Organizational Ecosystem Embeddedness.
Investigating the Relations Between Management Theory, Business Strategies and Social-Ecological Systems

Thesis presented by:
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“The major problems in the world are the result of the difference between how nature works and the way people think.”

– Gregory Bateson

“Just as we are beginning to appreciate not only the beauty of natural systems but also their essential role in providing an infinite range of goods and services on which humanity depends, we are reluctantly also learning that we are destroying those life-support systems and threatening the sustainability of the biosphere as we know it. Ecology, the unifying science in integrating knowledge of life on our planet, has become the essential science in learning how to preserve it”

– Simon Levin
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# Chapter 1

## Introduction

### 1.1 Overview

Over the last decades, the sustainability agenda has dramatically changed as a consequence of escalating pressure – generated by human activities – on natural resources, ecosystems functioning, and biodiversity. Publications such as the Millennium Ecosystem Assessment (MA, 2005), the Living Planet Report (WWF, 2012), and more recently, the Fifth Assessment Report by the International Panel on Climate Change (IPPC, 2013) clearly describe these transformations (a brief snapshot of these trends is provided in Table 1) and point to the urgency of making radical changes in the ways our society and economy are organized globally.

## Table 1 - Trends in natural resources depletion

<table>
<thead>
<tr>
<th>Issue</th>
<th>Trends</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planetary boundaries</td>
<td>Mankind has already transgressed three of the nine interconnected planetary boundaries identified by scientists, namely those regarding climate change, rate of biodiversity loss, and interference with the global nitrogen cycle (Rockström et al., 2009).</td>
</tr>
<tr>
<td>Ecosystem degradation</td>
<td>Over the previous 50 years, approximately 60% (15 out of 24) of the ecosystem services have been degraded or used unsustainably, including fresh water, capture fisheries, air quality regulation, water purification and waste treatment, soil erosion regulation, and the regulation of regional and local climate, natural hazards, and pests. These services are fundamental for the well-being of both current and future human generations and other living species (MA, 2005).</td>
</tr>
<tr>
<td>Climate change and global warming</td>
<td>Atmospheric concentrations of the greenhouse gases have all increased since 1750 due to human activity. In 2011, the concentrations of these greenhouse gases were 391 ppm (parts per million) and exceeded pre-industrial levels by about 40%. Each of the last three decades has been successively warmer at the Earth’s surface than any preceding decade since 1850 (when data are available) (IPCC, 2013).</td>
</tr>
<tr>
<td>Biodiversity loss</td>
<td>The population of vertebrate species fell by nearly one-third between 1970 and 2006, and continues to decline globally. For plant species alone, the corresponding figure is an alarming 70% (Secretariat of the Convention on Biological Diversity, 2010).</td>
</tr>
<tr>
<td>Ecological Footprint</td>
<td>Humanity’s Ecological Footprint (our impact on the Earth) has doubled since 1966 and is in overshoot since the 1970s. The Footprint exceeds our planet’s biocapacity, that is, the area actually available to produce renewable resources and absorb CO₂, by more than 50% (WWF, 2012).</td>
</tr>
</tbody>
</table>

Source: Tencati and Pogutz (2014)

This epoch, where human organizations and nature are fundamentally intertwined, has been labeled the Anthropocene by the Dutch Nobel Laureate P. J. Crutzen (2002), a neologism that
captures the idea that humans have become the main driver of the changes occurring in our biosphere (Steffen et al., 2011). In line with this vision, a large majority of scientists has converged in considering that the “[a]nthropogenic pressures on the Earth System have reached a scale where abrupt global environmental change can no longer be excluded” (Rockström et al., 2009a: 1), and calls for global and local action that protects the planet from further degradation. These changes could be irreversible, triggering consequences that could negatively impact our well-being and “leading to a state less conducive to human development” (Rockström et al., 2009b: 472).

At the same time, the need to establish global environmental governance mechanisms to address the sustainability challenge is increasingly recognized by all sectors of society. Failures by international conferences to reach a consensus on the steps to be taken (such as the UNFCCC Copenhagen Conference, 2009) do not detract from the growing recognition that protecting the planet has become a key issue in international politics, providing material for intense debates involving international agencies, governments, non-governmental organizations (NGOs), and corporations.

As a consequence of these dynamics, protecting the natural environment has become a salient issue for companies as well, increasingly entering corporate agendas and impacting both strategic and tactical behavior over the years. Since the early 1990s, influential networks of corporations have been established to communicate with stakeholders, implement strategies, and circulate best practices (e.g., the World Business Council for Sustainable Development, or the Global Roundtable on Climate Change). Individual companies have taken measures such as (1) incorporating sustainability into their missions, values, and strategies (Kiron, et al., 2013); (2) launching innovative programs to develop environmentally-friendly technologies (Nidumolu et al., 2009); (3) adopting environmental management standards worldwide (European Commission, 2014; ISO, 2010); and (4) incorporating environmental and social issues into their reporting initiatives (Townsend et al., 2011). Managerial approaches like eco-efficiency (Schimdheiny, 1992; Fussler & James, 1996), triple bottom line (Elkington, 1997), pollution prevention and product stewardship (Hart, 1995), or cradle-to-cradle and design for the environment (Braungart et al., 2007) have become part of business language in multiple industries, almost everywhere around the globe.
1.2 Business and the natural environment: a brief review of the field

Although scholars in management and organization studies began investigating the relation between business and the natural environment in the 1970s, this body of literature only began to fully develop in the 1990s, when environmental issues became more salient for companies as well as being a consequence of the 1992 UN Conference on Environment and Development held in Rio de Janeiro (Etzion, 2007; Hoffman & Georg, 2012).

During that decade, concepts such as the “natural environment,” “ecology,” “greening of business,” and “pollution prevention” increasingly appear in conference papers, workshops, and symposia inside a range of management and organizational fields of study. The Greening of Industry Network (GIN), an international network of professionals from research, education, business, civil society organizations, and government, was founded in 1991. In 1994, the Organization and the Natural Environment (ONE) Special Interest Group was established in the Academy of Management. Several scientific journals emerged to focus on investigating the linkages between management and the natural environment: Business Strategy & the Environment in 1992, Journal of Cleaner Production in 1994, Organization & Environment in 1997 (previously called Industrial and Environmental Crisis Quarterly from its inception in 1987), and the Journal of Industrial Ecology in 1997.

Amidst this growing activity, some of these early works provided a critical examination of the use and meaning of the term environment in management and organizations studies (MOS). The conclusion was that nature was conceptually absent in conceptions of a business environment that encompassed exclusively social-context domains like economic, technological, political, and societal factors (Roome, 1992; Shrivastava & Hart, 1992; Shrivastava, 1994). For example, Shrivastava observed the following in his pioneering work “Castrated environment: Greening organizational studies”:

“Given the pervasive environmental impacts of all organizational elements, it is important for OS [Organization Studies] to re-conceptualize organizational knowledge. It needs to rethink basic theoretical ideas in a way that allows discussion of the natural environment” (1994; 707).

This period of intellectual fervor culminated with the publication of AMR’s special topic forum on “ecologically sustainable organizations” in 1995. This issue contained several ambitious and farsighted articles that attempted to create a space for “nature” in management
studies and marked a significant theoretical advance of the field (Hoffman & Georg, 2012). Some of these contributions further underlined the de-natured conceptualization of the “business environment” (Gladwin et al., 1995; Shrivastava, 1995). Gladwin and colleagues, for example, remain uncomfortably accurate in stating that “most management theorizing and research continues to proceed as if organizations lack biophysical foundations. Organic and biotic limits in the natural world are excluded from the realm of organizational science” (1995: 875).

The following years proved to be a very fertile time for research, with articles published in top management and organization journals, edited volumes, and practitioner pieces related to business and the natural environment specifically, as well as broadening to sustainability more generally. Since the early 1990s, the volume of publications and the diversity of theoretical and empirical approaches has grown considerably. In sum, business and the natural environment (B&NE)1 studies have increasingly acquired methodological rigor and generated multiple streams of inquiry, providing an in-depth investigation of both the drivers of corporate environmental actions (e.g., regulations, customer pressure, social movements, industry self-regulation) and the responses to such pressures (corporate culture, individuals and managers perceptions, sustainable innovations, and entrepreneurship, etc.) (see Hoffman & Georg, 2012).2

At the same time, sustainability management research has not yet provided frameworks and theories that fully capture the linkages between organizations and their biophysical foundations (Starik & Kanashiro, 2013; Pogutz & Winn, 2009). Rather than generating its own theoretical frameworks or nature-based constructs (Kallio & Nordberg, 2006), this body of literature has tended to apply theoretical lenses from mainstream disciplines of MOS to analyze the relations between organizations and the natural environment (Hoffman & Georg, 2012; Starik & Kanashiro, 2013); these include (1) the resource-based view (Hart, 1995; Starik & Kanashiro, 2013); these include (1) the resource-based view (Hart, 1995;

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1 According to the disciplinary context management and organization scholars use alternatively the terms Business and the Natural Environment (B&NE) and Organization and the Natural Environment (ONE) to indicate the body of work inquiring into the relation between business/organizations and nature. In this thesis, and in the three papers presented, I have used both in accordance with the preferences of the journals where the papers have been submitted or will be submitted. In this introduction, I use the term B&NE.

2 A detailed review of this literature has been recently carried out by leading scholars in the field, who have analyzed the maturity of this body of work and the quality of the contributions to the parent discipline of management (cf. Bansal & Gao, 2006; Bercicchi & King, 2007; Etzion, 2007; Hoffman & Bansal, 2012; Hoffman and Georg, 2012). Further analysis of this literature is provided in Chapter 2 and Chapter 3 of this thesis.
Russo & Fouts, 1997) and dynamic capabilities (Hart & Dowell, 2010; Sharma & Vredenburg, 1988), (2) the institutional theory and institutional isomorphism (Hoffman, 1999; Jennings & Zandbergen, 1995), or (3) the stakeholder theory (Henriques & Sadosky, 1999; Roome & Wijen 2006).

On this point, Bansal and Knox-Hayes have stated that “[b]y treating the natural environment as merely an issue or context in preexisting management theory, we do not fully appreciate the unique aspects of the natural environment that may, in fact, call for new theory” (2013: 77). Similarly, Whiteman et al. have underlined that the corporate sustainability literature has mainly focused on organizational, social, or institutional phenomena, in isolation from quantitative indicators that assess the material impacts and dependence of organizations upon ecosystem functioning (2013: 308). Starik and Kanashiro remind us that “[m]uch of the literature on management continues to ignore sustainability issues, such as biodiversity, habitat protection (Dauvergne & Lister, 2010; Etzion, 2007), over-population, overconsumption (Starik, 1995), and a host of other issues” (2013: 8).

In sum, the field is most likely still lacking “necessary interdisciplinary perspectives” (Starik, 2006: 433). While corporate sustainability is holistic in its nature, cross-fertilization from disciplinary approaches from outside social sciences—particularly relevant is the lack of investigation into ecology—is missing. On the other hand, it is interesting to note that in the last few years, some scholars are trying to address these problems by looking at theories and methodologies that more adequately reflect the complexity of the relations between business organizations and the natural environment (Bansal & Knox-Hayes, 2013; Boons, 2013; Shrivastava & Kennelly, 2013; Whiteman et al., 2013; Winn & Pogutz, 2013).

In this thesis, I build on this emerging research and try to look outside the disciplinary boundaries of MOS by illustrating concepts taken from sciences such as modern ecology\(^3\) and

\(^3\) Ecology is the study of the relationship between organisms and their environment (e.g., physical and chemical). The word “ecology” (Ökologie) was coined in 1866 by the German scientist Ernest Haeckel. Ecology as a science has evolved into a broad interdisciplinary field and has divided into several branches (e.g., system ecology, conservation ecology, population ecology). It has also blended with other disciplines such as anthropology, geography, or economics to give birth to sub-disciplines such as human ecology, human geography, environmental sociology, or ecological economics. Over the years, ecology, now modern or new ecology, has become a system science, de-emphasizing the attention to stability, unique equilibria, and deterministic approaches, to adopt the perspective of complex adaptive system, social-ecological systems, resilience and adaptive management (see Abel & Stepp, 2003; Gunderson & Holling, 2002; Pickett & Cadenasso, 2002).
interdisciplinary research fields such as ecological economics. I attempt to provide the basis for a new foundation of the field and a re-conceptualization of organizations as entities embedded in a physical and material world (Pogutz & Winn, 2009).

1.3 Looking outside of the box: What modern ecology can tell us?
While the field of organization studies traditionally borrowed from sociology, psychology, and economics (Birkinshaw et al., 2014; Corley & Gioia, 2011; Oswick et al., 2011), scant interest has been given to those sciences that investigate the natural environment. This divide between social and natural sciences, however, seems to be a feature in common with the other domains. A remarkable quotation by Alf Hornborg, a Human Ecologist at the University of Lund, helps illustrate this point:

“Over the years, I have been struck by the paradox that the researchers who are most concerned about protecting the biosphere against anthropogenic damage (the biologists and ecologists) are the least equipped to analytically understand the origins of such damage, while those best equipped to do so (the social scientists) are the least concerned with an objective biophysical environment.

[Natural scientists] are not equipped to understand the driving forces of environmental degradation e.g., in culture, politics, and economy. Conversely, social scientists trained to think in terms of ‘social constructions of nature’ are ill equipped to visualize a biophysical environment objectively endangered by human activity.” (http://www.lucid.lu.se/html/human_ecology.aspx, accessed May 20, 2012).

Hornborg’s reflection underlines the risks related to a separation between natural and social sciences when it comes to addressing the global environmental crisis. On the one hand, natural scientists are limited in their capacity to understand the dynamics occurring in the social domain (e.g., individual and organizational behaviors), but social agents are the main drivers of the massive changes occurring in nature (e.g., climate change or ecosystem depletion). On the other hand, a large number of social scientists are “ill equipped”—and

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4 Ecological economics is an inter-disciplinary (or trans-disciplinary) field of research aiming at acknowledging the interdependencies between humans and ecosystems. It emerged in late 1980s as a reaction to environmental economics, with the aim of enlarging the neoclassical economic paradigm to further include elements outside of the market. Some specific features of the ecological economics approach are as follows: (1) the rejection of the proposition that natural capital can be substituted by human-made capital and (2) the idea that the economic systems and economic thinking are grounded in physical reality, especially in the laws of physics (particularly the laws of thermodynamics) and in ecosystems (Costanza, 1989; 1991).
probably not very interested—in studying the interdependencies between human (and thus organizational) activity and the dynamics occurring in nature, but nature’s transformation is already massively affecting humans and the way societies and economies are organized. While acknowledging the ontological and epistemological differences between these disciplines (some of these aspects will be further discussed in Chapters 2 and 3), in order to provide MOS with a stronger understanding of the interactions between nature and organizations, in this thesis I look mainly at modern ecology and ecological economics, as well as at some key concepts that have been developed with the purpose to represent these interactions. Next, I briefly examine the notion of ecosystem and social-ecological systems to familiarize the reader with the ontology and the language of these disciplines.

Ecosystems. The term “ecosystem” is one of the most fundamental and widely used concepts theorized in ecology. At the same time, the concept of ecosystem is complex, with multiple layers of meanings and use. Pickett and Cadenasso identify three dimensions of the ecosystem concept: meaning, model, and metaphor (2002: 2). It is outside the purpose of this section of the thesis to illustrate the history of this term from its first introduction by the British ecologist Sir Arthur Tansley in 1935, to its consolidation by the Eugene T. Odum (the father of modern ecology), and his brother Howard T. Odum during the 1950s and 1960s. I therefore provide a simple and modern definition (meaning) by S. Levin, 1988 Robert H. MacArthur Award winner, extracted from the “Princeton Guide to Ecology”. An ecosystem is:

“a natural unit consisting of all the plants, animals, and microorganisms (biotic) factors in a given area, interacting with all of the nonliving physical and chemical (abiotic) factors of this environment. An ecosystem can range in scale from an ephemeral pond to the entire globe, but the term most often refers to a landscape scale system characterized by one or a specified range of community types (e.g., a grassland ecosystem).” (Levin, 2009, p. 779).

The second feature is its use in modeling. Ecosystem models are fundamental for transforming a conceptual definition, which does not identify spatial and temporal scales and constraints, into a tool for empirical research and practical guidance (Pickett & Cadenasso, 2002). Scientists have developed a multitude of ecosystem models that analyze energy and nutrient flows, biodiversity, and, more recently, incorporate also the range of human interactions that are impacting on—and are impacted by—ecological dynamics.
The third aspect is that of a metaphor. The notion of ecosystem has been used as a metaphor in informal and symbolic terms. Examples are ecosystems as an “organism,” ecosystem as a “place,” or, in MOS, the notion of “organizational ecosystem” or “business ecosystem” (the interaction of a community of organizations and their business environment). This multidimensionality and flexibility has favored the wide diffusion of the concept of ecosystem. In this thesis, I will build on this fundamental concept of the ecosystem to investigate the interdependency between organizations and natural environment.

Social-ecological systems. Social-ecological systems (SES), introduced by Berkes and Folke in 1998, have emerged as the fundamental framework in which several disciplines or sub-disciplines, such as ecology or ecological economics, analyze human-nature relations and the challenge of sustainability (cf. Abel & Stepp, 2003; Folke, 2006; Gunderson & Holling 2002; Levin et al., 2013; Rammel et al., 2007; Turner, 2014). According to Levin, “linkages between ecological and socioeconomic systems are key to ensuring environmental protection and economic growth” (2006: 328).

SES are defined as nested systems of people and nature with reciprocal feedbacks and interdependencies, in a spatially determined geographical setting (The Resilience Alliance, 2007). Social systems include all types of relations between people and all forms of organizations and institutions. Ecological systems have been defined above.

SES are complex and adaptive, and share a number of properties such as connectivity, nonlinearity, uncertainty, scales, and diversity (a review of these properties is provided in Chapter 3). Quoting Levin et al., these:

“macroscopic properties emerge from local actions that spread to higher scales due to agents’ collective behavior; these properties then feed back, influencing individuals’ options and behaviors, but typically only do so diffusely and over much longer time scales” (2013: 113).

These properties generate unexpected dynamics and surprise that reduce our capacity to anticipate future evolution of the system (Folke et al., 2007). As a consequence, climate change, water pollution, or biodiversity loss are problems difficult to understand and even more difficult to manage.

The perspective of SES, while not exempt from criticism (Cote & Nightingale, 2012; Halliday & Glaser, 2011), provides an ontological foundation from which to examine relationships
between nature and human organizations. Moreover, it offers an important and promising operational ground to better understand the challenges of sustainable development and to manage them, working towards practical solutions (Ostrom, 2007).

1.4 Aim of the study and research questions
My purpose in this work is both challenging and ambitious. I build on the idea, discussed in the previous sections, that the B&NE field of study has not been successful in building new theories or conceptual frameworks that are able to:

- link organizations with their biophysical foundation;
- capture the interdependencies between organizations and the SES; and
- allow organizations to operate in accordance with an ecosystem’s functioning principles.

The aim of this thesis is twofold:

- first, to analyze why MOS, and specifically B&NE, has not successfully addressed the issue of the biophysical foundation of organizations and their embeddedness in a material and physical environment;
- second, to understand the linkages between organizations and SES in order to build useful knowledge for a new foundation of the B&NE field of studies.

Two groups of research questions follow.
The first group is mostly theoretical and investigates the relation between MOS and disciplines (or field of research) such as modern ecology and ecological economics:

- Is nature important to MOS?
- What are the reasons, including epistemological and ontological assumptions, for the failure of MOS to recognize nature’s salience and its relevance for organizations?
- What management and organizational theories share common assumptions with the disciplines that investigate SES? Which MOS theories are capable of accurately representing the interdependencies between organizations and the natural environment?
- How might MOS contribute to fruitful theorizing on organizations and nature?
The second group of research questions is more managerial and strategic, and aims at investigating the interdependencies between organizations and SES. A simplified representation of these relations is illustrated in Figure 1. Organizations exercise pressures upon and impact ecosystems through the utilization of ecosystem services and natural resources (e.g., use of raw materials and generation of pollution and emissions). At the same time organizations depend (directly or indirectly) on the availability of ecosystem services and natural resources because they gain benefits from the utilization of these services (e.g., the genetic diversity for a pharmaceutical company, or the availability of trees for a paper company) (UN Global Compact & IUCN, 2012; WRI, 2008). Changes in the stocks and flows of ecosystem services and natural resources call for adequate responses—or strategies—from organizations to mitigate their impact or reduce dependence (Pogutz & Winn, 2009).

**Figure 1 - Interdependence between organizations and ecosystems**

Source: Adapted from Pogutz & Winn, 2009.

The second group of research questions is as follows:

- What types of relations exist between organizations and SES (impact and dependence)?
- What types of risks are emerging for organizations when ecosystem services and natural resources upon which they depend are decreasing?
• What strategies can organizations develop to maintain their “fit” with social-ecological systems and ecosystem services (e.g., strategies that adapt to ecosystem services’ scarcity or strategies that protect and enhance the stock and flows of ecosystem services)?
• What resources and capabilities are required to manage the interdependence between SES and ecosystem services?
• What organizational changes are needed to sustainably manage these interdependences and adapt to growing scarcity of ecosystem services?

1.5 Structure of the work
The thesis is organized in 3 papers, plus a final chapter that contains concluding remarks, research limitations, and a discussion of the main implications of this work.

The first paper (Chapter 2), co-authored with Monika Winn, is titled “Constructing a Place for Nature in Management and Organization Studies.” The purpose of this work is to offer a new theoretical platform for research that links organization science and nature and serves as a foundation for the study and understanding of management and organizations as fundamentally interconnected with and mutually constitutive of nature. In the paper, we argue that MOS research will benefit by acknowledging the embeddedness and interdependency of organizations and natural systems. Such a broadened domain might offer new avenues for building knowledge that is theoretically more robust and practically more relevant for corporate strategy and global governance concerned with nature.

First, in order to create a compelling case and provide the foundations for expanding the domain of MOS, we 1) describe both the theoretical and practical “imperatives” motivating this project, 2) examine ontological and epistemological assumptions that serve as barriers to incorporating the relations between business and nature and to acknowledging the biophysical foundation of organizations, and 3) highlight opportunities to generate significant theoretical and practical contributions.

Second, we assess research on organizations and the natural environment. To do this, we identify two types of relations: how organizations impact the natural environment, and how organizations are affected by the natural environment. Then, we introduce a second
dimension: the valence of the impact, which can be positive or detrimental. On this basis we build a $2 \times 2$ matrix and map the current literature. Finally, we introduce an additional dimension termed mutual impact in order to capture the mutually constitutive character of the nature-organization relationship.

Next, we introduce social-ecological systems (SES) as a promising integrative approach for future research. Generated in interdisciplinary efforts by social and natural scientists, SES are complex adaptive systems (e.g., Berkes & Folke, 1998; Boisot & McKelvey, 2010; Levin et al., 2013) with distinctive properties and features: connectivity, non-linear feedback, multiple temporal and spatial scales, resilience, diversity, uncertainty, risk, and adaptability. We investigate each of these properties in-depth and provide examples. Applying an SES view to research on organizations offers the field important opportunities for building new, relevant, and robust theories (Birkinshaw et al., 2014; Suddaby, Hardy, & Huy, 2011). This perspective also has major methodological and theoretical implications. We conclude the paper by elaborating on and developing exemplary research questions, applying institutional logics and dynamic capabilities to illustrative mini-cases as two exemplary theoretical lenses to showcase future research directions.

Both authors contributed equally to the paper. The article has been submitted for review to the *Academy of Management Review* on the 28th of June 2014.

The second paper (Chapter 3), titled “Business, Ecosystem, and Biodiversity: New Horizons for Management Research” is also theoretical and co-authored with Monika Winn.

