Basin Environmental Office. 2013. A plan for wetland protection area, Nakdong River Basin Environmental Office district, Korea (online). http://www.me.go.kr/ndg/web/board/list.do (in Korean).

Namaalwa, S., Funk, A., Ajie, G. S., and Kaggwa, R. C. 2013. A characterization of the drivers, pressures, ecosystem functions and services of Namatala wetland, Uganda. Environmental Science & Policy **34**: 44-57.

National Research Council (U.S.). 1995. Wetlands: Characteristics and boundaries. Washington, D.C: National Academy Press.

Odum, E. P. 1968. Energy flow in ecosystems: a historical review. American Zoologist **8**: 11-18.

Ostrom, E. 1990. Governing the commons: The evolution of institutions for collective action. Cambridge university press.

Oudot-Canaff, J., Bornette, G., Viricel, M. R., Piola, F., Mousset, S., and Martel, E. 2013. The short-term impact of wetland restoration on the genetic diversity of a predominantly clonal plant species. Aquatic Botany **110**: 16-23.

Pagiola, S., Arcenas, A., and Platais, G. 2005. Can payments for environmental services help reduce poverty? An exploration of the issues and the evidence to date from Latin America. World Development **33**: 237-253.

Parrott, L. 2010. Measuring ecological complexity. Ecological Indicators **10**: 1069-1076.

Pascual, U., Muradian, R., Rodríguez, L. C., and Duraiappah, A. 2010. Exploring the links between equity and efficiency in payments for environmental services: A conceptual approach. Ecological Economics **69**: 1237-1244.

Polasky, S., Nelson, E., Pennington, D., and Johnson, K. A. 2011. The impact of land-use change on ecosystem services, biodiversity and returns to landowners: A case study in the State of Minnesota. Environmental and Resource Economics **48**: 219-242.

Ramsar Convention Secretariat, 2007. National Wetland Policies: Developing and implementing National Wetland Policies. Ramsar handbooks for the wise use of wetlands, 3rd edition, vol. 2. Ramsar Convention Secretariat, Gland, Switzerland.

Reid, M. A., and Brooks, J. J. 2000. Detecting effects of environmental water

allocations in wetlands of the Murray–Darling Basin, Australia. Regulated Rivers: Research & Management **16**: 479-496.

Rodríguez, J. P., Beard Jr, T. D., Bennett, E. M., Cumming, G. S., Cork, S., Agard, J., Peterson, G. D., et al. 2006. Trade-offs across space, time, and ecosystem services. Ecology and Society **11**: 28.

Russi D., ten Brink P., Farmer A., Badura T., Coates D., F.rster J., Kumar R., and Davidson N. 2012. The Economics of Ecosystems and Biodiversity for Water and Wetlands. Final Consultation Draft.

Sathirathai, S. 1998. Economic valuation of mangroves and the roles of local communities in the conservation of natural resources: case study of Surat Thani, South of Thailand. South Bridge: Economy and Environment Program for Southeast Asia.

Schneider, E. D., and Sagan, D. 2005. Into the cool: Energy flow, thermodynamics, and life. University of Chicago Press.

Schumpeter, J. A. 1954. History of economic analysis. New York: Oxford University Press.

Setlhogile, T., Arntzen, J., Mabiza, C., and Mano, R. 2011. Economic valuation of selected direct and indirect use values of the Makgadikgadi wetland system, Botswana. Physics and Chemistry of the Earth, Parts A/B/C **36**: 1071-1077.

Soons, M. B. 2006. Wind dispersal in freshwater wetlands: knowledge for conservation and restoration. Applied Vegetation Science **9**: 271-278.

South Korea's National Statistics Office. 2011. Gross regional product of cities and counties depend on economic activity in Gyeongsangnam Province, Korean Statistical Information Service (online). http://stat.gsnd.net/jsp (in Korean).

South Korea's National Statistics Office. 2013. Regional survey in agriculture, forestry, fishery, Sejong City Hall, Korean Statistical Information Service (online). http://stat.gsnd.net/jsp/sub02/02_02.jsp (in Korean).

Steyaert, P., Barzman, M., Billaud, J. P., Brives, H., Hubert, B., Ollivier, G., and Roche, B. 2007. The role of knowledge and research in facilitating social learning among stakeholders in natural resources management in the French Atlantic coastal wetlands. Environmental Science & Policy **10**: 537-550.

Thompson, P. M., Sultana, P., and Islam, N. 2003. Lessons from community based management of floodplain fisheries in Bangladesh. Journal of Environmental Management **69**: 307-321.

Tiner, R. W. 1999. Wetland indicators: A guide to wetland identification, delineation, classification, and mapping. CRC Press.

Turner, K. 1991. Economics and wetland management. Ambio 59-63.

Turner, M. G., and Carpenter, S. R. 1999. Tips and traps in interdisciplinary research. Ecosystems **2**: 275-276.

Turner, R. K., Van Den Bergh, J. C., Söderqvist, T., Barendregt, A., van der Straaten, J., Maltby, E., and van Ierland, E. C. 2000. Ecological-economic analysis of wetlands: scientific integration for management and policy. Ecological Economics **35**: 7-23.

Van den Belt, M., Forgie, V., and Farley, J. 2011. Valuation of Coastal Ecosystem Services.

Van Roon, M. R. 2012. Wetlands in The Netherlands and New Zealand: Optimising

biodiversity and carbon sequestration during urbanisation. Journal of Environmental Management **101**: 143-150.

Vatn, A. 2005. Rationality, institutions and environmental policy. Ecological Economics **55**: 203-217.

Water Supply and Drainage office (KWWA). 2011. A study on the development planning of water and sewage system in Changnyeong County (online). http://www.kwwa.or.kr/reference/develop01_list.php (in Korean).

Wilson, M. A., and Carpenter, S. R. 1999. Economic valuation of freshwater ecosystem services in the United States: 1971-1997. Ecological Applications **9**: 772-783.

Yashiro, M., Duraiappah, A., and Kosoy, N. 2013. A Nested Institutional Approach for Managing Bundle Ecosystem Services: Experience from Managing Satoyama Landscapes in Japan. Pages 191-205 in Muradian, R., and Rival, L. Governing the Provision of Ecosystem Services. Springer Netherlands.

Yi G-C, and Nam J-C. 2008. Management Program and Ecological characteristics of forest wetlands located at Sinbul Mountain. Korea Wetland Society **10**: 1-14.