The study aims to encourage research into how organizations can manage their relationship with the natural environment. We move from the observation that a large number of multinational companies, whether from a desire to secure critical resource inputs or respond to demands ranging from local communities to international stakeholders, are beginning to engage in ecosystem management. These organizations are developing strategic and tactical approaches to address biodiversity, ecosystem conservation, and restoration, often in partnership with international conservation organizations. While concepts such as biological diversity and ecosystem services may have entered the vocabulary of firms, these issues have not yet garnered much interest in the management literature.
We suggest that this in part reflects the disciplinary separation between natural science domains (like biology or ecology) and management and organization studies. At the same time, we argue that the initiatives we observe in business practice open up new opportunities for research. Building on Starik & Kanashiro’s (2013) call for a theory of sustainability management, we argue that any such theory would have both to incorporate the complexity of and interconnectedness between ecosystems and organizations and provide a solid framework for a managerial decision-making that is respectful of the biophysical constraints of natural capital.

Bridging knowledge domains, the paper introduces four key concepts from ecology and social ecology to MOS: ecosystems, biodiversity, ecosystem services, and ecological resilience. These concepts have played a particularly important role in prompting major breakthroughs in the understanding of relationships between human organizations and the natural environment. Like many concepts in MOS (e.g., strategy, organization, institutions, or management), these concepts are complex, interrelated, and subject both to multiple interpretations and criticism. Nevertheless, they provide powerful heuristics and foundations for future theorizing regarding nature’s functioning in MOS. In the last part of the paper, we include suggestions for future research in sustainability management, organization theory, and strategic management. More precisely, we introduce the concept of “organizational ecosystem embeddedness” to provide a representation of the interconnectedness (impact and dependence) of organizations and ecosystems. We focus on dependence as a novel and constitutive part this relationship and suggest that future research should consider not only the effect of organizational impacts on nature but also the effect of nature’s transformation upon organizations, since changes in ecosystems and ecosystem services can dramatically affect firms and their business models.


The third paper (Chapter 4) is a single author manuscript entitled: Knowledge-Creation for Ecologically Sustainable Practices Within and Beyond Firm Boundaries: The Case of Barilla. The paper is empirical and based on the case study methodology (Eisenhardt, 1989; Yin, 2003). It seeks to contribute to the literature on corporate sustainability exploring the role of
knowledge in developing new ways of producing goods that can capture business opportunities, while remaining grounded in the principles of sustainability. Moreover, I examine how knowledge about SES dynamics (ecological knowledge, see Berkes & Folke, 2002; Pretty, 2011), generated outside the company’s boundaries can be accessed, developed, and transformed into organizational knowledge. Adding this perspective on knowledge to the B&NE studies helps in understanding how companies develop long-term strategies that target real improvements in environmental sustainability and increase competitiveness.

The paper is built on the analysis of the project “Sustainable Farming,” developed by Barilla, a family-owned Italian company global leader in the pasta business. In 2008, Barilla applied the LCA methodology to the entire pasta supply chain. It was found that the stage with the greatest impact on ecosystems is raw material cultivation. On this basis, the company launched a new program with the goal of involving critical supply chain players and sharing experience and knowledge in growing different types of crops with them. Specific attention was dedicated to durum wheat cultivation, Barilla’s key raw material. Between 2010 and 2012, a two-phase pilot project was realized that combined different types of crop rotation (instead of monoculture) with innovative technologies to support farmers’ decision-making, and guidelines to disseminate cropping knowledge and practices. The results showed major improvements on multiple key performance indicators. The company, therefore, started a process of profound transformation towards sustainability.

To develop the case study, I have used multiple sources: in-depth interviews, observations, and archival data. A total of 11 informants, mainly senior executives including one Deputy Chairman, were interviewed. A write-up of the case study was circulated to the interviewees for validation. Triangulation among different sources was carried out to increase its validity. Findings are twofold. First, I found support for the idea that organizations that have developed profound knowledge about sustainability, both organizational and technical, can increase their capabilities to innovate, improve their performance, and significantly reduce their environmental impact. Extending the Knowledge-Based View to corporate sustainability, it was found that sustainability-oriented knowledge provides the company with a “platform of options” for future strategies (Kogut & Zander, 1992), and can increase its sustainability and competitiveness. Second, the findings provide evidence that profound knowledge about SES dynamics (both traditional and scientific knowledge) is fundamental to develop solutions that
dramatically reduce the environmental impact of business and generate economic and social benefits for both the company and farmers.

The last chapter (Chapter 5) contains the final remarks, discusses the main findings and the limitations this study.
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Chapter 2

Constructing a Place for Nature in Management and Organization Studies
The paper is co-authored with Monika Winn

Abstract
This paper offers a theoretical platform for research on the relationship between organizations and nature – the Social-Ecological Systems View (SESV). We argue that nature is an ‘organizational phenomenon’ on theoretical and practical grounds and propose a new ontology for an expanded domain of organization studies. After assessing current research on organizations and the natural environment (ONE), we introduce social-ecological systems (SES) as a promising integrative approach for future research. Generated in interdisciplinary efforts by social and natural scientists, SES are complex adaptive systems (e.g., Berkes & Folke, 1998; Boisot & McKelvey, 2010; Levin et al., 2013) with distinctive properties and features (connectivity, non-linear feedback, multiple temporal and spatial scales, resilience, diversity; uncertainty, risk, adaptability). Applying an SESV to research on organizations offers the field important opportunities for building new, relevant and robust theories (Birkinshaw, Healey, Suddaby, & Weber, 2014; Suddaby, Hardy, & Huy, 2011), and for contributing currently lacking knowledge about organizations to strategic governance efforts at organizational, national and supra-national levels. It also has major methodological and theoretical implications. We elaborate on both and develop exemplary research questions, using institutional logics and dynamic capabilities on illustrative mini-cases as two exemplary theoretical lenses to showcase future research directions.

Keywords: organization theory development; nature; social-ecological systems view; complexity; sustainability; strategy; governance; organization and natural environment.
2.1 Introduction

Over 40 years ago, in “The Sciences of the Artificial,” Herbert A. Simon observed that “[t]he
world we live in today is much more a man-made, or artificial, world than it is a natural
world” (1969/1981: 4-5), but “those things we call artifacts are not apart from nature…. [, t]hey
have no dispensation to ignore or violate natural law” (1981: 6). And yet, nature does not
feature much in management and organization studies (MOS), although nature-, ecology-, or
biology-based mechanisms and terms are often borrowed. Concepts like market ‘niche’ or the
field ‘population ecology’ (Hannan & Freeman, 1977, 1984) serve as two familiar examples
of the metaphorical use of ecological principles in organization theories.

Such terms are, however, metaphors only – borrowed from natural science and applied to
contexts of human organizing. Our actual understanding of the relationships, mutual
affectedness, processes, and dynamics between nature and human organizing remains
extremely limited. This is troubling, both because organization studies could contribute
important knowledge and because our own theories may have less explanatory power than
assumed. How then can we generate new organization theory to build knowledge of the
interrelationship(s) between nature and human organizing, and offer insights for better
managing these interrelationships?

The purpose of this paper is to offer a new theoretical platform for research that links
organization science and nature and serves as a foundation for the study and understanding of
management and organizations as fundamentally interconnected with and mutually
constitutive of nature. We argue that MOS will be well-served if its research recognizes the
embeddedness and interdependency of organizations and natural systems. Such a broadened
domain offers exciting new avenues for building knowledge that is theoretically more robust
and practically more relevant for corporate strategy and global governance concerned with
nature.

We start by distinguishing among widespread and divergent meanings of the term nature.
Indeed, “…the very word ‘nature,’” as the literary critic Raymond Williams (1983: 219)
famously observed, ‘is perhaps the most complex in the [English] language’” (Demeritt,
2002: 778). It can refer to the “essential quality or character of something,” “the inherent
force which directs either the world or human beings or both,” or “the external, material
world itself” (2002: 777-778). As a result, a multitude of intertwined meanings and
significances can emerge. In this paper we are concerned with what Demeritt calls the “material world itself.” We use the terms *nature, environment* and *natural environment* synonymously, drawing on definitions and distinctions put forth by scholars in the social and natural sciences, including organization studies (e.g., Banerjee, 2003; Crane, 2003; Gladwin, Kennelly, & Krause, 1995; Purser, Park, & Montuori, 1995; Shrivastava, 1994; Roome, 1992; Starik & Rands, 1995; Starik, 2006).

In order to create a compelling case and provide the foundations for expanding the domain of management and organization studies, and to incorporate the relationship between organizations and nature, we describe both theoretical and practical ‘imperatives’ motivating this project, examine ontological and epistemological assumptions that serve as (formidable) barriers, and highlight opportunities to generate significant theoretical and practical contributions. Throughout the paper, we use the broadly descriptive term management and organization studies, or MOS, to refer to the broad discipline, and as synonymous with organization science.

Our arguments for revisiting and revising the ontological assumptions that determine the boundaries of MOS pivot on when and how nature is an ‘organizational phenomenon’ (e.g., Pfeffer, 1993; Birkinshaw, Healey, Suddaby, & Weber, 2014; Suddaby, Hardy, & Huy, 2011). Expanding the domain of MOS beyond the strictly ‘social’ has important implications for the type of analytical and methodological approaches to use (and invent), and which calls for an examination of current key epistemological stances and assumptions in MOS.

Decades-long conversations and debates in other social science disciplines prompted the creation of vibrant, interdisciplinary fields, including environmental sociology, ecological economics and modern ecology. The theoretical and practical advances from this growing body of work offer important insights for studying the relationship between natural and organizational systems, including the concept of social-ecological systems (SES). Understood as complex adaptive systems (CAS) (Berkes & Folke, 1998; Costanza, Wainger, Folke, & Mäler, 1993; Levin et al., 2013), a social-ecological systems perspective offers MOS an important starting point for building new, relevant and robust theories. We introduce SES concepts and properties, and develop future research directions, using institutional logics and strategy as two theoretical lenses to showcase possible future research directions.
Applying a ‘social-ecological systems view’ (SESV) to the study of nature and organizations has major methodological and theoretical implications for research in MOS. It also offers MOS important opportunities for contributing currently lacking knowledge about organizations and organizing to efforts for effective social-ecological governance at supranational, national and organizational levels.

2.2 The Utility of Nature for Organization Theory

In this section, we aim to make a compelling case for expanding the domain of MOS to provide new opportunities for theory development. We review arguments on the critical importance of nature for human organizations and on the myriad impacts of organizations on nature, and elaborate on the resulting need for MOS to cast its theoretical net farther. While calls to incorporate the natural environment in research on business and organizations are far from new (e.g., Gladwin & al., 1995; Hart, 1995; Jennings & Zandbergen, 1995; Newton, Deetz, & Reed, 2011; Purser et al., 1995; Starik & Kanashiro, 2013), our intention here focuses on heightening the relevance of organization theories more generally (cf., Birkinshaw et al., 2014; Corley & Gioia, 2011; Daft & Lewin, 1990; Suddaby et al, 2011).

On the question of what constitutes a theoretical contribution, a number of organizational scholars agree on the critical role of advancing the understanding of a particular phenomenon in a way that is useful. Corley and Gioia suggest that “perhaps especially in AMR…the idea of contribution rests largely on the ability to provide original insight into a phenomenon by advancing knowledge in a way that is deemed to have utility or usefulness for some purpose” (2011: 12). For Pfeffer, “one way to evaluate [theories] is to ask the extent to which [they are] linked to a particular, important organizational phenomenon and affords insight into understanding that phenomenon” (1997: 197). This suggests that, to be worthy of study as a rightful target of scholarly attention in MOS, a phenomenon has to be viewed and construed as an organizational phenomenon, and knowledge about it has to be useful in some fashion.

Society and its organizations fundamentally depend on nature (MA, 2005; Rockström et al., 2009), so organization science, via organizational self-interest, should contribute meaningful knowledge on this relationship; organizations also impact nature, necessitating a sound understanding of that general effect as well – otherwise that which organizations depend on
might be diminished. Impact and dependence are generally considered to be two core aspects defining the relationship between nature and society (and thus organizations) as interconnected. This *interconnectedness* has critical organizational relevance. It establishes nature, and the organization-nature relationship, as an organizational phenomenon (Pfeffer, 1997). Theorizing this relationship, however, is no easy task: the greater the conceptual distance between phenomena, the more challenging it is to combine associated theoretical lenses for their investigation (Okhuysen & Bonardi, 2011), and nature and organizations have long been confined to and separated into their respective domains of the natural and the social sciences (e.g., Kallio & Norberg, 2006).

And yet, the emergence of research on organizations and the natural environment (ONE) has already pushed out the boundaries of management and organization studies. Vibrant research activity has generated a significant body of work (e.g., Etzion, 2007; Hoffman & Georg, 2012), suggesting that nature has become a legitimate area of research in MOS. But theorizing on nature makes up a surprisingly small proportion (less than 1.5%) of articles published in mainstream journals (Bansal & Gao, 2006; Jermier, Forbes, & Orsato, 2006) and the review article “Postcards from the Edge” concluded that ONE research remains relegated to a small and marginal sub-field within MOS (Berchicci & King, 2007).

This suggests that the main of MOS has not made nature its business. This amounts to missed opportunities for management and organization studies to (1) contribute critical theoretical insights from a range of perspectives (strategy, organization theory, organizational behavior, etc.) and (2) offer practically relevant knowledge allowing organizations to better navigate the challenges and ameliorate problems. Indeed, calls for greater theoretical and scholarly attention have increased accordingly (Bansal & Knox-Hayes, 2013; Boons, 2013; Newton et al., 2011; Porter, 2006; Starik & Kanashiro, 2013; Whiteman & Cooper, 2011).

We will examine more closely why this might be and how MOS might learn from the decades-long debates on this topic in other social science disciplines. Questioning epistemological and ontological assumptions that led to the exclusion of nature from social sciences domains broadly, and acknowledging the theoretical and practical usefulness of including nature, a number of fields have begun to build theoretical and methodological bridges between the natural and the social (Carolan, 2005; Catton & Dunlop, 1978; Costanza & Daly, 1987), including sociology and economics – generally considered base disciplines of
MOS (Birkinshaw et al., 2014). In contrast to the nuanced debates in those disciplines, mainstream organization studies has barely engaged in the conversation about either the ontological standing of nature, or the social construction of nature, nor does it offer concepts that capture the living systems of nature

2.2.1 Nature’s Salience for (and the Usefulness of) Organization Theory
As touched on earlier, we start from the position that today, life on earth (nature), and human society with all its organizations are fundamentally interconnected. We also take the position that nature and society are mutually constitutive, to the degree that our current geological epoch has been labelled the Anthropocene by Dutch Nobel Laureate P. J. Crutzen (2002). That term captures the sheer scale of human impact on the global environment (Steffen, Grinevald, Crutzen, & McNeill, 2011), which in turn affects the shape and very survival of human organizations; the recent founding of the journal “Anthropocene” suggests a fertile new research area. Humanity faces increasing pressures from a changing climate and declining biodiversity, even as the demand for natural resources, food and water is growing globally.

At the same time, corporations are among the most powerful organizations of today’s world – and according to many, they are a critical player in finding a path to sustainable development (e.g., Bower, Leonard, & Paine, 2011; Hart, 2005; Hoffman & Georg, 2012; Ignatius, 2012). The domain of MOS is that of organizations – small, medium-sized, large and very large business organizations in a myriad of forms, social enterprises, hybrid organizations and their competitive and institutional environments, and that of organizing and its various forms and logics. Organizations and organizing can contribute to problems and to solutions, so MOS faces what we will call a ‘practical imperative’ to speak to either.

By not engaging more in the conversation about critical global issues of our time, such as the governance and management of climate change, overpopulation, ecosystem degradation, or the role of organizations in contributing to problems, MOS leaves the building of meaningful knowledge to other sciences – and thus foregoes opportunities to contribute critical knowledge on management and organizations, and help address, counter and ameliorate undesirable impacts.
Hand in hand with the practical imperative is what we refer to as a ‘theoretical imperative,’ that is to generate valid and accurate theory and research. The omission of nature and the nature-organization relationship reduces both the practical relevance and the scientific accuracy and validity of theories on organization(s), and with that, their utility; with utility and opportunity closely linked, MOS misses important organization-scientific contributions to public discourse and political decision making.

What are the reasons for the failure of MOS to recognize nature’s salience for organizations and organizing? What factors, including epistemological and ontological assumptions, might obstruct active and meaningful theorizing across organization and natural science? And where, specifically, are the opportunities for MOS to contribute to theoretical and applied knowledge on organizations and nature? We address these questions in more detail next and, expanding on earlier points, explicate a foundational ontological position for including nature in the domain of MOS.

2.2.2 Contributions from Management and Organization Studies

Nature is and has been a critically important contingency for human organization and it has been managed by humans for millennia. Ecological systems play a fundamental and material role in supporting life on Earth and in generating natural resources and ecological services that humans and organizations depend upon (Holling, 2001; MA, 2005), providing essential material and energy inputs and absorbing the waste products associated with all manner of human industry, including organizations. The resultant need to establish global environmental governance mechanisms to address climate change and the crisis of ecosystems is increasingly recognized across all sectors of society, around the globe. Climate change and the biosphere have become key issues on the international political scene, providing material for intense debates involving international agencies, governments, non-governmental organizations (NGOs) and corporations, and challenging long-held beliefs, values and self-interests.

Reducing damage to, protecting, and increasingly also restoring the natural environment are also salient items for corporate strategy, having entered organizational agendas under the pragmatic rationales of eco-efficiency, clean technology, reputation management, win-win or
risk-reduction strategies (see Hoffman & Georg, 2012, for a comprehensive history of research on business and the natural environment).

If nature matters to organizations, then it stands to reason that nature is also an important domain for organization theory. And yet, the acknowledgement of these pressing global challenges by public, private and civil society organizations – and by natural sciences – has not prompted their broad inclusion in MOS.

We suggest that in an era of complex social-ecological global challenges, the usefulness of management and organization theory depends not only on its ability to include nature as a legitimate and fruitful part in its domain of inquiry, but to bridge formerly separate domains of research and build new knowledge domains at the intersection of newly linked disciplines. On the former, establishing the legitimacy of studying nature in MOS, has been achieved over the past 20 years. On the second, we know that organization theory can be made more useful by “theorizing across multiple bodies of literature” (Suddaby et al., 2011: 241) and by “blending among non-contiguous domains … [to] generate radically new insights” (2011: 243). To date, very little such cross-fertilization has occurred regarding organization-nature relations, both by MOS looking to ecology and vice versa.

2.2.3 Lessons from Other Fields
Why then – in light of such potent practical and theoretical reasons for considering the role of nature for organizations and organization theory – is nature not considered an organizational phenomenon worthy of MOS scholars’ attention? What can we learn from the conversations and debates that have led to the formation of the fields of environmental sociology or ecological economics?

For one, generally accepted notions of what constitutes a field’s legitimate domain can act as formidable barriers, as does the institutional infrastructure and associated norms of journals, academic associations and tenure systems (see Zahra & Newey, 2009). A deeply embedded logic in MOS that might work against the theorizing across disciplines is that the environment studied in MOS is essentially and fundamentally social – bounded by phenomena and processes that revolve around human actors and organizations made up of human actors (e.g., Carolan, 2005; Kallio & Norberg, 2006; Starik & Rands, 1995), and the various means by which these act, interact and interpret their actions (e.g., Newton et al., 2011; Al-Amoudi &
Willmott, 2011). The result is a firmly institutionalized and thus very real (ontological) separation into two theoretical realms: the natural and the social-organizational.

In management and organization theory, the strict focus on the world of the social was strongly challenged 25 years ago (e.g., Gladwin et al., 1995; Purser et al., 1995; Shrivastava, 1994) with arguments to ‘bring nature back in’ (Carolan, 2005). But while the ensuing conversations provided the foundation for research on ONE, the divide remains real.

MOS did not stand alone in its nearly exclusive focus on the social. Indeed, the field likely inherited and carried forward a tradition characterizing the social sciences more broadly, including base disciplines of MOS (Birkinshaw et al., 2014). In sociology, a fierce and decades-long debate on the topic started in the 1970s, when Catton and Dunlap questioned the anthropocentric focus of sociology and proposed the ‘human exemptionalist paradigm’ as a way to capture deep-seated and influential ontological and epistemological assumptions in the discipline (1978). In economics, similar debates led to the formation of ecological economics to integrate economics and ecology toward “understanding and predicting human behavior in the context of natural ecosystems” (Costanza & Daly, 1987: 2)

Our own field’s exclusive focus on the social has caused concern in other areas as well. The material world of objects and artifacts in general – natural, technical or otherwise – are perceived as separate entities, outside the field’s legitimate domain, and largely ignored by organizational scholars. On technology, Orlikowski and Scott find that “[d]espite the substantial empirical evidence of technology’s central role in organizational affairs, technologies remain largely understudied in organizational research” (2008: 466). They describe the mutually constitutive nature of the organizational and the technical in ‘mutual ensembles’, where “…on the one hand technology can become inscribed with institutional forces that set the rules of rationality (Powell & DiMaggio, 1991), while on the other it is one of the carriers within the environment that contributes to the structuring of organizations (Scott, 1995)” (Orlikowski & Scott, 2008: 447). Sandberg and Tsoukas (2011) echo such arguments to consider a socio-materiality beyond a purely socially constructed reality. This tendency to confine themselves to the social also hampers other fields. In medical sociology, not including knowledge from biology in the study of health, emotion and body highlight how ontological and epistemological foundations can produce a de facto (if theoretical) separation between them (Newton, 2003).
Such barriers, rooted in the history and sociology of science, do help to explain the absence of MOS attention to nature. But there is another possible reason: it is simply not interesting. While this may sound mundane, Weick (1995) makes a compelling case for the importance of such factors as the appeal, resonance or popularity of theories; indeed, whether a theory or theoretical direction meets a receptive body of scholars depends at least in part on the ‘prevailing concerns of the time.’

Yet here we face the paradox: we find ample concern among the general populace for issues related to the environment and we find ample scientific evidence to be concerned about. Then why has there been so little uptake by organization scholars? Weick points to the body of scholars themselves when he suggests that “[t]he reception of a theory is shaped by the extent to which a theory resonates with the cultural presuppositions of the time and the scientific audience that consumes it” (1995: 395). So it appears that the time has not been right for MOS, although the often fierce debates among scholars in other social science disciplines over the past decades (cf., Carolan, 2005; Dunlap, 2002) offered opportunity for MOS scholars to resonate with current concerns, tap into emergent scholarly conversations and even borrow their theoretical advances.

Institutional logics of action may apply to the scientific endeavor as much as to other institutions. Acting as “organizing principles that shape ways of viewing and interpreting the world” (Suddaby & Greenwood, 2005: 38), they can both constrain and enable the potential agency of actors through “vocabularies of motive, frameworks for reasoning, and guidelines for practice” (Kilduff, Mehra, & Dunn, 2011: 297).

So while theoretical progress has been made through research on organizations and the natural environment (ONE), there has been minimal theorizing on nature in other fields in organization studies, despite ample public and scientific debates. We echo Alvesson and Sandberg, suggesting that it is time again to “challeng[e] our assumptions in some significant way” (2011: 247) and to examine the “rationalized logics developed within the discourses of the philosophy of science” (Kilduff et al., 2011: 297), so that we can offer new directions for research on nature and organizations not only in a sub-field, but in MOS more broadly.
2.2.4 Knowledge Gaps and Opportunities for Management and Organization Studies

We have mentioned that, despite a long and productive history of borrowing from fields like sociology, psychology and economics (Corley & Gioia, 2011; Oswick, Fleming, & Hanlon, 2011; Zahra & Newey, 2009), MOS has largely ignored the natural sciences or those social science disciplines that have forged theoretical linkages to ecology, creating entire new research domains, frameworks and methodologies.

But the natural sciences are equally remiss in reaching across the chasm to the social sciences to attain a better understanding of that powerful source of massive changes in nature – human, and thus organizational, activity. Interestingly, “the researchers who are most concerned about protecting the biosphere against anthropogenic damage (the biologists and ecologists) are the least equipped to analytically understand the origins of such damage [or] the driving forces of environmental degradation, e.g., in culture, politics, and economy” (Hornborg, 2012). This suggests that knowledge from social sciences broadly, and from management and organization studies specifically, is not well accessed or used by other disciplines. As a result, neither the natural sciences, nor the emergent fields bridging natural and social science, such as ecology, human geography, environmental sociology or ecological economics (e.g., Demeritt, 2002; Scheiner & Willig, 2008) are currently well equipped to contribute knowledge on the role of organizations. Sharing knowledge across these gaps holds tremendous potential for theoretical advances and practical implications in both directions (see Figure 2.1).

2.2.5 Nature and Society: Mutually Constitutive, but Ontologically Asymmetric

Twenty years ago, Gladwin and colleagues pointed to a “profound epistemological crisis: the conceptual division and resultant disassociation between humankind (and its organizations) and the remainder of the natural world” (1995: 874-875). Here we take a different position: the epistemologically-focused disputes around positivism, social constructionism and critical realism (e.g., Al-Amoudi & Willmott, 2011; Newton et al., 2011), however important, may have distracted from an underlying issue: a world-view which takes humans and their social and organizational world(s) to be independent and separate from nature. This suggests that at the core of the conceptual split between nature and humans is an ontological problem: what
we view as the subject of study must be examined at least in parallel, if not prior to conflicting epistemological stances that examine how we know about and interact with it.

**Figure 2.1 – Knowledge Gaps in Modern Ecology and in Management and Organization Studies**

To bring the concept of nature to management and organization studies, we look to the ontological assumptions regarding nature in conversations from other fields. Drawing on the works of Demeritt (2002) and Carolan (2005), we take the view that nature and society are at once *ontologically asymmetric* and *mutually constitutive* (our term, also referred to as co-evolution, conjoined constitution). Mutually constitutive refers to the bidirectional impacts of nature on human society and of human society on nature; the global scale of the latter is what led leading scientists to coin the term Anthropocene for the current geological epoch. Ontological asymmetry refers to the fact that, while physical environments can exist without social environments, the reverse is not possible – nature is ontologically prior. Put differently, life on earth will go on with or without human organizations, although it would be a very different life on earth. Sandberg and Tsoukas, albeit as part of epistemological considerations, make a similar observation when they suggest that “our entwinement with the world is ontologically prior to the epistemological relation between a subject and an object” (2011: 

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350), even though there can be no knowledge of a priori physical environments without those knowing of such environments.

We thus explicitly prioritize nature – recognizing ontological priority of bio-physical environments over social realities – while also acknowledging that both are mutually constitutive. Acknowledging the ontological asymmetry of the bio-physical to the social (and thus organizational) is critical for our paper. It allows us to conceptualize nature directly, thus introducing a fundamentally new dimension to organization studies, provide theoretical foundations for more encompassing and holistic theorizing, and open new directions to theorize and empirically assess the complex relationships between organizations and nature. Next, we offer a simple heuristic framework as a new way to categorize research on organizations and nature; and to generate a novel perspective to identify critical gaps in scholarly attention, derive novel theoretical lenses, and open up new directions for future research.

2.3 Research on Organizations and Nature

Today, we can look to over twenty years of research on organizations and the natural environment, reflected in the growing number of review articles assessing work published in dedicated area journals and mainstream MOS journals (e.g., Bansal & Gao, 2006; Berchicci & King, 2007; Etzion, 2007; Hoffman & Georg, 2012; Jermier et al., 2006; Kallio & Nordberg, 2006; Montiel & Delgado-Ceballos, 2014; Starik & Kanashiro, 2013). While the field appears to be maturing, there is general consensus that attention to nature in the broader field of MOS remains sparse. Nature also does not feature in recent calls for invigorating future management research with new and relevant theory (Birkinshaw et al., 2014; Corley & Gioia, 2011; Suddaby et al., 2011), confirming that its critical importance for organizations and, by implication, for organization theory remains largely unrecognized.

First, and as described earlier, organizations both impact nature and are affected by nature – whether via the provision or scarcity of resources, or due to unplanned-for ‘surprises’ like natural disasters (King, 1995). Second, impacts in either direction can be either detrimental or beneficial. Accordingly, we use valence and direction of impacts as two primary dimensions of organization-nature relations. After mapping current research and trends in practice on the
resulting 2x2 matrix, we introduce a third dimension, termed mutual impact, to capture the mutually constitutive character of the nature-organization relationship (see Table 2.1).

Table 2.1 – Heuristic Categories for Research on Organizations (O) and Nature (N)

<table>
<thead>
<tr>
<th>Direction of Impact</th>
<th>Valence of Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Negative</td>
</tr>
<tr>
<td>O → N</td>
<td></td>
</tr>
<tr>
<td>I.</td>
<td>Focus: Managing, reducing and preventing a wide range of negative impacts by organizations on nature.</td>
</tr>
<tr>
<td></td>
<td>Research in MOS: Most of ONE research (see review articles.)</td>
</tr>
<tr>
<td></td>
<td>In Practice: Wide range of ‘sustainability’ drivers and initiatives, well established.</td>
</tr>
<tr>
<td>N → O</td>
<td>II.</td>
</tr>
<tr>
<td></td>
<td>Research in MOS: Few articles; growing interest.</td>
</tr>
<tr>
<td></td>
<td>In Practice: Receives growing attention by business and affected / vulnerable industries.</td>
</tr>
<tr>
<td></td>
<td>V.</td>
</tr>
<tr>
<td></td>
<td>Research in MOS: New; can draw on interdisciplinary advances by natural and social sciences.</td>
</tr>
<tr>
<td></td>
<td>In Practice: Intergovernmental environmental organizations; attempts to provide an integrated perspective based on impact and dependence (e.g., WBCSD and WRI; The Natural Capital Coalition including ICUN, The World Bank, WWF, WBCSD, GRI, The Nature Conservancy, and multiple business partners).</td>
</tr>
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2.3.1 Negative Impacts of Organizations on Nature

With its predominant focus on negative impacts by organizations on nature, most ONE research falls into the first quadrant: impacts are viewed as linear, uni-directional and negative
(i.e., harmful), motivating a host of drivers to reduce organizational impact. Much of the impressive body of ONE research examines regulatory, institutional and market pressures, organizational responses like organizational leadership or reactive compliance, and the dynamics behind them (cf. Hoffman & Georg, 2012).

Pressures on and responses by organizations tend to be operationalized in social measures that capture economic, organizational or broader societal variables. While Bansal and Gao (2006) find that 62% of studies focus on environmental outcomes, measures for such outcomes tend to be proxies from the social realm (e.g., certifications, legal compliance, data bases such as the Toxic Release Inventory). Operationalizing and measuring environmental variables as social variables has important methodological implications (e.g., access to data), but it also creates little impetus to remedy the resulting limited understanding of actual ecological impacts or use ecology- or nature-based constructs and measures (Kallio & Nordberg, 2006).

It confirms that the field of ONE has neither developed the “necessary interdisciplinary perspectives” (Starik, 2006: 433), nor generated its own theoretical foundations. ONE has largely adopted and adapted well-established organization-theoretical currents, both accepting the domain of the social as its theoretical (as well as methodological) boundary, and missing an opportunity to generate novel and potentially high-impact theory.

This has likely contributed to ONE’s standing and legitimacy in mainstream MOS (Suchman, 1995), but it does not respond to the calls for new paradigms issued so passionately at the time of the field’s founding. Nevertheless, today’s considerable body of ONE research has contributed to MOS more broadly, has drawn scholarly attention to nature, and has made nature a legitimate topic of research for MOS scholars.

2.3.2 Negative Impacts of Nature on Organizations

The reverse direction of impact is perhaps even more pervasive, if less researched: clearly, the natural environment impacts organizations both negatively and positively (e.g., entire industries are built on natural resources providing raw materials, most plainly seen in the sector providing human food). Calls to consider both ‘inside-out’ and ‘outside-in’ effects (Porter & Reinhardt, 2007; Winn & Kirchgeorg, 2005) highlight the importance of research on impacts in both directions (Boons, 2013).
Negative impacts are beginning to draw both practitioners’ and scholarly attention. Natural disasters, such as extreme weather events, and changing resource abundance, such as water in regions affected by extreme droughts, increasingly generate organizational responses to and recovery from their effects. A few examples of research in these areas include managing resource scarcity and resilience (e.g., King, 1995), adaptation to disasters, including sensemaking (Kolk & Pinkse, 2005; Weick, 1993; Winn, Kirchgeorg, Griffiths, Linnenluecke, & Günther, 2011), and adaptive capacity and resilience (e.g., King, 1995; Linnenluecke & Griffiths, 2010; Linnenluecke et al., 2012).

2.3.3 Positive Impacts of Organizations on Nature
While most research has focused on negative impacts in both directions, positive impacts have received extremely little consideration to date. Given the growing number and diversity of initiatives found in management practice, with considerable implications for firm strategy and business models, this is an area ripe for rigorous empirical studies. The notion of positively impacting nature is best illustrated by efforts to reclaim industrial sites and restore ecosystems to again become ‘self-sustaining.’ Removing harmful substances, and reintroducing species and structural features help reverse trends of declining ecological productivity. Innovative efforts by corporations across a range of industries, often in partnership with large NGOs offer case studies and growing data bases. An example is the WWF “Transforming Business” partnership program which focuses on improvements in the production of several commodities – cotton, whitefish, sugarcane, palm oil, timber, tuna, paper, etc. – and involves many companies such as The Coca Cola Company, IKEA, Unilever, Marks & Spencer, Mondi. At current, however, we find virtually no mention of research on such developments in ONE or MOS more broadly.

2.3.4 Positive Impacts of Nature on Organizations
Our final quadrant, least tended to in MOS and perhaps most thoroughly taken for granted, captures the provision of food, clean air, water, a stable climate and other resources so essential for human life to flourish. Issues such as the availability and affordability of raw materials as inputs into industrial supply chains, the wellbeing of employees, enough and healthy nutrition all speak to the fundamental dependency of human organizations on nature and its biophysical foundations. This is perhaps best captured in the concept of natural capital
from ecological economics (e.g., Berkes & Folke, 1992), but it is only rarely touched on in
MOS (e.g., Russo, 2003). Its taken-for-granted status tends to be challenged under conditions
of scarcity, changing dynamics of global competition, and shifts in geopolitics.

2.3.5 Bi-directional Impacts, Positive and Negative
Our 2x2 matrix is helpful to map research and highlight gaps; but by design, it captures only
linear, uni-directional and simple relationships for organizations and nature interactions, while
ignoring feed-back and other more complex effects. We have argued that the natural and the
social are mutually constitutive. This invites research on organizations to go beyond the study
of impacts of one on the other, and of only one valence. Early paradigm-challenging research
in ONE called for more inclusive and integrative perspectives and offered suggestions for
future research, including Starik and Rands’ multilevel/multisystem framework (1995),
Purser et al.’s ecocentric system approach (1995; Montuori & Purser, 1996); more recently,
see also Starik and Kanashiro (2013) and Stead and Stead (2008).
A separation into two distinct domains, the social and the natural, “is artificial and arbitrary”
(Folke et al., 2005: 443), and worse, may be theoretically inaccurate and misleading. New
empirical studies show that “simple linear and reductionist dynamics give a misleading
representation of how social-ecological systems work” (Levin et al., 2013: 113). An
integrated perspective also has compelling practical implications, since “[t]he issue of linking
ecosystems to socioeconomic-cultural ones is of central importance for the analysis underlying
almost any action related to sustainability” (Folke, Pritchard, Berkes, Colding, & Svedin,
2007: 1).
Notions of recursive causality, mutual causation and emergence of natural and social spheres,
and the mechanisms effecting mutual causation and co-evolutionary processes have been
captured in conceptual frameworks of social-ecological systems (SES). We suggest that the
theoretical and practical advances around SES, which draw on perspectives viewing social
and ecological systems as interconnected, complex and adaptive, can serve as inspiration and
foundation for intriguing new research in MOS. An example helps illustrate this point.
Impacts in either direction, from nature on organizations and from organizations on nature,
are amplified when feedback effects occur in addition to linear, uni-directional effects. The
epidemic of so-called ‘superweeds’ (Nature, 2014; Neuman & Pollack, 2010, examined in more detail below), illustrates the potential for escalating effects and highlights the complex dynamics of mutual (bi-directional) affectedness. Feedback mechanisms are further complicated when they are spatially dispersed (e.g., when the pesticides used in intensive agriculture hamper efforts to establish organic farming practices, and impact life in rivers and water basins) or time-delayed (e.g., shifting farmland to grow corn for ethanol, thus reducing food crops; persistent organic pollutants that slowly enter the food chain by accumulating in the body fat of living organisms, showing harmful effects decades later). Using a systems perspective for research on organization-nature relationships allows for theorizing such complex, multi-valence and bi-directional effects, and for capturing spatial dispersion and temporally delayed effects.

Earlier, we examined some of the barriers to building new theoretical foundations to study the complex relationships between organizations and nature. Indeed, contributions that offer MOS new and potentially radical research directions have remained few and on the periphery; examples are the works by Porter (2006) and Kallio and Norberg (2006) introducing mechanisms of co-evolution, or Whiteman and Cooper’s concepts of ecological embeddedness (2000) and ecological sense-making (2011).

Bridging knowledge from social and natural sciences in other disciplines, system-based conceptual approaches better capture the dynamics, feedback effects and complexity of relationships between social and ecological realms. Adopting the perspective of social-ecological systems, with focus on organizations as a component of, and embedded in, broader social systems (cf., Starik & Kanashiro, 2013; Winn & Pogutz, 2013) allows us to go beyond uni-directional impacts. Social-ecological systems help conceptualize impacts between organizational and natural systems as occurring in both directions.

Arguments from theory and practice urge MOS to not “proceed as if organizations lack biophysical foundations” (Gladwin et al., 1995: 875), despite the formidable barriers described above. We suggest that SES conceptions offer theoretical insights and methodological tools to MOS that have the potential to transform the field (Gladwin, 1993; Shrivastava, 1994), can account for interdependencies (Newton, 2002) and contribute to novel and relevant organization theorizing (Birkinshaw et al., 2014; Ferraro, Pfeffer, & Sutton, 2005; Suddaby et al., 2011).
On the other hand, it is worth noting that organizations and organizing appear to be vastly underrepresented or completely absent in many SES frameworks (Binder et al., 2013). This provides yet another opportunity for MOS to fill a major gap in international efforts to develop better science on and governance of social-ecological systems.

We have proposed a radically new ontology for MOS which rests on two “fundamental assumptions about the nature of organizational phenomena” (Gioia & Pietre, 1990: 585; see also Pfeffer, 1993; emphasis added). One is that the natural and the social (and thus organizational) spheres are mutually constitutive, with human impact growing dramatically. Two, ontological asymmetry describes nature as prior to human society and organizations, in the sense that “although the biophysical can exist without the social, the converse is categorically impossible” (Carolan, 2005: 394). This new ontology has profound implications for “the nature of knowledge about those phenomena” (Gioia & Pietre, 1990: 585), i.e., epistemology and methodologies, and requires new ways of building scientific knowledge about them.

Next, we take a closer look at research on social-ecological systems. It is our intent to take advantage of the work done by those scientists who overcame the deeply rooted divides between their respective disciplines to derive the underlying, and quite radical, ontology of interconnected social and ecological systems. Akin to the resource-based view versus the resource-based theory of the firm (Barney 2001; Barney, Ketchen, & Wright, 2011), we label this approach the Social-Ecological Systems View (SESV) to signify that at this time it does not qualify as a theory, but it does offer a coherent and promising research perspective for the study of the relationships between human organization(s) and nature. We examine how this work can inform research in organization theory, delineate critical characteristics that define social-ecological systems, and explore implications for research.

2.4 Adopting a Social-Ecological System View

Discussion on relations between organization and the natural environment as nested and integrated into complex ecological and societal systems is not entirely new, but the ideas proposed (e.g., Hart, 1995; Gladwin et al., 1995; King, 1995; Starik & Rands, 1995) have not been further developed or adopted in MOS. In contrast, fields like ecology and environmental
sciences (Berkes & Folke, 1998; Gunderson & Holling 2002; Holling, 2001), ecological economics (Costanza & Daly, 1987, 1992), political ecology (Peterson, 2000), and anthropology (Abel, 1998) have developed conceptual frameworks, models and practical tools to represent, understand and explain the complex relations and feedback loops characterizing the dynamics of the social and ecological as coupled systems.

A common feature of research on SES is its inherently interdisciplinary character, aimed at studying the interactions between humans and their institutions and organizations on one hand, and nature on the other hand (Folke, Hahn, Olsson, & Norberg, 2005; Westley, Carpenter, Brock, Holling, & Gunderson, 2002). Modern ecology (Abel & Stepp, 2003), with its expanded boundaries, brings a very different perspective to research on the management of natural resources. Two core assumptions are that ecosystems are inextricably linked with social systems, and that such coupled systems exhibit many, and strong, types of interactions. Both ecological and social systems contain connected units that interact, and each unit may entail multiple, interactive subsystems as well.

The term SES was first introduced in 1998 by Berkes and Folke, to “emphasize the integrated concept of humans in nature” (Folke et al., 2005: 443). Some have defined social-ecological systems as “nested, multilevel systems that provide essential services to society such as supply of food, fiber, energy and drinking water” (Binder, Hinkel, Bots, & Pahl-Wostl, 2013: 2). But the human species not only depends on the natural environment, it is also a dominant species with the ability to use, build, change, and destroy it. As mentioned earlier, the human capacity of organizing has overtaken the self-organizational capacity of ecosystems, to the point that scientists have named our (social-)geological epoch the Anthropocene (Crutzen, 2002). Addressing the question of natural resource management only from a socio-economic perspective, without understanding resource and ecosystem dynamics, will not guide our society towards sustainability, nor can it even render accurate theories. In practice, economic mechanisms like environmental taxes on emissions into a contaminated water basin may not lead to recovery if decision makers do not link ecological variables (e.g., biophysical aspects such as the trophic status of a lake, its depth, water temperature, sedimentation processes) to social variables (e.g., levels of sewage resulting from private and commercial human activities).
Similarly, focusing on ecological variables only can lead to a simplistic view of environmental problems, where both the role of social systems in generating damage to the biosphere, and the ability of individuals, organizations and institutions to respond, manage and even restore natural processes are underestimated. According to 1988 Robert H. MacArthur Award winner Simon Levin, “linkages between ecological and socioeconomic systems are key to ensuring environmental protection and economic growth” (2006: 328).

Moreover, ecological and social systems share structural and functional similarities that pose intriguing theoretical challenges for scholars working across disciplinary boundaries, opening exciting opportunities for research. Phenomena such as competition for resources, functional specialization, evolutionary processes, parasitism or cooperation are common themes to both spheres. Such commonalities have prompted management and organization scholars to borrow concepts from natural sciences to explain organizational behaviors (e.g., population ecology, Hannan & Freeman, 1977, 1984 and co-evolution, Volberda & Lewin, 2003). In the same vein, natural scientists have adapted theories from sociology or economics to explain ecological dynamics like competition for resources and cooperation (Chave & Levin, 2003; Tisdell, 2004).

Both systems can be described as complex adaptive systems (Levin, 1998) with multiple and diverse agents capable of changing, learning and organizing across multiple scales of time and space. A critical difference is that social systems have the distinctive capacity to generate symbolic construction and meanings through language (Westley et al., 2002). Social systems and humans, despite being subject to physical, biological and ecological forces “act primarily on the basis of representation and interpretation of the world that make meaning central to explanations of their behaviour” (Boisot & McKelvey, 2010: 419).

Employing a broader systems perspective opens up important opportunities to leverage interdisciplinary knowledge and build an integrated approach. Coupled social-ecological systems and their defining features provide the world-view and ontological foundation from which to examine relationships between nature and human organizations. In MOS, where the social and ecological nexus is barely acknowledged (Boons, 2013), it is not surprising that concepts of SES have not yet been adopted (Westley et al., 2002). To prepare the ground for novel theorizing, we introduce the distinctive features that characterize social-ecological systems.
2.4.1 Complex Adaptive Systems

Complex adaptive systems (CAS) and their properties were introduced to MOS by complexity theory scholars opening powerful research avenues for studying organizations from different ontological and epistemological perspectives (Anderson, 1999; Boisot & McKelvey, 2010; Ofori-Dankwa & Julian, 2001; Maguire, McKelvey, Mirabeau, & Öztas, 2006; McKelvey, 1997; Stacey, 1995). Even though we draw on some shared basic assumptions, our goal in this paper is different; we aim to show where and how conceptions of SES can inspire theoretical and applied contributions in MOS.

Systems perspectives first emerged in the early 1950s (e.g., von Bertalanffy, 1950; 1972), developing into complexity science and complex adaptive systems theory. In the environmental sciences, this led to a profound transformation, affecting what phenomena were observed and the ways in which knowledge is produced, including research tools and methodologies (DeLeo & Levin, 1997; Holling, 1998). Complex adaptive systems and their properties have been defined in multiple ways (Anderson, 1999; Gell-Mann, 1994; Simon, 1996). In general, they are considered as systems where components (or agents) and the structure of interactions among components (or agents) adapt over time to internal and external perturbations (Holland, 1992). There is agreement that CAS are self-organized and co-evolve with their environments, and that patterns at higher levels of organization result from dynamics of interactions at lower scales.

Both ecosystems and human systems exhibit complex and adaptive dynamics. Levin defined ecosystems as “prototypical examples of complex adaptive systems, in which macroscopic system properties such as trophic structure, diversity–productivity relationships, and patterns of nutrient flux emerge from interactions among components, and may feed back to influence the subsequent development of those interactions” (1998: 431). Due to their recursivity, social systems manifest even higher levels of complexity, since humans and their organizations are agents with the capacity for deliberate action and intentionality, exercise of power, adaptive learning, and foresight (Walker, Gunderson, Kinzig, Folke, Carpenter, & Schultz, 2006). Unlike physical or natural systems, agents in social systems can therefore behave in response to and manage the state of the systems (Anderson, 1999; Boisot & McKelvey, 2010). Science itself, through the knowledge and understanding of natural and social worlds it produces, could be viewed as an agent in this perspective – particularly in light of its dramatic
expansion and increased resource allocation around the globe, and “the social authority it carries” (Meyer, 2008: 795).

System complexity increases with the number of interconnected components and with the density and nonlinearity of the interdependent outcomes (Boisot & McKelvey, 2010). The result is that coupled social-ecological systems are “devilishly complex,” as Costanza et al. suggested two decades ago (1993: 545). As a further consequence, environmental problems such as overharvesting natural resources or misuse of ecosystems are difficult to understand and even more difficult to manage. Multiple causes resulting from non-linear feedbacks generate unexpected effects and surprise, and the structures (i.e., the systematic physical organization of their abiotic and biotic components) and functioning of ecosystems, covering a wide range of spatial and temporal scales, impede anticipating future dynamics of the system (Folke et al., 2007). Five properties of SES as complex and adaptive systems have particularly important implications for theoretical investigation; although interrelated, we describe them individually for analytical clarity.

2.4.2 Properties of Social-Ecological Systems

Connectivity and modularity. Components of the system (or agents) are partially connected to one another and the particular state (or behavior) of a component depends on sub-system components. In SES, connectivity can take multiple forms; functional interdependencies link elements of the biophysical environment with socio-economical agents and vice versa. Three examples help to illustrate connectivity: intensive agricultural practices in the Great Planes of the U.S. Midwest produce nutrient loading which creates “dead zones” in the western Gulf of Mexico (Stafford, 2010); the deforestation of an area resulting from socio-economic forces including policy decisions, land use practices, and market dynamics can generate impacts in areas far away from the changes in local land-cover; and the decision to build a dam has consequences for social-ecological systems far away from the flooded area.

Connectivity is linked to modularity, the degree to which system components can be separated and recombined (Levin et al., 2013). The role of modularity is evident in processes where harmful properties (physical or social) spread through a system (e.g., a pest in agriculture; the 2008 economic crisis; a flu virus). Modularity refers to mechanisms blocking or isolating parts of the system, thus allowing it to reorganize.
Connectivity and modularity generate some interesting theoretical and methodological questions. How can the boundaries of organizations conceived as part of an SES be defined? What is the effect of considering only first-level impacts of organizational activities on ecosystems (e.g., pollution, waste, resource use such as trees), versus second-level impacts on ecosystem functions and connected ecosystems? Does the notion of connectivity change how scholars define the scope of their analysis, for example by including ecological variables in expanded notions of supply chain beyond the firm-supplier relationships?

**Non-linear feedbacks.** Non-linear feedbacks are at the essence of relationships between agents in CAS, where inputs are often not proportional to outputs, and where “small perturbations can become magnified and lead to qualitatively unexpected behaviours at more macroscopic levels” (Levin et al., 1998: 227). As a consequence, non-linear feedbacks can prompt accelerating snow-ball effects that lead to sudden, rapid and irreversible changes in the system, and might cause it to flip into another state with unexpected and undesirable effects. Natural scientists have observed these dynamics in several different ecosystems as consequences of human pressures: grasslands can change permanently into desert lands; fisheries can suddenly collapse in response to small percentage increases in fishing (Levin et al., 2013). In human systems, the term ‘escalating commitment’ refers to a similar dynamic.

**Multiple spatial and temporal scales.** Another important characteristic of coupled SES is that human social and economic activities are “nested in the biosphere,” itself composed of nested biological, chemical, and physical processes with multiple scales (Abell & Stepp, 2003: 4). Impacts from social systems on the natural environment (e.g., technology and production regimes, markets of goods and commodities, life-styles and consumption patterns) and associated ecological degradation manifest themselves in spatial and temporal scales that rarely match or overlap (Folke et al., 2007). Plastics and micro-plastics, for example, often accumulate in geographical spaces (e.g., marine coastal areas) distant from where manufacturing and consumption occurs. While they are produced and utilized according to short-term economic cycles, it is unlikely that they will fully degrade even over a span of centuries.
Levin et al. illustrate this property suggesting that in SES “macroscopic properties emerge from local actions that spread to higher scales due to agents’ collective behavior; these properties then feed back, influencing individuals’ options and behaviors, but typically only do so diffusely and over much longer time scales” (2013: 113). Moreover, scales in complex SES are not static, but change over time: ecologists have observed that many environmental problems requiring attention have characteristic time-periods but can speed up, and spatial scales that can geographically expand. The well-known example of the effects of DDT and other pesticides on the human body reflects the issue of systems evolving in different slow-fast dynamics, with relevant implications on the resilience of the whole system (Maguire & Hardy, 2009). To ignore the importance of time and spatial scales carries serious risks. When interactions among events are simplified or isolated, and when SES are treated as if their dynamics were time and space free, the effects of disturbances on the system are underestimated and the risk of dramatic flips to different state conditions increases.

Both non-linearity and multiple scales pose challenges not only to management practice, but also to research. Short-term profit-maximization serves as an example of an institutional paradigm which effectively blinds organizations and their managers to those ecosystem processes that occur over longer time scales, thus both obscuring them and making them managerially irrelevant (in the short term) (e.g., Bansal & desJardine, 2014; Bansal & Knox-Hayes, 2013). An example is intensive agriculture, where large-scale use of fertilizers has generated immediate, vastly improved efficiency and economic value; over time, however, it causes wide-spread soil erosion, salinization and acidification locally, and it impacts geographically distant ecosystems like rivers, water basins and open sea waters for extended periods of time (Folke et al., 2007). While “the physical sciences have moved beyond Newtonian concepts of time as static, measurable, and divisible through a number of discoveries that characterize time as dynamic” (Slawinski & Bansal, 2013: 1557), reductionist research approaches are particularly ill-suited to capture complex natural (i.e., biological, chemical and physical) processes that occur at multiple, longer temporal and more distant spatial scales.

How can organizations manage, or even measure, slowly changing environmental variables such as progressive soil degradation or the decline of fish populations, when the same organizations are exposed to financial market pressures and strong short-termism (Bansal &
desJardine, 2014)? What kind of information is needed to understand, capture and measure the effects of organizations-ecosystems interactions occurring at multiple temporal and spatial scales? Complexity scholars have called for a new epistemology “that tracks the dynamics by which certain tiny events get amplified into extreme outcomes” (Boisot & Mc Kelvey, 2010: 426). To the degree that social-ecological dynamics follow non-linear paths and occur at scales not captured in our representations of the world, their impact on risk management, firm performance and firm value will remain understudied. We suggest that modern ecology can offer access to new information and help guide theory development that takes such nested, multi-scale phenomena into account.

**Resilience.** The concept of resilience has been discussed in multiple disciplinary contexts ranging from MOS (e.g., Sheffi, 2005; Sutcliffe, Sitkin, & Browning, 1997), to psychology (Luthar, Cicchetti, & Becker, 2000), system analysis (Holling, 2001), economy and sociology (see Folke, 2006, for an extensive review). More specifically, resilience has acquired particular importance in ecology and resource management science as a fundamental property of complex social-ecological systems. According to this school, ‘ecological resilience is the capacity of a system “to experience shocks while retaining essentially the same function, structure, feedbacks, and therefore identity” (Walker et al., 2006: 2), or without shifting into a qualitatively different state (Gunderson & Holling, 2002). The more resilient a system is, the more disturbance it can absorb and reorganize after the perturbation without flipping to another state; when a system loses resilience, it becomes more vulnerable to external shocks. In coupled social-ecological systems, resilience is particularly difficult to build since multiple alternate systems states, according to societal values and beliefs, may be considered desirable by some, and undesirable by other segments of society (Gunderson & Holling, 2002). Creating a specific state of system resilience, moreover, such as building dikes to prevent a river from light flooding and allowing social-economic activities to develop close to the river banks can be ineffective for containing large and less frequent floods, leaving people more vulnerable to these events (Levin et al., 2013).

Applying these ideas to MOS, we see vast opportunities for research, although few MOS scholars have drawn on the concept of ecological resilience (King, 1995; Marshall & Toffel 2005; Whiteman et al., 2013; Winn et al., 2011; Winn & Pogutz, 2013). If organizations are,
in fact, key agents in SES, then their role in building resilience is significant, as is the need to collaborate with other agents to strengthen overall system adaptability. How does this affect the way in which management and organization theories define firms’ responsibility towards shareholders, stakeholders and society at large (e.g., Scherer & Palazzo, 2011)? To what degree will organizations have to adapt their strategy to maintain or build resilience of social-ecological systems? What type of competencies and capabilities will companies need to develop and how?

Diversity. Another fundamental property associated with CAS is diversity or heterogeneity (Holland, 1995), which has been studied with regard to ecosystems (Levin, 1998), social systems (Low, Ostrom, Simon, & Wilson, 2003; Ostrom, 2005) and coupled SES (Levin et al., 1998; Walker, Holling, Carpenter, & Kinzig, 2004). The generation and maintenance of diversity allows SES to preserve their capacity to adapt, compensate for external shocks, and therefore increase their stability. For example, the loss of genetic heterogeneity in fisheries and agriculture can potentially accelerate the evolution of pest genotypes, leading to the collapse of the stock (Levin et al., 2013). Similarly, the process of socio-economic globalization, through the increase of connectivity among agents, fosters the homogenization of agro-ecosystems and the loss of species diversity (Young, Berkhout, Gallopin, Janssen, Ostrom, & van der Leeuw, 2006), with potentially dramatic consequences on ecosystems and their capacity to continue providing the resources and services on which humans and organizations depend (MA, 2005).

Diversity links strongly to other system properties, such as resilience and connectivity. Indeed, “[t]he key to resilience in any complex adaptive system is in the maintenance of heterogeneity, the essential variation that enables adaptation” (Levin, 1998: 435). Work on environmental protection pays increasing attention to diversity and heterogeneity also in the context of social systems. Institutional diversity, for example, has been studied with regard to its role in absorbing disturbance and increasing the resilience of coupled social-ecological systems (Low et al., 2003; Ostrom, 2005). More interdisciplinary research is needed that relates such dynamics to diversity, and its role in avoiding undesirable system transformations.
New research in MOS might examine diversity from a broader SES perspective. Ecological or bio-diversity has generated minimal interest among organization scholars (Etzion, 2007), with few contributions on the linkages to management and organizations (Westley & Vredenburg, 1996, 1997; Whiteman et al., 2013; Winn & Pogutz, 2013). Research might investigate how the preservation of diversity either matches or conflicts with industrial economics logics like scale economies or efficiency. For companies operating in the agro-food industry (e.g., coffee, tea, cereals), forestry or textile, future research could focus on how the preservation of ecological diversity impacts farming practices and corporate supply chains. More broadly, what conditions and incentives are required for organizations to nurture social and ecological diversity to increase the adaptability of broader SES and cope with disturbances? What are the implications for organizational structure and corporate strategy, what competencies and capabilities are needed for companies to manage diversity effectively, and what are some implications for competition and industry dynamics? We hope that our suggestions on each of the SES properties spark new ideas for interesting and useful future research.

Three additional features characterize SES, with major implications for research and practice. Considered to be structural system conditions (Holling, 1998), uncertainty and risk limit the capacity to manage SES and anticipate surprises (e.g., King, 1995); the concept of adaptation is also gaining increasing attention in modern ecology, natural resource management and MOS (see prior section).

### 2.4.3 Uncertainty, Risk and Adaptation

Social–ecological systems as complex adaptive systems exhibit high levels of uncertainty and unpredictability, which stem from their distinctive features as CAS and lead to the risk of surprise and structural changes (Holling, 2001; Gunderson & Holling, 2002). System uncertainties have generated many surprises not previously considered or anticipated by managers, policy makers or scientists, and complexity theorists have explored the implications for organizations (e.g., Anderson, 1999). In the context of SES, uncertainty also places constraints on improving adaptation and system resilience (Gunderson & Holling, 2002).

The case of the Georges Bank fishery, formerly one of the most productive and accessible Atlantic fishing banks between New England and Nova Scotia, illustrates the point. Marine
ecologists and economists used logistics models to determine sustainable levels of fishing, but were not able to prevent the collapse of several fish stocks in the early 1990s (Kinzig & Starrett, 2003). Today, many years later and despite fishing reduced to a mere 20% of prior quota, Atlantic cod has not yet recovered.

Uncertainty in CAS has many sources, including lack of practical knowledge (e.g., on species, their populations and distributions) due to insufficient global or national monitoring systems, and scientific knowledge related to a “lack of understanding of ecosystems’ functional dynamics, a limited modeling capacity, …the lack of theories to anticipate thresholds, and the emergence of surprises and unexpected consequences” (Levin et al., 2013: 127). While system complexity limits the capacity to predict the future, social actions that can lead to irreversible transformation are of special concern (e.g., biodiversity loss; climate change; large scale deforestation in Borneo or the Amazon). And yet, generating knowledge on how complex adaptive system self-organize and co-evolve is absolutely critical to manage resilience and avoid surprises from dangerous regime shifts that can suddenly interrupt the provisioning of ecosystem resources and services (Berkes & Folke, 1998; Folke et al., 2005) at various scales.

Management of ecosystem resilience is a distinctive feature of SES and differentiates these complex systems from natural or physical ones, where spontaneous organization happens without centralized intent or hierarchical control (Anderson, 1999; Levin, 1998). In the case of social-ecological systems, when considering the system as a whole, scientists assert that self-organization is a process independent from single agent intentions or goals. Holling suggests that living systems of people and nature are “self-organized, and a small set of critical processes create and maintain this self-organization” (2001: 391), while Walker et al. highlight the critical role of science and deliberate management of SES, saying that “although the system as a whole self-organizes without intent, the capacities and intent of the human actors strongly influence the resilience and the trajectory of the SES” (2004: 2).

Humans and human organizations thus play a special role in social and ecological systems. Individuals and organizations pursuing their specific goals have the capacity to influence the dynamics of the system to a breadth and depth unprecedented in the history of the Planet (Rockström et al., 2009; IPCC, 2014). Phenomena such as the current climate transformation and the rate of biodiversity loss are the result of human actions – intentional or unintentional –
in social-ecological systems at local, regional and global scales. On the other hand, individuals through their organizations and institutions can potentially manage some of the system variables, build governance systems, and avoid flips to undesirable situations (e.g., irreversible environmental crises or system collapse), and sustain the capacity of ecosystems to provide resources and services that we all – individuals, organizations and entire societies – depend upon (Folke et al., 2007).

Human actors are said to have the “capacity to reorganize the system within a desirable state in response to changing conditions and disturbance events” (Folke et al., 2005: 444). Indeed, adaptability is defined as the collective capacity of human actors in the system to manage resilience (Walker et al., 2006), and a growing body of literature in natural and social sciences studies how actors can manage SES change and enhance system adaptability.

The inherent uncertainty and unpredictability of the organization-ecology relations has multiple implications for management and organization theorizing and practice. There is ample research in MOS which has investigated risk from multiple perspectives, including operations, strategy, and finance, and extensive literature on how conditions of uncertainty affect individual and collective decision-making. The notion of risk has also been addressed by some scholars in ONE, starting with the early works of Shrivastava (1995a) and King (1995), who investigated the effects of ecosystem degradation and the unpredictability of ecological changes on organization. More recently, climate change has drawn scholarly attention to the risks of global warming to various industries (Winn et al., 2011). A new area for future research on sustainability is the development of theoretical frameworks that help increase societal and organizational capacity to anticipate future events, adapt to them, and avoid abrupt transformations.

Complexity theorists who investigated the implications of CAS for organization and organizing offer novel directions for future research. Developments like the power law or agent-based simulation modeling provide scientists with conceptual frameworks and tools to deal with complex and scalable phenomena (e.g., Boisot & McKelvey, 2010). Tighter collaboration with the modern ecology school can also prove fruitful; competencies in and advances on social and ecological systems knowledge help understand the implications of organizing in increasingly unpredictable environments, and anticipate and increase the organizational adaptability.
2.4.4 Implications for Methodology

Building research in MOS on an SES perspective (with system properties that greatly increase the complexity of nested and interacting systems), which relies on expertise from historically vastly different sciences, is not without challenges – whether due to diverse and not always compatible epistemologies, theoretical concepts and reasoning, or knowledge based in mutually unfamiliar phenomena and processes. We expect an additional major challenge to lie in the development of new, and the fine-tuning of shared, methodologies, modelling and other approaches to gathering empirical data. We touch on just a few areas where methodological innovation and collaboration between researchers from different fields can help capture and explain the various sources of complexity between nested organizational and natural systems.

The overarching question is how we can empirically assess multi-level, nested phenomena that operate through non-linear processes and are subject to multiple spatial and temporal scales. More generally, how can a perspective based on coupled social-ecological systems be adequately represented in empirical methodologies? What is the role of inductive case studies and other qualitative methods for building theory?

Deductive analyses might expand their empirical toolkits and draw on rules and modeling approaches of ecological dynamics from natural sciences in order to assess and/or test system properties. As we pointed out earlier, most extant ONE research uses proxies for environmental performance, measuring organizational or social outcomes (e.g., emissions or legal compliance) rather than actual effects on and in the environment (e.g., changes in temperature averages or ecosystem resilience). What can measures of organizational impacts in terms of actual ecological effects contribute? What approaches are available to assess and analyze complex systems, including multiple feedback effects? Levin et al. (2013) propose ‘agent-based models’ and ‘adaptive-learning agent based models’ to study complexity, also viewed as promising for organization science by McKelvey et al. (1997). Such a methodology, which is flexible and can be combined with other empirical methods, might provide interesting opportunities for research at the intersection between organizations and the natural environment (Grimm et al., 2005; Janssen & Ostrom, 2006).

Finally, how can research teams combine or bridge knowledge from different fields into an integrated approach or system of approaches? Focused discussions (e.g., as proposed by Whiteman et al., 2013) can bring together competencies from multiple scientific fields to
assess the ecological, economic, political and other social effects of complex phenomena such as deforestation for palm oil or fisheries collapse.

Guided by recent work at the intersection between the natural and social sciences, we have introduced the social-ecological systems view (SESV) as a promising new perspective for MOS to expand its boundaries, include nature in its theoretical domain, and define organizational phenomena as deeply affected by and affecting nature. Adopting an SESV, rooted in SES as complex and adaptive systems, calls for new theories and methodologies to adequately represent organization-ecosystem interdependencies. This view also invites us to (re-)conceptualize relations between social agents (individuals, organizations and institutions) in light of the properties and dynamics of ecological and social-ecological systems.

2.5 New Research Perspectives, New Research Directions
Since complex adaptive systems exhibit uncertainty and are only loosely predictable, managing system resilience and adaptability is critical to avoid crossing into undesirable system regimes with potentially dramatic consequences for the provisioning of services and resources (Walker et al., 2004). Below, we touch on how MOS can contribute to our understanding of social-ecological systems more generally, and how the field can enhance our capacity to manage them more sustainably. Using two illustrative mini-cases, and applying an SESV to research on (a) institutional logics and (b) strategic capabilities and competitive advantage, we develop a number of exemplary research questions.

2.5.1 Research Questions for Institutional Theory: Institutional Logics
Institutional theory (Scott, 1987; Scott & Meyer, 1983) has been an important foundation for ONE since the early works by Jennings and Zandbergen (1995) and Hoffman (1999), guiding research on institutional isomorphism and institutional logics, corporate environmentalism and institutional entrepreneurs (for a review, Hoffman & Georg, 2012). Unlike institutional economists (Ostrom, 2007; 2009), organization institutional scholars have not brought ecological system considerations into their work (some exceptions are King, 1995; Westley et al., 2013).

The notion of institutional logics has spawned a rich and dynamic area of inquiry (Friedland & Alford, 1991; Thornton & Ocasio, 2008), including hybrid logics and associated tensions in
sustainability-related phenomena (e.g., Besharov & Smith, 2014; Hahn et al., 2014a,b). Defined as “formal and informal rules of action, interaction, and interpretation that guide and constrain decision makers” (Thornton & Ocasio, 1999: 804), institutional logics “encode the criteria of legitimacy by which role identities, strategic behaviors, organizational forms, and relationships between organizations are constructed and sustained” (Suddaby & Greenwood, 2005: 38).

In practice, the dissociation of social systems from ecological systems and their complexity, by oversimplifying social-ecological interactions, has led to perverse learning patterns in multiple fields (Asher, 2001). Strengthened by self-fulfilling theories (Ferraro et al., 2005) and supported by institutional interests, these processes recursively influence the reality we construct, therefore consolidating logics that guide us towards misuse of ecological resources, but that are considered legitimate and valuable by multiple institutional agents. An example helps illustrate this complex dynamic. Over the last two decades, agriculture practices and massive use of herbicides have spawned the rise of superweeds – plants whose modified genes make them highly resistant to herbicides, like Monsanto’s flagship Roundup. An example is the palmer pigweed, “a weed that can reach more than 2.5 meters tall, grow more than 6 centimeters a day, … produce 600,000 seeds and has a tough, woody stem that can wreck farm equipment that tries to uproot it” (Nature, 2014).

The rapid diffusion of superweeds is causing increasing economic damage to U.S. farmers, while rapidly spreading in countries like Australia, Brazil and Argentina. Academic journals such as Nature, magazines and newspapers like Scientific American, Businessweek and The New York Times have recently drawn attention to the battle against this “growing menace” (Adler, 2011). Created in the 1990s, Roundup was marketed for crops genetically modified to tolerate the chemical. This innovative product combination allowed farmers to spray their fields, kill the weeds, and leave their crop unharmed. Roundup Ready crops and the herbicide, then sold by other companies under the generic name glyphosate, rapidly diffused in the U.S. market: in 2010, it accounted for 90% of soybeans and 70% of corn and cotton (Neuman & Pollack, 2010). Leading agro-chemical companies (e.g., Monsanto, Syngenta, Bayer, Dow) are responding with ever more powerful herbicides and new generations of engineered-resistant crops. While reassuring farmers that “the cavalry is coming”, as Monsanto CEO Hugh Grant commented in an interview with Businessweek (Kaskey, 2011), agro-chemical
companies assure environmental organizations and the media that the issue is serious, but manageable; that there is no need to worry, new technologies and innovation will solve the problem; and that (their) modified crops are better for the environment than other alternatives (Nature, 2014; Neuman & Pollack, 2010). Scientists, however, point to a vicious cycle which drives up the volume of herbicides needed each year while making superweeds more and more resistant (Adler, 2011). At the same time, alternative ways to combat resistance (using more targeted herbicides, reintroducing crop rotation, and tilling practices based in agro-ecological science) are neglected or downplayed as ineffective and costly (Gurian-Sherman & Mellon, 2013).

For one, the example of superweeds shows how ‘perverse’ institutional logics can develop and become firmly entrenched. Asher argues that: “Perverse learning patterns often arise because of oversimplification in the face of complexity, or because the lessons run counter to institutional interests. Thus, learning becomes perverse because it is institutionally convenient rather than valid” (2001: 744). The dominance of agro-chemical multinationals like Monsanto, Dow or Bayer in the farming industry builds on a reductionist view of SES complexity, one that has traditionally oversimplified linkages between system-parts. Connectivity, non-linear feedbacks, and slow-fast scales among natural phenomena are being downplayed or ignored. The superweed phenomenon is directly connected to (and co-constructed by) the diffusion of genetically modified crops and herbicides, emerging from non-linear and slow-scale processes (Gurian-Sherman & Mellon, 2013). They are an unexpected, sudden change that impacts thousands of farmers, their communities and their practices as a result of transformations in the social-ecological systems that generate the ecological surprise (King, 1995).

Two, this example highlights the relation between monoculture, economies of scales, volumes and efficiency, all features at the core of the industry’s competitive structure, but which run directly counter to the preservation of SES diversity and heterogeneity. Natural scientists stress the importance of maintaining long-term ecosystem functionality and ecological resilience in order to preserve natural soil fertility and pest control; this, however, is not in the ‘institutional interests’ of the industry (Adler, 2011). Special interests combine with rules of actions, material practices and rhetoric to favour the maintenance of a status quo. It, in turn, is based on a separation of the social-organizational realm from the ecological one, and blocks
the uptake and diffusion of new, more sustainable farming approaches. At the same time, our theories can become self-fulfilling and “influence reality in profound ways by influencing how we think about ourselves and how we act” (Ferraro et al., 2005: 8). We suggest that the case of monoculture in farming and the overreliance on herbicides and GM crops is an example of such a dominant (and perverse) logic, powerfully shaping our reality.

Incorporating knowledge from modern ecology can offer scholars new institutional lenses: to explore ways by which SES complexity can be understood as a factor of institutional life, and be brought to bear on institutional logics and theories. New research can create a better understanding of how and why, at the organizational level, perverse processes of learning take hold. How do logics contribute to misrepresenting and materially damaging nature and human-nature interactions in today’s global society? Organization theory might expose and break down the vicious cycles fed by simplistic accounts of (social-)ecological complexity and the dominance of institutionalized self-interests.

2.5.2 Research Questions for Strategy: Agency, Flexibility, Capabilities

The social-ecological systems view can also inform business strategy. As one of the main lenses for research on organizations and the natural environment, strategic perspectives guided the study of organizational responses to environmental pressures (e.g., Aragón-Correa, 1998; Shrivastava, 1995b), corporate environmental strategies, intra-organizational processes, environment-related capabilities (Aragón-Correa & Sharma, 2003; Hart, 1995; Hart & Dowell, 2011; Sharma & Vredenburg, 1998), and their implications for competitiveness.

An SESV could contribute to one of the important debates on the role of agency and structure in strategic decision making (Oliver, 1991; Powell and DiMaggio, 1991; Stacey, 1995). For example, what are the impacts of transformations in SES, whether system flips or reduced resource productivity, on corporate strategy? How does an SESV change theorizing on agents and their degree of choice? What are the impacts of changing conditions on shifting competitive dynamics and new sources for competitive advantage? A short case helps illustrate these points.

Palm oil is one of the most important vegetable oils in the global consumer goods industry: in terms of production, it is second only to soybean oil. Indonesia and Malaysia alone handle more than 85% of the global production, but plantations are also located in Colombia,
Australia, and Africa. Palm oil is by far the most versatile oil, and several multinationals like Unilever, Cargill, Procter & Gamble, Nestlé and Kraft make intensive use of palm oil for a host of applications in cosmetics, detergents and food. According to many NGOs, palm oil production drives deforestation and destruction of irreplaceable habitats, fuelling climate change and loss of biodiversity. Greenpeace (2008) traced the main palm oil suppliers operating in Kalimantan, showing that large corporations are responsible for “burning up Borneo” to expand palm oil plantations. And “[a] scenario realized by UNEP in 2002 suggested that most natural rainforest in Indonesia would be degraded by 2032. Given the rate of deforestation in the past five years, and recent widespread investment in palm oil plantation and biodiesel refineries, this may have been optimistic. New estimates suggest that 98% of the forest may be destroyed by 2022, and the lowland forest much sooner” (UNEP/UNESCO, 2007: 6).

Unilever took the lead in trying to promote a change in the industry. The Anglo-Dutch multinational joined forces with partners such as WWF and Migros, and in 2004 co-founded the Roundtable on Sustainable Palm Oil, an independent organization that aims to promote the growth and use of sustainable palm oil products by setting credible global standards and engaging with a wide range of stakeholders. But with changing consumption patterns in countries like India, China and Brazil driving up global demand for detergents and other products using palm oil, and given the absence of viable natural or synthetic alternatives due to palm oil’s unique functional properties, palm oil production is likely to increase dramatically. As a result, companies are expected to face increasingly difficult challenges in light of their dependence on a resource whose immediate continued supply is threatened by stakeholder pressures for the protection of Borneo’s fragile ecosystem.

This case illustrates how access to critical natural resources, their availability/scarcity, and the manufacturing of raw materials into final products result from impact-dependence relations between social-organizational and ecological systems. In the case of palm oil, the constraints deriving from trade-offs between forests and palm oil plantations, and from the interdependence between local, regional and global ecosystems (at multiple geographical scales) with regard to biodiversity and climate change, put growing pressure to companies to rapidly implement sustainable solutions.
The SESV provides a new perspective for research on structural determinants versus agency. A new area of inquiry might focus on how growing ecological constraints reduce the freedom of choice of agents through pressure on social and competitive forces. The availability and quality of natural resources is changing quickly, and several SES are at risk of flipping to new and uncertain regimes. How do such transformations affect future social and economic choices (Stacey, 1995), including a reduced range of options available to agents?

Industry structure and dynamics is also likely to be affected by natural resource availability. In the case of the agro-chemical industry discussed earlier, monoculture is the industry’s dominant agricultural practice. In the future, sustainable cropping techniques that acknowledge ecosystem complexity and foster ecological resilience might develop as a result of pressures from multiple social and natural forces and impact organizations, requiring significant changes in strategy, and destabilizing the market positions of leading companies.

In the example of palm oil, features such as connectivity, non-linearity, scales, and loss of diversity impact the SES resilience and generate increased risks of regime flips. The planting of palm oil trees affects biodiversity, causes water pollution impacting communities living along the rivers, and greenhouse gases released from peatland destruction contribute to climate change. As a consequence, NGOs and consumers exercise pressures on companies to modify their supply strategy and search for innovative solutions.

Another area of investigation can address how organizations develop capabilities to anticipate sudden transformations in SES and build social-ecological resilience. Due to inherent complexity features, transformation in SES can be sudden, rapid, and unexpected. One possible stream of inquiry could adopt the perspective of strategic flexibility (Evans, 1991; Hitt, Keats, & DeMarie, 1998), namely the ability to intentionally adapt to environmental changes through strategic actions, such as reconfiguring resource inputs and supply chain processes.

In a future where access to (natural) resources changes suddenly and dramatically (Winston, 2014), SES dynamics as drivers of only loosely predictable change might be added to strategic research foci, joining technology, market and macroeconomic considerations. Companies able to reduce their dependence on scarce, but critical natural resources through product innovations and more flexible, ecologically and economically sustainable business
models (Boons & Lüdeke-Freund, 2013; Teece, 2010) might be better positioned to increase or keep their market share – or at least survive.

Another major focus of strategy research is on firm-based resources and dynamic capabilities (Aragón-Correa & Sharma, 2003). The natural-resource based view (Hart, 1995; Hart & Dowell, 2011) also highlights the growing importance of base of the pyramid (BoP) strategies (Prahalad & Hart, 2002) for sustainability. A better understanding of the interrelationship between ecological and social dynamics is particularly critical in light of the combined effects of increasing social pressures due to poverty and inequity, and concurrent natural resource constraints on escalating the risk of system flips (see also Catton & Dunlap’s early work reviewing global stratification, 1978). Building on more recent BoP research on and beyond its earlier corporate focus (London & Anupindi, 2012; London, Anupindi, & Sheth, 2010), what type of internal and boundary-spanning capabilities will allow organizations and partnerships to address new threats and opportunities? Studying the characteristics of sustainable industries, Russo argued that “organizations that recognize – and to the extent possible, inventory—their natural capital assets will have a competitive advantage in coming decades. Their mandate is to protect and enhance their supply of natural capital” (Russo, 2003: 326). How can organizations protect or enhance their supply of natural capital to guarantee long-term sustainability? Echoing the call “to move beyond a narrow social or economic concept of organizational resilience and embrace … ecological resilience” (Whiteman et al., 2004: 371), we also invite research on how organizations can contribute to maintaining – or even strengthen – social-ecological resilience and adaptability.

2.5.3 Future Contributions from Management and Organization Studies

In reviewing the literature on social-ecological interdependencies, we found that organizational phenomena received extremely limited attention (see Figure 1). When discussing ways to manage coupled human and natural systems, modern ecology has drawn on concepts and theories from social sciences like sociology and economics (e.g., agency, governance, institutions or learning), but for a number of reasons outside the scope of this paper, have somehow marginalized the attention to the role organizations and organizing. Within the interdisciplinary community of scientists addressing social-ecological resilience and system adaptability, for example, the number of publications that include MOS scholars
on the research team is very limited (Westley et al., 2002, 2011; Whiteman et al., 2004). And yet, with the role of organized (including virtuous) ‘actorhood’ said to be expanding globally and at every level (Meyer, 2008), organizations are increasingly seen as both responsible for environmental degradation and as key actors in (a) reducing such impact and (b) increasing overall system adaptability through new management practices (Folke, 2006).

This current lack of attention to organizational levels of analysis represents an important opportunity for MOS scholars to more actively contribute to the broad debate on ecology and society, both theoretically and in practice. Two areas, governance and decision making, may offer ideas on how our community of organizational scholars can add to the understanding of social-ecological dynamics, and leverage such knowledge into practical guidance.

The notion of governance offers potential for bridging MOS with natural sciences (and other social sciences). Governance in modern ecology refers to the structures and processes by which agents in societies make decisions and share power with the goal to preserve natural resources and ecosystems from the perils of human pressures (Dietz, Ostrom, & Stern, 2003; Folke et al., 2005). The focus on governance has grown in proportion to the recognition that complex social-ecological systems cannot be controlled by conventional top-down, command and control approaches; what is required instead are new forms of ‘adaptive governance’ that include collaboration, partnerships, and networking among agents at multiple levels (Folke et al., 2005). Looking to MOS, the field offers knowledge on governance both within organizations and among organizations, and by involving several theoretical approaches (Eisenhardt, 1989; Williamson, 1999). Network governance (Jones, Hesterly, & Borgatti, 1997) and cross-sector partnerships (Selsky & Parker, 2005) are promising fields of interdisciplinary collaboration that fit with calls for adaptive governance. Work on network governance can contribute to building adaptive and flexible multilevel governance systems (Dietz, Ostrom, & Stern, 2003) with knowledge on how organizations develop forms of coordination through informal social structures. Work on cross-sector partnerships, which is inherently multi-disciplinary, investigates environmental and social issues and ‘trisector’ partnerships involving institutions, businesses and NGOs. Since an adaptive governance approach relies on “the collaboration of a diverse set of stakeholders operating at different social and ecological scales in multi-level institutions and organizations” (Folke, 2006: 262), we see significant opportunities for bringing organizational perspective to the debate.
Decision making is a second potential area where MOS can contribute a better understanding of social-ecological system dynamics. The high levels of complexity and uncertainty that characterize SES call for theoretical advances on how critical decisions are made by multiple agents (Polasky, Carpenter, Folke, & Keeler, 2011). Environmental sciences have studied decision-making mostly from decision theoretical perspectives and with decision tools such as threshold approaches, multi-criteria analysis, or scenario planning. Modern ecologists have added laboratory experiments and agent-based modelling to the methodological toolbox, aiming to address the issue of system complexity and decision under highly uncertain conditions (Janssen & Ostrom, 2006). Nevertheless, Levin and colleagues point out that decision making under limited information, but with substantial policy implications is only poorly understood, and yet, “how groups of humans make decisions is crucial to understanding how to manage the global commons” (2013: 124). On the other hand “since Simon’s break from the sterile view of ‘economic man’” (Eisenhardt & Zbaracki, 1992: 35), MOS has developed powerful theoretical frameworks that build on insights from multiple fields such as organizational behavior, organizational theory and strategy, to analyze organizational and strategic decision making. This body of literature can help better understand determinants of decision making in complex SES systems. It introduces organizations as key agents in decision making processes that impact on, and are impacted by, ecosystem dynamics, and helps explain individual and group behavior facing complex decisions.

2.5.4 Concluding Thoughts

I Paradigms are ways of thinking that reflect fundamental assumptions and beliefs about the characteristics of social, organizational and natural phenomena (Burrell & Morgan, 1979; Gioia & Pitre, 1990; Kuhn, 1970). Both the introduction of the ‘new ecological paradigm’ as an alternative to sociology’s ‘human exemptionalist’ orientation (Catton & Dunlap, 1978), and the founding of ecological economics (Costanza & Daly, 1987), confronted the theoretical foundations of their respective mainstream disciplines with new schools of thought based on a different view of the world (Dunlap, 2002; Murphy, 1995; Spash, 2012) – one where a finite, material, and constrained nature structurally conditions, and is conditioned by, social and economic factors.
In our own field, complexity theory has inspired management and organizational scholars to address tensions and antagonism between positivist and postmodernist approaches, and to develop a third way that “hinges on recognizing that organization science comprises both intentional and naturally caused phenomena” (McKelvey, 1997: 374). Rooted in an ontology and epistemology of complexity, the inherent interdisciplinarity of this new perspective has favored the development of different views of, and innovative theories on, organizational phenomena (Anderson, 1999; Boisot & McKelvy, 2010).

Developing an SESV at the interface between MOS and modern ecology responds to calls by ONE scholars to acknowledge the embeddedness of organizations in nature, and thus overcome the inadequacies of current theoretical approaches (Bansal & Knox-Hayes, 2013; Boons, 2013; Gladwin & al, 1994; Shrivastava, 1994; Slawinski & Bansal, 2012; Starik & Kanashiro, 2013; Starik & Rands, 1995; Whiteman et al., 2013; Winn & Pogutz, 2013). Earlier efforts to view organizational phenomena as embedded in and mutually constituted with nature have not been very successful. An SESV, however, built on a systems perspective and an understanding of complexity and associated system properties, provides a promising foundation for investigating organizational processes at the interface between social and ecological domains.

Modern ecology is inherently holistic, integrative, and open to contributions from a multitude of disciplines, including anthropology, ecology, geography, economics, political science; MOS is built on multiple base disciplines from social science. And since “[m]ultiparadigm approaches to theory building can generate more complete knowledge than can any single paradigmatic perspective” (Gioia & Pitre, 1990: 599), bridging MOS with modern ecology is bound to offer a promising outlook for research on organizations and nature.

We invite scholars from the many areas and theoretical directions in MOS to engage in this conversation, contribute their expertise toward novel theoretical and empirical insights and contribute practically relevant insights for management and public policy.
References


Chapter 3

Business, Ecosystem, and Biodiversity: New Horizons for Management Research

The paper is co-authored with Monika Winn

Abstract

Whether to secure critical resource inputs or responding to demands ranging from local communities to international stakeholders, leading multi-national companies are beginning to engage in ecosystem management by developing operations models with biodiversity, ecosystem conservation and restoration in mind – often in partnership with international conservation organizations. While promising to infuse business strategy with knowledge from natural science, specifically ecology, the emerging practice appears well ahead of research in this area. This paper aims to encourage research into how organizations can manage their relationship with the natural environment so as not to destroy the very life-supporting foundations provided by nature. Bridging knowledge domains, the paper introduces key concepts from ecology and social ecology to organization and management studies – ecosystems, biodiversity, ecosystem services and ecological resilience. We illustrate these concepts with advances in ecosystems management and conclude with suggestions for future research in sustainability management, organization theory and strategic management.

Keywords: corporate environmental management, corporate sustainability, ecosystems, biodiversity, ecosystem services, ecological resilience, interconnectedness, nature conservation, organization theory, strategic management.

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3.1 Introduction
In their recent article calling on scholars to place their effort behind the development of sustainability management theories, Starik and Kanashiro conclude that so far, “the promise of infusing management theory with biophysical foundations remains largely unrealized” (2013: p.8). While management scholarship and theory development might struggle to find ways to bridge relevant knowledge domains from natural and social sciences in order to account for, explain, and contribute to stemming or reversing current global trends of ecosystem degradation, business is charging ahead. Theorizing about “sustainability management” may not have made global economic development any more sustainable, but we do find promising initiatives in the business world.

There are ample examples of small firms and new startups designed on new business models that acknowledge both their immediate dependence and their impact on nature; Stoneybrook Organic Farm and Nature’s Path are familiar examples. More surprising, perhaps, are recent developments in large corporations. For instance, dozens of well-known multi-national enterprises managing vast, complex, and global supply chains are engaged in initiatives that suggest they not only recognize their biophysical foundations, but that they are actively developing capacity to better understand and work with those foundations, thus avoiding destructive and enabling constructive, even restorative, management practices instead.

Unilever, a global consumer goods company with presence in 190 countries, 2 billion consumers worldwide, and 2011 revenues of €46.5 billion, recognized that dependence first-hand in 2002. As one of the world’s largest buyers of fish for its Iglo, Findus, and Birds Eye brands, the company found itself highly vulnerable to the effects of the over-harvesting of ocean fish, especially cod, the main fish species used in the company’s premium frozen food product – fish sticks. Cod stocks in the western North Atlantic had declined abruptly in the 1990s due to overexploitation. Cod prices subsequently increased dramatically, eroding the margins of Unilever’s cod-related product lines. The company tried to substitute this whitefish with New Zealand hoky fish, but consumers in the UK, dissatisfied with taste and quality, rejected the alternative. Retailers responded by delisting the product through 2004, further hurting profitability (Maitland, 2005; Porritt & Goodman, 2005).

Unilever’s story is not unique. While only a small fraction of Unilever’s profits was affected, economic survival of product lines for many firms across different industries depends on the
availability of and their ability to manage and use specific ecological services (WRI, Meridian Institute & WBCSD, 2008) – yet such services are in major decline worldwide. Ecosystem services have been defined as the benefits that human populations and organizations derive – directly or indirectly – from proper ecosystem functioning (Costanza et al., 1997). An ecological system or ecosystem is “a natural unit consisting of all the plants, animals, and microorganisms (biotic) factors…interacting with all of the nonliving physical and chemical (abiotic) factors of this environment” (Levin, 2009, p. 779) through characteristic energy flows and material cycles. An interesting observation is that “[s]ince the beginning of life on Earth, organisms have not only adapted to physical conditions but have modified the environment (e.g., increase O2 and reduce CO2)” (Odum, 1992, p. 543).

A massive worldwide effort to assess the current status and trends of global ecosystem functioning, the Millennium Ecosystem Assessment (MEA), classified ecosystem services into four categories: the provisioning of goods and products (wood, fibers, freshwater, food, genetic resources), regulation services (i.e., climate regulation or pollination), cultural services (i.e., recreation or tourism), and supporting services (i.e., water cycling or nutrient cycling) (Fisher, Turner & Morling, 2009; MEA 2005). Ecosystems vary in their ability to withstand and rebound from disturbances like increased floods or droughts, pollution or encroachment by human settlement, and that ability or ecological resilience is weakening overall. The notion of biodiversity (defined as “the variety of life, including variation among species and functional traits,” Cardinale et al., 2012, p. 60) and its relevance for business has also become a topic of growing attention in international conventions (e.g., MEA, Biodiversity Conventions), and it has begun to find its way into the vocabulary of firms – especially large corporations.

A growing number of corporate initiatives suggest that firms are beginning to focus on managing relevant ecosystems, or rather ecosystem functions, more deliberately⁶. But while biological diversity and ecosystem services may have entered the language of firms, these issues have not yet garnered much interest in the management literature. We suggest that this

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⁶ In this paper, we use the term ecosystem management, strategic ecosystem management or ecosystem services management to refer to the range of emerging efforts by firms to either deliberately design their operations such that the sustainability of affected ecosystem functions is enhanced, or to restore and enhance ecosystems and ecosystem functions. The term managing ecosystems refers to managing processes; it does not imply an inherent ability to control complex ecosystems any more than the term human resource management refers to controlling people.
is in part a matter of disciplinary separation – natural science domains like biology or ecology, but even fields like ecological economics, arguably in greater disciplinary proximity, appear to exist in knowledge domains that – in certain aspects – remain quite separate from organization studies.

We say this although fruitful theoretical advances in organization studies such as “population ecology” or “co-evolution” have indeed applied discoveries from biology and ecology to the dynamics of human organizations, by using principles of nature’s functioning as interpretative lenses to theorize about human organizations and organizational networks. With very few exceptions, however, (e.g., Hoffman, 2003; Porter, 2006; Stead & Stead, 2009; Whiteman, Walker & Perego, 2013; covered in more detail below), such approaches do not build the actual, material aspects of nature’s condition and functioning into their theorizing about organizations and organizational dynamics. These bodies of organizational theory use ecological concepts and principles as analogies – they look to nature to understand and theorize about organizations (Oswick, Fleming & Hanlon, 2011). The focus and intent of this paper is different.

It looks to nature to understand organizations in their biophysical environment, theorize about the interconnectedness between both and bring the substantive material and energy flows of nature’s organization into the study of human organizations. We start by introducing recent strategic initiatives of corporate ecosystem management. To allow us to place such business initiatives into the context of the vibrant and rapidly growing knowledge domains related to ecology and society (e.g., Cardinale & al., 2012; Levin, 2009), we next discuss the meanings of ecosystems, biodiversity, ecosystem services and ecological resilience in some detail. We chose these four concepts to both raise management scholars’ interest in and provide a coherent introduction to critical advances in those domains, fully aware that a more comprehensive treatment of such an expansive knowledge domain is impossible within the scope of an article. Lastly, linking these concepts back to business, we explore implications for management theory and practice and close with suggestions for future research.
3.2 Biodiversity and Ecosystem Conservation: The New Strategic Business Issue?

In 1999, Paul Hawken, Amory Lovins and L. Hunter Lovins published their book “Natural Capitalism,” summarized in the HBR article “A Roadmap for Natural Capitalism”. Linking “capital,” a core concept for economics and business, with “nature,” this groundbreaking article offered a new way of thinking to environmental management: a host of examples illustrated that simple changes in how companies run their business can improve competitiveness and profits while not only reducing harm to the environment, but actually preserving and even restoring natural resources. The authors called this approach natural capitalism, “because it’s what capitalism might become if its largest category of capital – the ‘natural capital’ of ecosystem services – were properly valued” (Lovins et al., 1999, p. 146).

The promise that was encapsulated in such radical new thinking, however, has yet to be fulfilled. Clearly, attention to ecosystems and ecosystem services has increased tremendously over the past decade, fuelled especially by advances in the new interdisciplinary field of ecological economics and by high-visibility efforts to systematically measure and assess the state of ecosystems globally (MEA, 2005).

And yet, troubling trends in habitat destruction, freshwater decline, biodiversity loss and other forms of eroding natural capital continue to accelerate (Kumar & Martinez-Allier, 2011; MEA, 2005; TEEB, 2010). The critical importance of biodiversity and well-functioning ecosystems for social and economic well-being are now routinely acknowledged and examine by articles in scientific journals (e.g., Cardinale et al., 2012; Crutzen, 2002; Rockström et al., 2009), but this debate has remained largely outside the scholarly work on business organizations and management.

The language of sustainability and greening has certainly become an integral part of business across a wide range of industries, and many firms have developed environmental innovations, products, and processes, while also incorporating sustainability into their missions and strategies (Hall & Vredenburg, 2003; Marcus & Fremeth, 2009; Nidumolu, Prahalad & Rangaswami, 2009). The strategies and operations of many firms reflect a growing awareness of environmental sustainability, be that through eco-efficiency, life-cycle thinking, “green” product lines, or other eco-innovations seen as opportunities for company growth, product differentiation and competitiveness (e.g., Porter & Kramer, 2011; Willard, 2002).
Despite the many types of corporate greening activities, biodiversity and ecosystem preservation have until recently remained largely peripheral to mainstream business strategies and investment decisions driven by companies’ corporate sustainability and environmental departments. This is not too surprising since (aside from pioneering efforts by organizations like the TNC or the WBCSD, see below) business leaders generally show only limited awareness of the potential business risks posed by biodiversity loss and damage to ecosystem functionality (PriceWaterhouseCoopers, 2010). The last few years have witnessed a shift, however, as nature conservation and ecosystem protection appeared as new features of interest for a number of leading firms, business organizations, NGOs, and international agencies (Bishop, Kapila, Hicks, Mitchell & Vorhies, 2008; WBCSD, 2011; WRI et al., 2008).

The Nature Conservancy (TNC), a global NGO focused on nature conservation, provides an example. During the 2012 Rio+20 Summit, the Rio de Janeiro United Nations Conference on Sustainable Development, the TNC unveiled the results of a groundbreaking initiative on business and ecosystem protection involving 24 pioneer companies with more than $500 billion in combined revenues (including Alcoa, Coca-Cola, Dell, Dow Chemical, Duke Energy, Marriott International, Nike, Patagonia, Unilever, The Walt Disney Company, Xerox and others). The report shows that these companies engage in a number of initiatives to protect forests and safeguard freshwater and marine ecosystems. The individual case studies suggest that protecting nature and biodiversity is becoming recognized as a corporate imperative since it is essential to long-term business continuity across many industries (The Nature Conservancy, 2012).

The World Business Council for Sustainable Development (WBCSD) also played a leading role in promoting attention toward an understanding of company-ecosystems relations. In 2007, this CEO-led association of international companies established a specific Ecosystem Focus Area, publishing several guidelines and handbooks in order to inform companies about risks related to ecosystem degradation and calling for a collective response from the business community to address the scale of environmental change taking place. The first publication, “Business & Ecosystems: Issue Brief Ecosystems Challenges and Business Implications,” was released in November 2006 jointly with three leading NGOs specialized in the area of environmental protection and sustainable development: the Earthwatch Institute, the World
Resources Institute, and World Conservation Union. This document marked a watershed development. It introduced business to a new way of perceiving its relations with the natural environment, acknowledging that firms not only use and impact ecosystems and their services but, crucially, also rely on these services to generate long-term value. This report was followed by several publications looking in more detail at the business case for biodiversity and ecosystems protection (WBCSD and ICUN, 2007; TEEB, 2010), providing guidelines and toolkits for corporate ecosystem evaluation (WBCSD, 2009; 2011) along with illustrative case studies of companies involved in ecosystem service protection.

In order to check the breadth and relevance of this phenomenon and to better understand the type of initiatives that companies are undertaking, we conducted a preliminary scan of the first 100 companies in the Global Fortune 500 ranking. We matched this dataset of corporate initiatives with two other sources of information, The Nature Conservancy report (2012) and the WBCSD case study database on ecosystem and biodiversity (http://www.wbcsd.org/publicationsand-tools.aspx). The result is surprising. More than 70 firms are involved in over 100 specific initiatives across a broad range of sectors. Participants are both from industries that directly interact with ecosystems (e.g., agriculture, food and beverages, water services, tourism, forestry and paper) and industries relating only indirectly to the ecological services provisioned by nature (e.g., retail, healthcare, financial services, manufacturing). Four examples will illustrate the range and diversity of these new corporate initiatives (Table 3.1).

Table 3.1 - Business Initiatives in Ecosystems Management

<table>
<thead>
<tr>
<th>Firm</th>
<th>Industry</th>
<th>Ecosystems Dependence and Management</th>
<th>Specific Initiative</th>
<th>The Business Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acelor Mittal</td>
<td>Steel and mining</td>
<td>Extracting operations have a profound impact on local ecosystems and biodiversity. Several initiatives include site restorations and mitigation of effects on ecosystems during the onsite operations. Multiple stakeholders involved.</td>
<td>Commissioned major environmental study in 2005 and implemented a biodiversity compensation program in the Nimba Mountains, Liberia, close to the mine site. This region represents one of the few remaining West African wet-zone forests and a hotspot for many endemic species of flora and fauna, including chimpanzees.</td>
<td>Improve stakeholder Relations (government, UNESCO, NGOs); keep license to operate in the region; positive impact on local communities.</td>
</tr>
<tr>
<td>Company</td>
<td>Sector</td>
<td>Description</td>
<td>Action</td>
<td>Benefits and Outcomes</td>
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<tr>
<td>Syngenta Agriculture, seeds and pesticides</td>
<td>Depending on the region and type of crops, the business relies on ecosystem services like freshwater availability, water regulation, pollination and natural nutrient cycles. Several initiatives aim to protect ecosystems and mainstream best management practice among farmers in countries like India, Europe and USA. Involves agricultural experts, NGOs, farmers and academia, including 13 EU countries and the USA.</td>
<td>In 2009, launched program ‘Operation Pollinator’ aiming to restore native pollinators (e.g., bees) in agriculture by creating suitable habitats near the farmland. Program includes growing of vegetables, melons, and blueberries.</td>
<td>Increase long term agricultural productivity and soil fertility, positive impact on communities of farmers. Positive effects on reputation.</td>
<td></td>
</tr>
<tr>
<td>Unilever Consumer goods</td>
<td>Strong dependence on the quality and availability of raw materials coming from agriculture (tea, vegetables) and forest (palm oil). Several initiatives aim to preserve natural resources from overexploitation and climate change effects through better agricultural practice and reforestation. Involves suppliers, farmers, NGOs, local authorities and others.</td>
<td>In 2006, started project with the Kenya Tea Agency to support the diffusion of sustainable practices among Kenyan smallholder tea growers. In 2007, Unilever started to certify its Kenya producers with Rainforest Alliance standard to promote improved environmental, social and economic conditions. Farmers learn to reduce pesticide use, eliminate waste and introduce better farming techniques. The overall project helps protect the biodiversity in the farmland area.</td>
<td>Improve productivity, reduce costs, and enable growers to obtain higher prices for their tea. Increase product quality. Positive impact on Lipton brand and market opportunities.</td>
<td></td>
</tr>
<tr>
<td>Veolià Env. Environment and water services</td>
<td>Highly dependent on ecosystem functioning for both availability and quality of water resources; sites often located near biodiversity sensitive areas. Several initiatives to regulate water abstraction from rivers and basins, and protect habitats and biodiversity (e.g., through flora and fauna inventories). Collaboration with local stakeholders, including city and conservation groups.</td>
<td>The water supply of the Lyon metropolitan area in France is managed by Veolià Waters and depends on the Crépieux-Charmy water withdrawal site. Since 1996, a team of environmental technicians with experts from local NGOS and government authorities has worked to maintain and restore the well-field and to monitor the area’s ecological heritage.</td>
<td>Preserve quality of critical resource - water; enhance site management efficiency and strengthen positive relation with local authorities. Return of species that had previously disappeared from the site.</td>
<td></td>
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</table>
First, AcelorMittal is one of the world’s leading firms in the steel and mining industry with over 20 mines in operation worldwide. The firm implemented a biodiversity compensation program to minimize the impact of its iron mining activity in Liberia’s Nimba mountain, one of the few remaining West African rainforests and considered one of the top biodiversity hot-spots on the continent. Second, Unilever branded itself as the “Sustainable Living” company and developed a specific action program directed at its farmers around the world to educate and train them on the business case for biodiversity protection. The company’s initiatives include the supply chains of some of Unilever’s leading brands, such as Lipton, Knorr or Dove. Third, Syngenta, the Swiss-based agribusiness specializing in seed and pesticides markets, developed a conservation program with the goal of increasing farm productivity by reversing ecosystem services decline. As part of the program, the company has launched a specific initiative called Operation Pollination with the goal of restoring native pollinators in agricultural landscapes and affecting growers in 15 European countries and the USA. Fourth, Veoliá Environment, a global environmental services company focusing on water, waste and energy solutions for public and private clients, engaged actively with experts and NGOs to maintain and restore the ecological heritage of the area from which the city of Lyon in France draws its water supply.

These initiatives differ widely in terms of aim and scope, including the reduction of operational risks, the control of the quality and quantity of critical resource inputs, or improving company reputation. We also note the importance of strategic partnerships in such initiatives. Several large food and agriculture companies are increasingly involved in promoting and buying certified products. Prominent initiatives include Chiquita, Kraft Foods, Unilever, or Nestlé which purchase bananas, coffee, or cocoa certified by the Rainforest Alliance (RA), a global NGO promoting the conservation of biodiversity and sustainable management practice of forest resources through market-based certification programs. Similarly, retail company IKEA has partnered with the World Wildlife Fund (WWF) since 2002 to promote responsible forest management to increase the amount of purchased wood certified by the Forest Stewardship Council (FCS). Since 2005, it has sought to reduce the environmental and social impacts of conventional cotton production in regions like India and Pakistan.
We also find initiatives in the financial services sector, an industry with less direct connections to ecosystems or biodiversity conservation than those industries whose supply chains and operations depend directly on raw materials such as food or fiber. In 2002, for example, HSBC launched the conservation program Investing in Nature in partnership with the WWF. Ten years later, the British multinational banking and services provider started the Water Program, a new initiative with the goal of protecting some of the world’s most important rivers, investing $100 million in partnership with the WWF, Earthwatch Institute, and Water Aid, three leading environmental and development NGOs.

Our preliminary review highlights the sheer scale, breadth and depth of corporate initiatives engaging directly with nature. It also suggests that biodiversity conservation and ecosystem restoration has not only drawn the attention of corporations at strategic levels (Hoffman & Ocasio, 2001), but that firms see business opportunities in doing so. The ecosystem services resulting from biodiversity, ecosystem conservation, and sustainable use initiatives appear to be increasingly recognized for the direct benefits they provide to firms that depend on such natural capital in their products and services and for the indirect benefits via offsetting emissions (e.g., in the case of voluntary programs for offsetting greenhouse gases through forestation in developing countries) or enhanced reputational benefits.

We also note that the initiatives introduced here encompass a wide variety of actions on and engagement with ecosystems ranging from the protection of forest and soil to the conservation of biodiversity, freshwater and fisheries, the restoration of contaminated areas, and the diffusion of sustainable management practices with farmers and suppliers. Drivers for such corporate engagement in and deliberate management of nature’s functions are likely varied, ranging from recognizing the strategic dependencies on the quantity and quality of goods and services provided by ecosystems, to reducing both regulatory and reputational risks through more symbolic actions of nature protection (Delmas & Toffel, 2008; Ramus & Montiel, 2005).

Whatever the motives, such corporate initiatives point to a growing attention to and deliberate engagement with nature, and this new attention by business towards ecosystems and their functioning offers intriguing research directions for investigating both the biophysical dimensions of impact-dependence linkages between organizations and the natural environment as well as cognitive and management dimensions of these linkages.
While much of the field of organization and the natural environment has pointed to reducing negative impacts by business activity on ecosystem functioning, it has paid little attention to the dependence of business on critical provisioning services like freshwater, fiber, or food, and regulatory services like the climate regulation, flood control, water purification, or waste treatment that ecosystems provide.

As mentioned earlier, nature and nature’s functioning have not yet been sufficiently integrated into ONE literature or into broader organization theory, despite the promise of pathbreaking articles in AMR’s October 1995 issue, and aside some note-worthy exceptions (King, 1995; Marshall & Toffel, 2005; Porter, 2006; Whiteman et al., 2013). The fundamental interconnectedness between organizational (business) life and ecosystems has been examined only occasionally, as for example by linking industrial ecology more directly to organization studies (Hoffman, 2003), using co-evolutionary concepts to generate a meta-theory linking natural organization and human organization (Porter, 2006; Stead & Stead, 2009), linking the resilience of communities to their relationship with nature (King, 1995), and offering a metatheoretical framework cognizant of planetary boundaries (Rockström et al., 2009) to corporate practice and management research (Whiteman et al., 2013. Concepts like biodiversity, ecosystem functioning, ecosystem services, or natural capital have rarely entered the work of management and organization scholars in a substantive manner as several scholars have pointed out (Bansal & Gao, 2006; Etzion, 2007; Kallio & Nordberg, 2006; Starik & Kanashiro, 2013; Starik, 2006).

There are organizational theories which appear to link organizations to nature, such as the literature on population ecology (Hannan & Freeman, 1977; 1984) or on coevolution (e.g., Baum, 1996; Lewin & Volberda, 1999). Such similarity is deceptive, however. There is a fundamental difference between using concepts and principles from ecology as an analogy or interpretative lens (Oswick et al., 2011) and using them in a substantive, even ‘literal’ manner for studying organizations and nature such that the biophysical foundations of organizational life becomes part of organizational theorizing.

Heeding the calls from the founding years of the field, which implored management scholars to acknowledge the embeddedness of organizations in the natural environment and to expand and enrich management studies with concepts recognizing that embeddedness (Gladwin,
Kennelly & Krause, 1995; Jennings & Zandbergen, 1995; Shrivastava, 1994; Starik & Rands, 1995), we argue that the practical and wide-spread initiatives we observe in business practice open up new opportunities for research in just that direction. If, as Starik and Kanashiro (2013) recently called for, the field were to advance a theory of sustainability management, any such theory would have to both incorporate the complexity of and interconnectedness between ecosystems and organizations and provide a solid framework for a managerial decision-making respectful of the biophysical constraints of natural capital and opportunities resulting from more proactive approaches.

3.3 Toward a Deeper Understanding of Nature’s Functioning

A first step in that direction is to introduce core concepts and insights from research typically considered to be external to our own field of organizations and management. Our intent is to expand the vocabulary and conceptual arsenal of management studies toward a deeper understanding of ecosystems functioning and the role of biodiversity, toward more focused research into the emerging phenomenon of businesses deliberately managing their impacts on ecosystem on which they depend, and toward a stronger foundation for future sustainability management theories.

We focus on those concepts that played a particularly important role in prompting major breakthroughs in the understanding of relationships between human organizations and the natural environment. We start by introducing the foundational concept of the ecosystem, then discuss biodiversity, ecosystem services, and ecosystem resilience and how they interrelate (Costanza et al., 1997; Levin, 1998; 2009). Research on these concepts emerged from disciplines like biology and ecology and their sub-disciplines evolutionary ecology, conservation ecology, and ecosystem science. Under the umbrella of the new and multi-disciplinary field of ecological economics, knowledge in this area has grown dramatically in the last 20 years (Abel & Stepp, 2003; Cardinale et al., 2012; Holling, 1998).

Since the 1992 Earth Summit in Rio de Janeiro especially, hundreds of studies and major joint research initiatives around the world have generated vibrant debates and fertile ground for new theories and knowledge creation. The Global Biodiversity Assessment commissioned by United Nations Environment Program in the 1990s played a major role in focusing research
attention on biodiversity and ecosystem functioning (BEF). In parallel, work on biodiversity and ecosystem services (BES), which are “built on the idea that ecosystems provide essential services to humanity,” expanded equally rapidly (Cardinale et al., 2012: p. 59).

These new ideas and frameworks galvanized not only growing scientific momentum but also drew significant political and public attention with the publication of the Millennium Ecosystem Assessment in 2005. Launched by the United Nations Secretary-General Kofi Annan in 2000, the scope of this research project was truly global, involving 1,360 experts, 95 countries, and 850 reviewers (MEA, 2005). It is important to stress that the concepts of ecosystems, biodiversity, ecosystem services, and ecosystem resilience themselves emerged from a number of different scientific fields, with the result that – despite growing consensus in some areas, there is no unanimous agreement on their interpretative capacity, relevance, or even utility. Like many concepts that populate organization and management studies (e.g., strategy, organization, institutions, or management), the meanings of ecosystems, biodiversity, ecosystem services and ecological resilience are complex, interrelated and subject both to multiple interpretations and criticism. Norgaard (2010) points out that many ecologists view ecosystem services as a weak theoretical construct and refuse to interpret ecosystems using a stock–flow framework or to attribute nature a value – yet these are two key aspects underlying the concept of ecosystem services. There is much discussion about definitions and classifications, and “perhaps we should accept that no final classification can capture the myriad of ways in which ecosystems support human life and contribute to human well-being” (TEEB, 2010; p.10).

Nevertheless, these concepts and the growing knowledge base around them provide powerful heuristics and foundations for theorizing nature’s functioning in organization and management studies. In this article, we have no ambition to reduce these distances or smooth differences that likely stem as much from divergent ontological and epistemological assumptions of different disciplines as from the youth of these fields. Instead, we think that, treated as heuristics, these concepts can help ONE scholars build a stronger understanding of the interconnectedness between nature and organizations and that they offer promising perspectives from which to advance theory in our domain. Recognizing the complexities and challenges for corporations to more effectively manage their relationship with ecosystem on
which they depend, these constructs provide foundations for new research directions and implications for organization theory and strategy.

Next, we examine ecosystems, biodiversity, ecosystem services and ecological resilience and their relationship to human social and economic well-being. To provide an overview and guide for our readers, Figure 3.1 attempts to visually map these biophysical foundations and focuses specifically on the organizational (and implied institutional) levels of analysis.

### 3.3.1 Ecosystems

An ecosystem is “a natural unit consisting of all the plants, animals, and microorganisms (biotic) factors in a given area, interacting with all of the nonliving physical and chemical (abiotic) factors of this environment. An ecosystem can range in scale from an ephemeral pond to the entire globe, but the term most often refers to a landscape scale system characterized by one or a specified range of community types (e.g., a grassland ecosystem)” (Levin, 2009: p: 779).

**Figure 3.1 - Linking Ecosystems to Social and Economic Well-Being**

![Ecosystems Diagram]

The term “ecosystem” identifies perhaps one of the most fundamental, widely used and successful concepts theorized in ecology. Far from being simple and straightforward, the

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7 Future work, outside the scope of this paper, needs to examine the relationships between individual, organizational, institutional and societal levels in order to expand our understanding of the social dimension of sustainability within the broader framework of the biophysical dimensions mapped here.
ecosystem is a subtle and complex concept with multiple layers of meanings and use (Pickett & Cadenasso, 2002). The concept and its meaning have evolved over the years, as ecosystem science itself evolved into a significant body of both small-scale experimental studies and large scale (landscape-scale) correlational research and practical applications. The first use of the term in print is attributed to the British ecologist Sir Arthur Tansley (1935), although the term was probably coined in the early thirties by Roy Clapham. Then a young biologist at Oxford University’s Department of Biology, Clapham was asked by Tansley if he could think of “a suitable word to denote the physical and biological components of an environment considered in relation to each other as a unit” (Tansley, 1935; cited in Willis, 1997: 268). Tansley provided the first definition of an ecosystem as a biotic community and its associated physical environment located in a specific place. He was also the first scientist who noted the importance of relations between inorganic factors and organisms, thereby highlighting the existence of a constant interchange of materials between biotic and abiotic systems or biogeochemical systems.

Two decades later, Eugene P. Odum, often considered the father of modern ecology, popularized the concept through his research and findings. In the book “Fundamentals of Ecology,” he described the ecosystem as “any entity or natural unit that includes living and nonliving parts interacting to produce a stable system in which the exchange of materials between the living and nonliving parts follows a circular path” (Odum, 1953; cited in Purser et al., 1995: 1070). The book’s second edition, published in collaboration with his brother Howard T. Odum, promoted the view of ecology as a science of systems (Odum & Odum, 1959). An important aspect of E. Odum’s ecosystem formulation is its flexibility. An ecosystem can exist at any level and size as long as organisms and the physical environment interact within it. As mentioned above, the concept of ecosystem is scale-independent. Ecosystems can be a small lake, an estuary, the rainforest, the entire biosphere, or even the digestive flora and fauna of an individual human; boundaries are not fixed in objective ways. Similarly, ecosystems may be simple and in existence for only a very short time or extremely complex and persisting over time.

Another important feature introduced by E. Odum’s research is the recognition that human beings are a key part of ecosystems and that ecosystem science must incorporate the study of human-generated activities and processes. His younger brother H. T. Odum, a maverick and
innovator, further contributed to the development of ecology as a systems discipline, taking a holistic approach to the study of ecosystems (Odum, 1983), and focusing attention on the links between ecosystem ecology, energetics and thermodynamics. The Odum brothers’ work was fundamental for the development of ecosystem science and interdisciplinary fields like ecological economics (Gunderson, Folke, Lee and Holling, 2002).

The seventies and eighties witnessed heavy criticism on the linear mechanical assumptions used to explain ecosystem dynamics. At the same time, theoretical advances in ecosystem ecology, fruitful cross-fertilization with other scientific disciplines (e.g., biology, geochemistry, physics, sociology, anthropology) and growing scholarly interest in complex adaptive systems prompted a break from earlier directions and, in the 1990s, resulted in the formation of the “new ecology.” Modernized and revitalized, this new system science addressed the dynamics of ecosystems as complex systems (Abel & Stepp, 2003) and was quickly accepted by the academic society and disseminated among scholars via new and popular journals, such as *Ecosystem* and *Conservation Ecology* (now *Ecology and Society*). Meanwhile, the rapid growth and global scope of the ecological crisis, biodiversity loss, and climate change has stoked widespread, public concern for environmental issues.

Modern ecosystem studies are grounded in Tansley’s and Odum’s early seminal works (Pickett & Cadenasso, 2002), which offered a clear, inclusive and remarkably current account of the concept and functioning of ecosystems. In contrast to the earlier works, however, they deemphasize notions of stability, unique equilibria, normative states, and deterministic approaches, focusing instead on complex system characteristics. Ecosystems are defined as “prototypical examples of complex adaptive systems in which macroscopic system properties, such as trophic structure, diversity-productivity relationships, and patterns of nutrient flux emerge from interactions among components and may feed back to influence the subsequent development of those interactions” (Levin, 1998: 431). In this view, an ecosystem consists of many heterogeneous components that interact in parallel and have a range of basic properties associated with any complex adaptive system (Levin, 1998). *Aggregation* refers to the way scientists group individuals in populations, populations into species, and species into functional groups. *Non linearity* denotes that transformations occur through complex paths primarily governed by reinforcing stochastic events, non-linear causation, and path
dependency. *Diversity* refers to the variety of species present in the ecosystem and its generation and maintenance of this diversity.

Finally, the notion of *flow* suggests that any ecosystem is based on a range of different nutrient, energy, material, and information, and other flows, which interconnect the single parts in a web of relations. This transition of ecosystem science into new theoretical and practical domains has generated two conflicting streams of study (DeLeo & Levin, 1997; Holling, 1998). The earlier approach, rooted in experimental science with a focus on small spatial scales and short time frames, is reductionist and highly analytical. Emphasizing structural aspects of ecosystems, it focuses on processes that influence specific variables (such as population dynamics of species, levels of nutrients, and flux of materials). The more recent approach with its macro-level and functional perspectives is inherently holistic and integrative. Analyzing ecosystem dynamics with a broad and exploratory perspective, this field employs simulation models to observe large spatial and temporal scale changes that are impossible to study through experiments. Holling (1998) observes the tensions between these two domains, suggesting that the latter acknowledges that ecosystems are inherently uncertain, unknowable, and unpredictable. Here, uncertainty is seen as a system property that needs to be managed, whereas the former emphasizes the need to reduce uncertainty.

### 3.3.2 Biodiversity

The United Nations Convention on Biological Diversity (CBD) in its Article 2 defines biodiversity as “the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems” (1992; p.3). A shorter definition refers to it as “the variety of life, including variation among species and functional traits” (Cardinale et al., 2012, p. 60).

As the anthropogenic transformation of the planet has intensified (The Economist, 2011; Steffen et al., 2011), research on ecosystem processes and functioning has grown rapidly. At the same time, attention to biodiversity and specifically to biodiversity loss has increase dramatically in the last two decades. United Nations-supported assessments, initiatives, and conventions of global scale (e.g., MEA, 2005; Convention on Biodiversity) have prompted extensive reports and journal publications. Results highlight that the distribution and
abundance of species have been reduced dramatically due to massive transformation of land use, natural capital over-exploitation, global transportation networks, human induced environmental changes such as climate change, and increasing levels of pollution (MEA, 2005; Peterson, Allen & Holling, 1998; TEEB 2010). Rockström and colleagues (2009) conclude that “[t]oday, the rate of extinction of species is estimated to be 100 to 1,000 times more than what could be considered natural” (p. 474).

The Living Planet Index – an indicator of the state of the global biological diversity based on the dynamics in the vertebrate populations provided by the World Wildlife Fund for nature in collaboration with Zoological Society of London – suggests that the populations of vertebrates (birds, mammals, amphibians, reptiles and fish) declined about 28% between 1970 and 2008 (WWF, 2012). This decline has been particularly severe in tropical areas and freshwater ecosystems. Similarly, the ICUN reports that by 2009, of the over 47,677 species assessed, 36% were threatened with extinction (2012); plant species reached an alarming 70% (Secretariat of the Convention on Biological Diversity, 2012). The implications of this “great extinction” of species (Brown, 2008) are equally dire for humans, considering for example the imminent threats to one crucial ecosystem service, the supply of food (with 75% of global fish stocks either fully or partially overexploited, the collapse of a number of global fisheries appears imminent).

Biodiversity loss is occurring at global, regional and local levels (e.g., EEA, 2009; Federal, Provincial and Territorial Governments of Canada, 2010). According to "The Economics of Ecosystems and Biodiversity" (TEEB, 2010), a “business as usual” scenario will lead to a continued or accelerated loss of biodiversity, affecting the provisioning of ecosystem services (discussed below) and seriously impacting human well-being, however unevenly, at a global scale (Nordhaus et al., 2012).

The term *biological diversity* has been used widely since the nineteenth century, although its first formal appearance in a publication is attributed to the socio-biologist E. O. Wilson as recently as 1988 (Colwell, 2009). Among ecologists, biodiversity is often defined as “the genetic, taxonomic, and functional diversity of life on Earth including temporal and spatial variability” (Naeem, 2009). In other words, it consists of “communities of living organisms interacting with the abiotic components that comprise, and characterize, ecosystems” (TEEB, 2010; Chapter 2, p.5). Together, these definitions capture several important aspects. First, the
concept of biodiversity captures far more than just the number of species. It is a multilevel construct applied at different organizational scales (genes, individuals, populations, species, communities, ecosystems, and biomes) and to different perspectives, including evolutionary (phylogenetic) and ecological (functional). The term biodiversity may apply to biological populations explaining genetic variation among individuals and lineages; ecologists and conservation biologists largely use the term at the species level, which is probably the meaning most commonly associated with this concept. Species richness, for example, is the number of species in a specific taxon (e.g., birds, mammals) in a particular ecosystem type (e.g., the savannah). At macro-scales – landscapes, marinescapes, or regions – biodiversity can apply to the number, relative frequency, and spatial organization of ecosystem types, or ecosystem diversity.

A second important aspect is the difference between functional (Lawton and Brown 1994) and response diversity (Elmqvist, Folke, Nyström, Peterson, Bengtsson, Walker, & Norberg, 2003). Both can range from low to high, but while functional diversity refers to the number of species that fulfill different ecological functions in an ecosystem (e.g., pollination or nitrogen), response diversity refers to the number of different ways in which a specific function, such as pollination, may be performed (e.g., by insects and birds) (Colwell, 2009; Vold & Buffett, 2008).

In any community of organisms, each functional group (e.g., pollinators) primarily participates in a specific process and, in doing so, contributes to the functioning of the overall system (TEEB, 2010). Biodiversity thus also captures the interconnectedness and functioning of ecosystems, and species diversity is positively associated to higher ecosystem productivity. Response diversity also refers to the diversity of responses to environmental change among species contributing to the same ecological function. Species that perform the same function may respond in different ways to transformations in the ecosystem. Hence, response diversity can be a proxy for the adaptive capacity in a world of complex systems, uncertainty, and human influence and thus relates to the concept of ecosystem resilience (Elmqvist et al., 2003) discussed below. Although some uncertainty remains about the mechanisms that link biological diversity to ecosystem structure and processes (Peterson et al., 1998; TEEB, 2010), the relevance of biodiversity stems also from the fact that species richness generally increases the capacity of ecosystems to self-organize, absorb disturbance, and regenerate after
disturbance (Folke, Carpenter & Walker, 2004). In other words, biodiversity loss affects ecosystem functionality since it reduces the capacity of ecosystems to regenerate or reorganize after a perturbation while a high level of biodiversity (response diversity) can buffer and help revitalize the system without tipping it irreversibly into an undesirable state (i.e., the former dynamic equilibrium is not recoverable, leading to “ecological surprise”). We will return to these relationships and to the theoretical and practical implications for management in a later section of this paper.

3.3.3 Ecosystem services
The notion of ecosystem services links the study of ecosystems firmly to “the province of humanity” (Kinzig, 2009), introducing a fundamentally different aspect – namely that humans derive essential benefits from ecosystem functioning and from biodiversity. Ecosystem services are commonly defined as “the benefits that humans obtain from ecosystems, and they are produced by interactions within the ecosystem” (MEA, 2005; p.3). Ecosystems like forests or wetlands provide such services as food, timber, fibers, water purification, climate regulation, genetic diversity, and medicines that support our well-being. As mentioned, one widely accepted classification groups these services into four types: supporting services (which maintain all other services), provisioning, regulating, and cultural services system (MEA, 2005).

Ecosystem services have increasingly attracted the interest of at least two broad scientific communities in recent decades – ecologists and economists – helping to describe the relation between humans and nature and to underline the societal dependence on the life-support systems of the environment (Gómez-Baggethun, de Groot, Lomas & Montes, 2010; Norgaard, 2010). The concept originated in the late 1970s (Westmann, 1977) or early 1980s (Ehrlich & Ehrlich, 1981), but it was in the 1990s that ecosystem services entered the mainstream literature. The concept rapidly, even exponentially (Fisher et al., 2009; p. 644), diffused into articles and books (Costanza & Daly, 1992; Costanza et al., 1997; De Groot et al., 2002) offering a powerful framework for thinking about sustainable development as well as designing and supporting decision-making processes (UNEP, 2008; World Bank, 2009). The multi-year Millennium Ecosystem Assessment (2005) served as another major factor in the diffusion of this concept, inspiring natural and social scientists to engage in theoretical and
empirical research on the topic while also placing ecosystem services squarely on the public agenda (Fisher et al., 2009).

We mentioned that ecosystem structure and processes (e.g., the primary production or nutrient cycles) are at the heart of providing functions (e.g., water purification). The services that individuals, organizations, and society obtain from these functions (e.g., food and clean water) contribute to human welfare and generate benefits that range from nutrition and water to satisfying cultural needs, such as aesthetics. At the same time, through its multi-scale organizational components and attributes, biodiversity (e.g., species richness or functional diversity) influences ecosystem functioning and the provisioning of ecosystem services. Table 3.2 provides some illustrative examples of the links among biodiversity, ecosystem functions, ecosystem services and benefits, both in general terms (MEA, 2005) and with regard to business organizations.

The concepts of ecosystem services and benefits fundamentally rest on humans utilizing ecosystems and their functions, whereas ecosystem functions exist even if humans are not using them as services (see for example Fisher et al., 2009). The distinction between services and benefits highlights that the same service can generate multiple and different benefits and points to the potential for conflicts between different human values and uses. Trees (the service) in a forest (the ecosystem) may offer an aesthetic pleasure and can provide outdoor experiences for ecotourism, wood for paper or furniture, protection from floods or storms, or improved living conditions through climate regulation and CO2 sequestration.

The following quote helps to further explore linkages among biodiversity, ecosystem functioning and ecosystem services (and resulting benefits for humans): “The biological activities of plants, animals, and microorganisms influence the chemical and physical processes of their surroundings, and if one were to modify the distribution and abundance [and diversity] of these organisms, ecosystem functioning, or biogeochemical activity, would change. For example, trees in a forest sequester atmospheric carbon dioxide and locally enhance evaporation; invertebrates in a marine ecosystem mix and aerate sediments; and microorganisms in an aquatic ecosystem decompose organic matter. Reduce the number or mass of these organisms, and ecosystem functions, such as primary production in the forest, the rates of sediment aeration in the marine ecosystem, and rates of decomposition in the aquatic ecosystem, are likely to be altered. If ecosystem functions are altered, then it stands to
reason that ecosystem services, which are ecosystem functions that benefit humans, are also likely to be altered” (Naeem, 2009; p. 584). Table 3.2 offers a number of examples for further illustration.

Table 3.2 - Biodiversity, Ecosystem Functions, Ecosystem Services and Benefits: Examples

<table>
<thead>
<tr>
<th>Specific aspect of biodiversity</th>
<th>Example of ecosystem functions</th>
<th>Examples of ecosystem services</th>
<th>Example of benefits</th>
<th>Benefits for organizations and businesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genetic diversity</td>
<td>Source of unique biological materials and products</td>
<td>Medicine and agricultural products</td>
<td>Control of disease; health from use of medicines; nutrition; individual pleasure from enjoying variety in food</td>
<td>Pharmaceutical and agro-food companies rely on genetic biodiversity to find new drugs or seeds</td>
</tr>
<tr>
<td>Population size and biomass</td>
<td>Primary production extractable as food</td>
<td>Food from crops, fisheries or timber</td>
<td>Health and human material well-being, energy for comfortable temperature control, quality of life, recreational value, etc.</td>
<td>Consumer goods and retail companies benefit from higher productivity rates and improved quality (e.g., Unilever, IKEA).</td>
</tr>
<tr>
<td>Interaction between organisms and their abiotic environment</td>
<td>Recovery of mobile nutrients and removal or breakdown of excess nutrients and compounds</td>
<td>Water purification</td>
<td>Clean and safe drinking water, avoidance of disease, recreational value, etc.</td>
<td>Water management companies benefit from higher efficiency and increased quality (e.g., Veolia Waters).</td>
</tr>
<tr>
<td>Interaction between organisms and species</td>
<td>Movement of floral gametes (reproductive cells)</td>
<td>Pollination</td>
<td>Health, adequate food production, recreational value, etc.</td>
<td>Companies in the agriculture industry benefit from increased land productivity (e.g., Syngenta).</td>
</tr>
</tbody>
</table>

Source: Adapted from Costanza et al., 1997; MEA, 2005; TEEB, 2010.

The concept of ecosystem services thus highlights those ecosystem functions that are particularly relevant for humans. It is often combined with manufactured or man-made types of capital, put in place to more deliberately or more intensively extract benefits. It is this latter aspect which effectively establishes ecosystem services as a social-ecological concept. Humans can for example benefit from the service of constant water flow for producing energy by building a dam; fishing or boating similarly relies on man-made capital to access ecosystem services of food provision or recreation (Fisher et al., 2009).
Another aspect of the relationship between services and benefits deserving further attention is that ecosystem services can result in multiple benefits or “joint production” (Fisher et al., 2009), depending on the way people use the services. For example, clean water can be used for drinking and also for washing or swimming; the services provided by a regulated stream of water can include irrigation and recreational opportunities. A regulated stream can also reduce the risks of flood and increase safety for people (a short-term benefit), while reducing biodiversity along the river banks over the long term. Not surprisingly, benefits obtained from the same service can cause conflict, for example when timber generated by a forest in a tropical area can be extracted and sold or be valued for climate regulation or for its contribution to the cleaning of water.

A distinction between functions, services, and benefits (including acknowledging joint production and trade-offs) is critical for economic valuation purposes, and “[t]he issue of valuation is inseparable from the choices and decisions we have to make about ecological systems” (Costanza et al. 1997; p: 255). Therefore, the concept of ecosystem services must lend itself to a solid interpretative framework if it is to better support social decisions with regard to the protection and management of ecosystems and biodiversity as well as make our dependence on nature more clear – be that at individual, organizational or societal levels.

At the same time, the critical importance of ecosystem services for business, both in terms of risks and opportunities, calls for a valuation method that can inform and support strategic and operational decisions (WBCSD, 2009). According to several scholars (Fisher et al., 2009; TEEB, 2010) and despite offering an excellent and intuitive heuristic, the classification proposed by the MEA (2005) is not suitable for economic ecosystem service evaluation since it does not address issues such as risks of double counting or trade-offs, nor does it account for those benefits that are indirect or not formally valued, such as intrinsic appreciation (TEEB, 2010). Much research needs to be done to properly capture the myriad of ways that ecosystems services contribute to our well-being and to integrate them in our decision-making processes.

The spatial and temporal scales of services provided, and whether they serve as rival or excludible goods further affects the relationship between organizations and ecosystems. Rival and excludible goods have been broadly investigated by economists, management scholars, and by colleagues in the ONE field (Ostrom & Ostrom, 1997; Prakash & Kollman, 2004).
Typically, public goods like air or national public defense are considered non-excludible in economic theory in the sense that it is not possible to exclude people from consuming them. They are also nonrival, which means that the consumption by one consumer does not prevent others from doing so. Ecosystem services provide benefits that can be characterized along a continuum from rival to non-rival and from excludible to non-excludible (Fisher et al., 2009). Typically, timber or fibers are rival and excludible while the benefits from the service of climate regulations provided by ecosystems like forests are non-rival and non-excludible.

Without entering into the discussion about the classification of the multitude of bundled services and joint production of benefits that we derive from nature, this distinction has important implications when it comes to excluding others from the consumption of ecosystem services or when services become scarce, generating problems of trade-offs and conflict between rivaling beneficiaries. Deep-sea fisheries, when abundant, are usually considered typical public goods since they are non-excludible and non-rival (the abundance of species such as cod meant it was not in discussion until the fishery collapsed a few years ago). When scarcity increases, however, goods can suddenly become rival; when specific barriers like fishing quotas or monitoring systems are introduced, they become excludible.

Also important are spatial and temporal scales of services and benefits (Levin, 1992; Scholes, 2009). Ecosystem services, in fact, provide benefits that can be spatially and temporally contingent on or separated from the ecosystems production area. The benefits of soil formation are typically in situ, while pollination or carbon-sequestration benefits extend to an area around their production place. In the case of a forest, the water purification service can generate benefits to communities living downstream and far away from the woodland (different spatial scale) many weeks after the service is provisioned (different time scale) (Fisher et al., 2009; MEA, 2005; Scholes, 2009). Scale, therefore, comes into play in many ways in assessing and managing ecosystem services, raising questions on how organizations can manage and govern these dynamics (Kinzig, 2009).

To conclude, ecosystem services have acquired relevance both as an interpretative scheme of the interdependencies between humans and nature and as a framework to include nature more fully in our social and economic decision-making. Before we discuss the management implications for research and for business, we turn our attention to another important concept that is closely linked to ecosystems and biodiversity: ecological resilience.
3.3.4 Ecological resilience

Resilience has been investigated by a number of disciplines and from diverse theoretical perspectives, including management and organization science (e.g., Sutcliffe, Sitkin & Browning, 1997; Sheffi, 2005), psychology (Luthar, Cicchetti & Becker, 2000), system analysis (Holling, 2001), and economy and sociology (cf. Folke, 2006 for an extensive review). In this paper, we focus on ecological resilience as a specific quality of ecosystems (an exploration of the relationship between ecological resilience and organizational resilience, while relevant, goes beyond the scope of this article). We define resilience as the capacity of a system (e.g., an ecosystem) to cope with disturbances without shifting into a qualitatively different state (Gunderson and Holling, 2002). A clear understanding of the concept of ecological resilience appears paramount in the context of this paper, because it is considered an essential factor underlying the capacity of ecosystems to continue the production of services in complex systems coping with disturbance and uncertainty.

When ecosystems are stressed persistently and cumulative effects reach a certain threshold, they may undergo sudden and dramatic changes. This can shift the ecosystem to another state with large and unpredictable effects on the capacity to provision services. Examples are eutrophication (the over-enrichment of water with nutrients and subsequent excessive plant growth) of lakes, a reduction of fish stocks, or the breakdown of the coral reef. When ecosystems have accumulated stress, they become more fragile and even small perturbation can trigger their capacity to maintain structure and functionality. For example, the loss of response diversity in the case of human-made disturbances in specific terrestrial or aquatic ecosystems reduces their resilience along with the system’s capacity to remain within a specific state. Several papers and publications show that ecosystems increasingly shift between states as a consequence of human actions that impact and weaken resilience (Gunderson & Holling, 2002; MEA, 2005; TEEB, 2010).

The resilience perspective has emerged in ecology in the late 1960s and early 1970s in parallel with the previously discussed transformation of the discipline from being deterministic and single-equilibrium steady-state based, to a discipline of complex adaptive systems with multiple equilibria and feedbacks among multiple scales that allow self-organizing processes (Levin, 1998; Holling, 2001; Folke, 2006). Ecological resilience is
defined as “the capacity of a system [an ecosystem, a community or society, addition by authors] to absorb and re-organize while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks” (Folke, 2006: p. 259). This definition encompasses three different but complementary features.

The first is the capacity to absorb or buffer shocks while maintaining structure and function. This aspect is often called persistence. Here, resilience can be considered as a measure or a threshold and although difficult to determine, it plays a substantial role in managing ecosystems in order to maintain ecosystem functionality and the provisioning of services (Brand, 2009). Flips or state changes in ecosystem functions may prompt a sudden reduction of biological productivity, with direct consequences on the ecosystem’s capacity to support human well-being and human life.

The second is the potential of the system to recombine structure and processes and to reorganize and renovate itself. Ecological resilience, therefore, is also an indicator of the capacity of an ecosystem to allow for its dynamic development, its transformability. A resilient ecosystem, for example, can turn disturbances into opportunities to innovate, change, and improve its capacity to provide services. In the case of weak resilience, even small turbulences can determine dramatic social and ecological consequences.

The third feature, adaptability, refers to the capacity of an ecosystem to adapt and learn. Recognizing that humans, their activities, and their organizations are deeply embedded in and part of ecosystems points to the broader conception of social-ecological systems. In this sense, resilience has become a perspective and interpretative lens that supports ecologists and social scientists in the analysis of social-ecological systems.

Extending these concepts to our domain of studies, we next examine their implications for core assumptions and future directions of organization theory and strategy. We know that this is a complex exercise, but we argue that the development and maturation of our field requires a bold move towards a new re-conceptualization of the discipline, breaking its merely social boundaries to the outside world.
3.4 Linking Two Knowledge Domains: Challenges and Implications

A number of organization scholars have called for transdisciplinary cross-fertilization as an important method to build powerful new theory and models (Corley & Gioia, 2011; Oswick & al., 2011; Suddaby, Hardy & Huy, 2011; Zahra & Newey, 2009). Similarly, ONE scholars have for two decades highlighted the need for looking outside our disciplinary boundaries and at the natural sciences in particular (Gladwin, Kennelly & Krause, 1995; Kallio & Norberg, 2006; Porter, 2006; Shrivastava, 1994; Starik & Rands 1995; Starik and Kanashiro, 2013; Whitehead et al., 2013) to bring relevant concepts, perspectives and models of the biophysical foundations to the study of the organization-natural environment relationship.

In this article, we have discussed critical contributions provided by disciplines outside the domain of organization and management studies, namely ecology and ecological economics, to offer our readers a better understanding of nature’s functioning principles and to begin to sketch the myriad interconnections between ecosystems and human, and thus organizational, life. We also offered examples of companies implementing initiatives intended to manage ecosystems and biodiversity, thus acknowledging the interconnectedness of their organizational models with the natural capital from which they draw. Our reviews of ecosystems and biodiversity, ecosystem services, and ecological resilience required profound immersion into other sciences in order to capture their ontological and epistemological underpinnings, language, dominant interpretative frameworks, and experimental practices (Abel & Stepp, 2003; Braat & de Groot, 2012; Costanza, 1987, Holling, 1998).

Investigating both ecology and ecological economics for this article, we observe an intense commitment in those fields to the conservation of nature as a fundamental tenet underpinning the way these disciplines build their models and tools. A quote by Levin in the Preface to the Princeton Guide to Ecology (2009) illustrates this point: “Just as we are beginning to appreciate not only the beauty of natural systems but also their essential role in providing an infinite range of goods and services on which humanity depends, we are reluctantly also learning that we are destroying those life-support systems and threatening the sustainability of the biosphere as we know it. Ecology, the unifying science in integrating knowledge of life on our planet, has become the essential science in learning how to preserve it” (p: vii).

At the same time, a large branch of ecological economics research is dedicated to study market mechanisms such as ‘pay per ecosystem services’ and refine methods like ‘cost-
benefit analysis’ to effectively and efficiently incorporate ecosystems’ services into our decision-making processes with the ultimate goal to preserve nature (Farber, Costanza & Wilson, 2002; Farley & Costanza, 2010).

Underlying this commitment is a growing realization that society appears to be maneuvering itself to the outer side of “a safe operating space for humanity” (Rockström et al., 2009), and that exceeding the safe boundaries of a number of planetary system changes such as the global climate change, biodiversity loss or ocean acidification may prompt unprecedented and disruptive global environmental change – along with associated social change and upheaval.

While not uncontested (Nordhaus et al., 2012), Rockström and colleagues (2009) cite evidence for their conclusion that boundaries have already been exceeded in three such systems – biodiversity, nitrogen cycles, and climate change.

Looking back at the organizational and management domain, we raise questions around the role of ONE scholars in contributing to (or detracting from) the conservation of nature. Arguing that a significant part of responsibility for the ecosystems and biodiversity crises – as well the search for solutions – falls to organizations (in addition to individuals, institutions, and society at large), we take the liberty to pose some pointed questions.

To what degree has our discipline been able to provide useful lenses to analyze the transformations that are occurring in our society? Have we raised the right questions to prompt a profound rethinking in the management discipline outside the discourse in the ONE subfield? Are we providing the interpretative frameworks capable of favoring or supporting the conservation of our fragile ecosystems? As management scholars, are we jointly responsible for or complicit in nature’s progressive degradation, or is this outside our boundaries of responsibility?

As theorists trained to study organizations, and as members of organizations immersed in a biophysical world, we share the view of our colleagues in the fields of ecology and society and think that our branch of social science must actively contribute to protecting nature – particularly since the absence of doing so implies contributing to nature’s decline.

If we acknowledge the mutual influence – or interconnectedness – of organizations and ecosystems, what are the implications for organization theory? In Figure 3.2, we graphically represent this bidirectional relationship: on the one hand, humans – whether as individuals, through business organizations (our main focus here), or through any form of organizing
(including institutional arrangements and entire societies) – affect ecosystem functioning and stress ecological resilience through the over-consumption of services (be that overexploitation of natural resources, emissions of pollutants, or other wastes at rates above the recovery capacity of natural systems).

On the other hand, organizations fundamentally depend on the services provided and are vulnerable to shortages in the availability of these services: depletion of fish stocks threatens global fisheries and companies operating in the food industry; growing pressure on water resources affects both the supply and the quality of water and undermine businesses’ continuity in sectors such as agriculture, forestry, beverages, or energy. We refer to this mutual relationship of impact and dependence as organizational ecosystem embeddedness.

Figure 3.2 - Theoretical Model of Organizational Ecosystem Embeddedness

What is new in this representation is the focus on dependence as a constitutive part of the ecosystem-organization relationship. Future research should consider not only the effect of organizational impact on nature but also the effect of nature’s transformation on organizations, since changes in ecosystems and ecosystem services can dramatically affect firms and entire business models. Climate change provides a good example. Strategies aimed
at reducing a firm’s impact on the climate system (by reducing carbon emissions) are increasingly accompanied by strategies aimed at increasing the firm’s resilience to the heightened risk of extreme weather events (by preparing for floods or droughts) (Kolk, Pinkse & Van Houten, 2010; Winn et al., 2011).

As mentioned above, the concept of organizational ecosystem embeddedness relies on dependence and impact as two constitutive aspects of the relationships between ecosystems and organizations. This effectively establishes business organizations as social-ecological systems – something that has not been closely examined in organizational studies before.

3.5 Implications for Research on Organizations and Strategic Management

New attention by business towards ecosystems and their functioning offers intriguing research directions for investigating both the biophysical dimensions of impact-dependence linkages between organizations and the natural environment, as well as cognitive and management dimensions of these linkages.

Earlier, we discussed ecosystems as complex adaptive systems. If organizations are also forms of complex adaptive systems which jointly form social-ecological systems, then scholarly research needs to investigate more specifically how the interconnectedness between them is structured and how it might change in a context of rapid mutation of ecosystems’ capacity to provide services. This raises a number of questions. Which theories – organizational and other – deal with interconnectedness and can provide solid conceptual models to examine the ecosystem organization relationship and its potential joint or co-evolution (Porter, 2006)? Can theories anchored in knowledge domains of human and social organization (such as co-evolution, industrial ecology or population ecology) be adapted or expanded to include the material aspects of nature and ecosystem functioning, and deepen knowledge of organization-nature interconnections? What are the conditions that increase or mitigate impact and dependence? How much can and do institutional contexts influence these organization-ecosystem interconnections?

An example are new market mechanisms intended to protect ecosystem services, such as tradable permits, increasingly popular in sectors like fisheries or water system management; scholars are also looking at biodiversity as a new area to experiment with tradable rights
(UNEP FI, 2008). Research is needed to understand how such institutional innovations can, for example, incentivize private investment in conservation initiatives aimed at enhancing ecosystem services (e.g., by protecting and restoring fisheries or water systems). Ecological resilience, furthermore, is crucial for maintaining ecosystem functionality and to avoid flips to other states with unpredictable consequences for society. Global fisheries serve as an example: having proven resilient through extended and extensive overfishing and widescale destruction of marine ecosystems, once pushed into collapse, result in massive reductions in food sources, livelihoods and global business. Important questions to ask include: what are the barriers that keep organization theory from expanding more fully into examining the mismatch between spatial and temporal scales at ecosystem levels and those at organizational levels? Indeed, why are ecological scales not or very rarely (e.g., Bansal & Knox-Hayes, 2013) even considered? How can social and organizational systems and their functioning be linked to ecosystems and their functioning, such that impacts and dependence are accurately represented?

3.5.1 Strategy and Risk – Nature as the New Corporate Reality

Earlier, we discussed how a number of multinational companies are addressing ecosystems and biodiversity conservation by implementing a range of initiatives. Future research will need to provide a full review of current initiatives and build a comprehensive framework to interpret and classify them. In the context of this paper, a closer look at how ecosystem interconnectedness impacts and, perhaps, inspires management strategy does open fruitful directions for future research.

One important set of questions relates to business risk. As awareness and understanding of the strategic dependencies of firms on specific ecosystem services grow, firms will want to reduce both direct operational risks and secondary regulatory and reputational risks. In recent years, some industry associations (e.g., the WBCSD), NGOs (e.g., the World Resources Institute), and consulting companies (e.g., PriceWaterhouseCoopers for the World Economic Forum) have explored the relationship between ecosystem degradation and risks from a business perspective and identified multiple areas of impact on companies’ strategies and operations (WRI et al., 2008; PriceWaterhouseCoopers, 2010). Still, methodological rigor is
required to investigate how the degradation of ecosystem services and loss of ecological resilience affect organizational risk and risk perceptions, and how the type of industry, type of firm, and operational activities affect both. What kind of new business risks are emerging as a consequence of the degradation and transformation of ecosystems? What is the nature of such risks? Which industries and organizations are more exposed and why? Are risks of a reputational or regulatory type, or do they undermine core strategies of companies, directly affecting the sustainability of the business model by threatening availability of and access to critical resources? We expect that entire research agendas can be built around the question of how such risks impact the competitive advantage of firms.

Another important area of investigation involves the strategic responses of companies. The following questions map possible future directions: Facing changes in and deterioration of ecosystems services, how are companies transforming associated business risks into opportunities to reshape their strategies and to innovate? What factors prompt firms to adapt only reactively to such changes, what factors contribute to building anticipatory capacity, and what contributes to transformational changes that lead to sustainability management? Which types of firms undergo changes in their core strategy and why? What are the emergent strategies to address ecosystem service scarcity and loss of ecological resilience (e.g., biomimicry and other approaches that increase the efficiency of using ecosystem service), and what innovations lead to viable ecosystem services substitutes (e.g., the use of water filtration and treatment techniques to purify water; implications of replacing wood fiber with bamboo fiber for supply chains, production technologies and marketing strategies)? How can ecosystem and biodiversity conservation strategies contribute to reducing the corporation’s negative impact on ecosystems? To increasing its sustainability management on both environmental and social dimensions? How robust is such engagement when competitive pressure goes up, how much proves to be only symbolic or greenwashing? Engaging actively in ecosystem management is likely to have ripple effects through firms’ entire supply chains thus placing new demands (as well as opportunities) on innovations in supply chain management and related literature. Clearly, this also places new demands on developing (or tapping into) relevant firm competencies and dynamic capabilities. Here, a theoretical anchor for new research might be the natural resource-based view (NRBV) of the firm (Hart & Dowell, 2011), as well as the rich body of research on dynamic capabilities (e.g., Aragón-
Correa & Sharma, 2003; Teece, Pisano & Shuen, 1997). Questions include what competencies and dynamic capabilities are needed to address and learn from changes in ecosystem service availability? Can such capabilities reside narrowly in expert knowledge in the firm or do they require broader cultural shifts throughout the entire organization, similar to the quality revolution, or even more transformative change. Are more fundamental organizational systems needed, and if so, what kind? More specifically, how can companies manage the protection and restoration of relevant ecosystems in light of their complexity, varied spatial and temporal scales of ecosystem services, and competing uses and users. Potentially conflicting demands will likely require new forms of partnerships with local, regional, and international partners and across market, regulatory, and civic sectors. What theoretical advances might this area offer to the NRBV and resource-based theory in general?

3.5.2 Competition, Co-operation, Conflict
As corporations learn (and are even called upon) to actively manage their relationship with and ideally restore and even strengthen ecosystems, they are bound to encounter conflicts (internal and external) and governance challenges that stem from private sector organizations managing the commons. Difficult organizational and governance challenges include finding mutually acceptable forms of joint engagement amongst a range of different stakeholders, principled with transparency and accountability, and taking into account perceptions of fairness and justice in light of differential endowments of power (e.g., voluntary self-regulating approaches, Berchicci & King, 2007). Linking the intra- and inter-organizational challenges of cross-sector partnerships to the complexities of different temporal and spatial aspects of ecosystem functioning places considerable strain on businesses to innovate, and find models that allow them to cooperate on the ground, while retaining their competitive advantage vis-à-vis competitors in other areas, such as their cost structure, branding, etc. This is not entirely new ground: the Marine Stewardship Council, Roundtable for Sustainable Palm Oil or Rainforest Alliance provide additional examples to those mentioned earlier, and will serve as an important empirical base for in-depth case studies and rigorous investigation of different aspects of these challenges.
Value and Values. New decision-making tools (e.g., ecosystem evaluation tools, software programs, etc.) will need to be developed that permit both the difficult task of monetizing ecosystem services (and the ecosystem functions that lie behind them), as well as capture the divergent, and often conflicting ‘values’ held by different stakeholders. To use the example of AccelorMital’s initiative cited in Table I: retaining healthy chimpanzee populations in the Nimba Mountains may or may not be crucial for the integrity of ecosystem functioning, but they are clearly an important aspect of the UNESCO effort and environmental NGOs (and their supporters), who view chimpanzees as having intrinsic value in their own right. Discussions around the loss of species and biodiversity must necessarily tap into both scientific knowledge and personal, cultural and societal values. The literature on conflict and multiple-stakeholder management may have important contributions to make for both scholarly purposes and practice.

3.5.3 Nurturing Multidisciplinary Perspectives
As a concluding observation, we argue that the bridging of knowledge domains (as aimed for in this paper) and the development of effective new approaches to ecosystem management and corporate involvement absolutely require cultivating of cross-disciplinary discourse, nurturing of multi-disciplinary perspectives, and drawing on the innovative capabilities of the many practitioners developing new approaches on the ground. To the degree that sustaining the biophysical foundations of business is recognized as essential to long-term business continuity, new perspectives, decision approaches, and methodologies are required. We observe hopeful signs of new partnerships and forms of interactions that support a fruitful discourse and a search for rigorous, scientifically based collaborations among scientists (natural and social), civil society leaders (e.g., TNC, WWF), business pioneers (e.g., WBCSD), and governmental/intergovernmental efforts. Organization scholars have an important contribution to offer.
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The Economist, May 26th. 2011. Welcome to the Anthropocene. Humans have changed the way the world works. Now they have to change the way they think about it, too.


Knowledge-Creation for Ecologically Sustainable Practices Within and Beyond Firm Boundaries: The Case of Barilla

Abstract

This paper utilizes a single case study methodology (Yin, 2003) to investigate the critical role of knowledge creation for developing innovative strategies that are simultaneously building business opportunities and are grounded in principles of ecological sustainability. Theoretically, I draw on the knowledge-based view of the firm (Grant, 1996, Kogut & Zander, 1992) and on research in modern ecology (Berkes & Folke, 1998, Gunderson & Holling 2002) to examine how knowledge about social-ecological systems (“ecological knowledge”) generated outside the company’s boundaries can be accessed, developed, transformed into, and blended with, organizational knowledge.

The setting for this in-depth case study is the Italian firm Barilla, the global leader in the pasta market and a pioneer in the adoption of environmental management tools. In 2010, the company initiated a sustainable farming project aimed at significantly reducing the environmental impact of durum wheat cultivation, its most important raw material. By replacing monoculture with crop rotation, collectively creating innovative technologies to support farmers’ decision-making, and providing guidelines for disseminating cropping knowledge and practices, Barilla was able to obtain major improvements in terms of reducing environmental impacts, improving the sustainability of farming practices and increasing production yields. The company effectively initiated a process of profound transformation, both internally and beyond the organization’s boundaries.

The findings from the study suggest that developing deep knowledge about sustainability can increase an organization’s capability to innovate. There is also clear evidence that ecological knowledge can serve as a critical resource for dramatically reducing the environmental impact of a business, while also generating economic and social benefits for the firm and surrounding local communities. I conclude that a knowledge-based perspective offers new opportunities for research on firm-based sustainability strategies, providing a theoretically promising lens for studying organizations as part of the broad social-ecological systems in which they are embedded.

Keywords: Environmental sustainability; knowledge; knowledge creation; ecological knowledge; social-ecological systems; innovation; sustainable farming.
4.1 Introduction

Barilla Group, the family owned Italian company who is the global leader in the pasta business, was among the pioneers in the food industry in adopting environmental management tools, such as integrated Health, Safety and Environmental (HSE) management systems, Life Cycle Assessment (LCA), and Environmental Product Declaration (EPD). In 2008, Barilla applied the LCA methodology to the entire pasta supply chain. When Barilla found that the life-cycle stage with the greatest impact on ecosystems was the cultivation of raw materials (Barilla, 2010), the company launched a new strategy: the goal was to involve the key players in the supply chain from seed producers to farmers and share experience and knowledge in growing different types of crops with them. Specific attention was dedicated to durum wheat cultivation, Barilla’s most critical raw material input for pasta. Between 2010 and 2012, a two-phase pilot project combined different types of crop rotation to replace monoculture, innovative technologies to support farmers’ decision-making, and guidelines for disseminating cropping knowledge and practices. The results were major improvements in terms of sustainability broadly (BCFN, 2011), with specific indicators measuring production yields, environmental impact, food safety and food quality. The company thus had started a process of profound transformation towards sustainability – both internally and beyond the organization’s boundaries.

In this paper I treat the story of Barilla as the case of a company that has developed strong knowledge about its interdependence with nature: organizational knowledge and technical environmental knowledge (Boiral, 2002; Rothenberg, 2003), along with traditional ecological (Pretty, 2011; Turner & Clifton, 2009) and scientific knowledge on farming practices and on social-ecological system (Folke et al., 2007). The combination of these dimensions appears critical to sustainably manage environmental impacts and reveals innovation opportunities that might lead to competitive advantage.

Knowledge has emerged as an important research area in management studies with the knowledge-based view of the firm and organizational learning (Grant, 1996; Kogut & Zander, 1992; Spender, 1996). According to this literature, knowledge allows firms to innovate and is

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8 An Environmental Product Declaration, EPD, is: “a verified document that reports environmental data of products based on life cycle assessment (LCA) and other relevant information and in accordance with the international standard ISO 14025 (Type III Environmental Declarations).” (http://www.environdec.com/en/What-is-an-EPD/#.VBwOllf-7To)
essential for competitive strategy and performance (Eisenhardt & Santos, 2002). Knowledge plays an important role in modern ecology, too. With the emergence of the social-ecological systems (SES) perspective (Berkes & Folke, 1998), ‘ecological knowledge’ has become a key resource to understand ecosystem dynamics and develop adaptive and sustainable strategies through learning processes (Folke et al., 2005). In the field of corporate sustainability management, on the other hand, the knowledge perspective (Boiral, 2002; Hörisch et al., 2014; Siebenhüner & Arnold, 2007) has been met with less interest when compared to other approaches (such as the resource-based view, institutional theory or stakeholder theory) used to understand the relationship between business organizations and the natural environment (see Hoffman & Georg, 2012; Starik & Kanashiro, 2013 for a review).

This paper seeks to contribute to the literature on corporate sustainability exploring the role of knowledge in developing new ways of producing goods that both capture business opportunities, and are grounded in the principles of sustainability. I examine how knowledge about SES dynamics, generated outside the company’s boundaries, can be accessed, developed and transformed into, and blended with, organizational knowledge. Adding this perspective on knowledge to business and environment studies contributes to our understanding of how companies develop long-term strategies that target both real environmental sustainability and increase competitiveness.

The remainder of the paper is structured as follows. First, I review the concept of knowledge both in the management literature, and in modern ecology focusing on SES, and I clarify the research problem motivating this study. Second, I describe the study’s design and research methodology. Then, I present and discuss the findings of the Barilla case study. Finally, I examine the implications and offer suggestions for future research.

4.2 A knowledge-based view of business relationship with social-ecological systems

4.2.1 Knowledge-based view of the firm

For several years scholars in the fields of management have investigated the role of knowledge. This movement lead to the development of the knowledge-based view or KBV (Grant, 1996; Kogut & Zander, 1992; Spender, 1996), and to extensive research on how
knowledge affects innovation processes, enhances the firm’s ability to detect future market opportunities, and impacts firm performance (Eisenhardt & Santos, 2002). Organizational scholars have investigated knowledge with regard to organizational learning, and the capacity of the firm to acquire, coordinate and integrate past and new knowledge (Cohen & Levinthal, 1990; Kogut & Zander, 1996). Strategy theorists have analyzed knowledge to understand the sources of competitive advantage and the sustainability of the firm’s performance (Grant, 1996).

The KBV developed on these theoretical foundations, emphasizing the strategic importance of knowledge as a resource (Grant, 1996). Knowledge resources, due to their intangible nature, are particularly difficult to imitate and can provide an important component for competitive advantage. Kogut and Zander highlight that “the knowledge of a firm can be considered as owning a portfolio of options, or platforms, on future developments” (Kogut & Zander, 1992: 385). Innovation, therefore, is a function of the firm’s ability to create, integrate and transfer knowledge, and knowledge allows firms to grow to the degree that it favors innovation and the exploitation of new markets.

The distinction between individual and organizational knowledge is another important contribution by these scholars. Individual knowledge is the knowledge held by the organization’s members. Organizational knowledge is viewed as a process that integrates and amplifies the specialized knowledge that is stored in individuals in order to produce goods and services (Grant, 1996). This knowledge is embedded in knowledge networks of the organization, which result from an iterative process involving both tacit and explicit knowledge, at individual and organizational levels (Eisenhardt & Santos, 2002; Nonaka & Takeuchi, 1995). These networks can extend outside the firm, and knowledge can be integrated from external sources that span the organizational boundaries (Grant, 1996). Networks are both important repositories of knowledge for firms, and knowledge sourcing and external linkages provide important opportunities for innovation (Powell et al., 1996).

Other streams of research have focused on examining the mechanisms that favor knowledge transfer and knowledge integration within and across firms (Cohen & Levinthal, 1990), or have analyzed the concept of knowledge as a process (Spender, 1996).

In sum, the knowledge perspective in management studies offers many relevant insights to better understand management processes, including organizational learning, innovation and
competitive advantage. The concept also offers important lenses for analyzing the interdependence of business organizations with the natural environment.

4.2.2 Knowledge and social-ecological systems
Since its introduction in 1998 by Berkes and Folke, the social-ecological system (SES) framework has become a fundamental approach to observe human-ecological relations and the challenge of sustainability (Abel & Stepp, 2003; Gunderson & Holling 2002; Levin et al., 2013; Rammel et al., 2007, Turner, 2014). SES are defined as nested systems of people and nature with reciprocal feedbacks and interdependencies, in spatially determined geographical settings (The Resilience Alliance, 2007). SES are complex and adaptive, and share a number of properties such as connectivity, nonlinearity, uncertainty, multiple scales and diversity (Levin et al, 2013). Quoting Levin et al. these “macroscopic properties emerge from local actions that spread to higher scales due to agents’ collective behavior; these properties then feed back, influencing individuals’ options and behaviors, but typically only do so diffusely and over much longer time scales” (2013: 113). These properties generate unexpected dynamics and surprise that reduce our capacity to anticipating the future evolution of the system (Folke et al., 2007; King, 1995). As a consequence, environmental problems such as climate change, water pollution or biodiversity loss are difficult to understand and even more difficult to manage.

The perspective of SES, while not exempt from criticisms (Cote & Nightingale, 2012; Halliday & Glaser, 2011) provides important and promising theoretical and operational ground to better understand the challenges of sustainable development and to manage them, working towards practical solutions. On the one hand, focusing on the systemic nature of SES requires a systemic view of knowledge that engages different disciplinary fields, and involves cross-fertilization and mutual learning among researchers. In recent decades, a wide variety of sub-disciplines have emerged in order to address the intersection between social, cultural and ecological systems that span across core disciplinary boundaries of science specialization (Pretty, 2011: 128). Examples are environmental sociology, ecological economics, human ecology, political ecology, system ecology. These sub-disciplines have tried to bridge natural and social sciences, giving rise to new theoretical approaches, assumptions, and
methodologies with regard to the management of social-ecological systems (Mascia et al, 2003; Pretty, 2011).

At the same time, the complexity of social-ecological challenges calls for diverse sources of knowledge and involves collaborative efforts by multiple types of actors, including both the communities of academics and practitioners (Schaltegger et al., 2013). In other words, ecological knowledge is produced not only by scientific groups, but also by communities of users of natural resources and networks of professionals that generate knowledge as a result of observation and direct interaction with the natural environment. Quoting Folke et al., “[i]t comes as no surprise that knowledge of ecosystem dynamics and associated management practices exists among people of communities that, on a daily basis and over long periods of time, interact for their benefit and livelihood with ecosystems” (2005: 445-446). This type of knowledge has been termed variously “local knowledge,” “traditional knowledge” and “indigenous knowledge,” according to its specific characteristics and the field of study (Pretty, 2011). What is critical for this paper is that a growing body of literature, spanning multiple disciplinary fields, focuses on how communities learn about ecosystems and develop capacity to sustainably manage and adapt to environmental changes (Berkes & Folke, 2002; King, 1995; Pretty, 2011; Whiteman & Coopers, 2011).

Ecological knowledge is therefore a combination of different types of knowledge about social-ecological system dynamics, including sciences that research human-ecosystems interdependencies, and local knowledge that derives from communities and networks of practitioners and their interaction with the natural environment (Lang et al., 2012). The urgency and complexity of environmental challenges calls for an integration of these diverse knowledge types and for methodologies that favor the participation of multiple sources of knowledge production through mutual learning (Brandt et al., 2012; Schaltegger et al., 2013; Shrivastava et al., 2013).

4.2.3 Knowledge and corporate environmental sustainability

While not often acknowledged, for a firm to adopt environmental strategies and to generate sustainable innovations requires the acquisition and development of specific knowledge on environmental issues (Boiral, 2002; Siebenhuner & Arnold, 2007; Hörisch et al., 2014; Siltioja, 2014). Yet the role of knowledge has been barely examined in the corporate
environmental sustainability literature (Hoffman & Georg, 2012, Starik & Kanashiro, 2013). Next, I review the limited literature on the role of knowledge in sustainable strategy.

Environmental knowledge has been addressed from the perspective of the natural resource-based view (Hart, 1995; Hart & Dowell, 2010). Work in this area focuses corporate environmental strategies (Shrivastava, 1995; Aragón-Correa, 1998) and investigates the development of environmental resources and capabilities that can lead to superior performance (Christmann, 2000; Darnall & Edwards 2006; Russo & Fouts; 1997; Sharma & Vredenburg, 1998). Some scholars in this area highlight the importance of developing specific knowledge about the business/natural environment relations as a source for environmental strategies. Managerial and organizational environmental knowledge, for example, is a source of continuous improvement and innovation, and helps addressing uncertainty and complexity (Aragón-Correa & Sharma, 2003: 84-85).

Other scholars focus more specifically on the role of specialized environmental knowledge as a driver for applying sustainability management tools and the development of sustainable management strategies (Schaefer & Harvey, 2000; Schaltegger et al., 2012; Hörisch et al., 2014). Here, increasing environmental knowledge leads to more successful implementation of environmental management tools and corporate sustainability strategies.

Other research investigates the role of environmental experts at both external and corporate levels as key resources that can facilitate the transfer of specialized knowledge through organizational learning processes and analyzes how the management of this knowledge can guide the development of sustainable solutions and generate organizational changes (Aragón-Correa & Sharma, 2003; Halme, 2002; Siebenhuner & Arnold, 2007; Zietsma et al., 2002).

A final stream of research in this area investigates the characteristics of environmental knowledge with regard to employees’ contribution to pollution prevention and resources efficiency. Boiral, for example, distinguishes between explicit environmental knowledge that is technical and factual, and tacit environmental knowledge defined as “know-how based on observations, routines and work experience which helps to improve environmental management but whose empirical, context-specific and personal nature does not easily lend itself to formal explanations” (2002: 298). Boiral shows that tacit environmental knowledge is particularly relevant for understanding the sources of pollution, for proposing innovative solutions and for addressing environmental crises. In a similar line of research, Rothenberg
(2003) investigates workers’ participation in environmental management and identifies different types of environmental knowledge (contextual, process, intra-organizational and external). Her findings show that the role of specialist staff (both internal and external to the environmental function) is critically important for environmental improvements (Rothenberg, 2003: 1783).

Overall, this literature on corporate environmental sustainability views environmental knowledge as complex and multifaceted. Such knowledge encompasses organizational and technical dimensions, and it can be either explicit and part of management procedures or technologies, or implicit and embedded in the workforce at different organizational levels. Moreover, it can be acquired from external sources such as environmental experts, consultants, suppliers, and customers. On the other hand, this literature rarely looks at the role of knowledge of and about broader systemic dimensions of the business-natural environment relations.

Modern ecology investigating complex social-ecological system on the other hand, points to individual, organizational and institutional dependence on ecosystem services and functions, and highlights the crucial importance of healthy ecosystems for human well-being (Berkes & Folke, 1998; MA, 2005; Rockström et al., 2009). The management of environmental issues, at minimum, requires an understanding of local and global ecosystem dynamics and of how business activities interact and interfere with SES (Winn & Pogutz, 2013; Whiteman et al., 2013). This important and extensive body of work in ecology has remained mostly peripheral to business studies; until now, corporate sustainability has benefited from only very limited cross-fertilization with natural sciences data, theories and practices (Bansal & Hoffman, 2011; Winn & Pogutz, 2013; Whiteman & Coopers, 2011).

In this paper, I develop this interesting and new research perspective further, taking the position that a closer investigation of knowledge and knowledge strategies which incorporate ecological knowledge can contribute not only to our understanding of, but also to addressing the corporate sustainability challenge. The Barilla case provides an intriguing, albeit illustrative, example of how such knowledge can be accessed and developed further by an organization, and how it can become a source of opportunities for innovation, competitiveness and sustainability.
4.3 Research design and methods

This research draws on case study methodology (Eisenhardt, 1989; Yin, 2003) focusing on a single case. The Barilla Group case fits the requirements of a theoretical sampling logic, and provides opportunities to explore a significant and phenomenon under specific conditions (Siggelkow, 2007). First, Barilla has a long history of and associated experience in managing environmental issues, considered a leading-edge company in managing environmental sustainability in the food industry. Second, by implementing its sustainability policy and strategy five years ago, the company started a profound transformation involving its most important supply chains, in particular the cultivation if its key raw material, durum wheat. This change seems to have been guided by developing deep knowledge about the firm’s interdependence with SES. The Barilla case thus is exemplary in highlighting the critical phenomena focused on in this research. Finally, Barilla is a privately owned company in the hands of the founders’ family (the three Barilla brothers) and, founded in 1877, has a long entrepreneurial history that is based on values, culture and traditions of the SES where the company is located and embedded.

4.3.1 Data collection

Multiple data sources have been used to triangulate findings and increase the study’s reliability, including in-depth interviews, observation and archival data. Data were collected in two phases. Two key informants in particular helped with organizing interviews and collecting archival materials along those two phases and during data analysis. The first phase from May 2012 to March 2013 was dedicated to collecting archival materials, conduct semi-structured interviews, and interact with company managers during workshops and an international forum organized by the company. The second phase from September 2013 to May 2014 was dedicated to checking and validating earlier findings with supplementary interviews, information exchange with key company’s informants, and additional company observations.

Interviews. A total of 11 informants were interviewed. Interviews have been mainly conducted with senior executives (see Table 4.1 for a short description of the interviews), including one of the deputy chairmen. The selection of interviewees responded to the requirement of obtaining a complete and holistic view of the phenomena under observation from different perspectives (Eisenhardt & Graebner, 2007). Interviews lasted between 45
minutes and 3 hours, with an average length over 60 minutes. All interviewees have had a long tenure with the company (in many cases over 20 years). To carry out the interviews, a semi-structured approach was taken, and the list of open-ended questions was previously sent to the informants in accordance with the data collection protocol (Yin, 2003).

**Table 4.1 - List of informants and key topics discussed during the interviews**

<table>
<thead>
<tr>
<th>Interviewee position</th>
<th>Key topics for the interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deputy Chairman</td>
<td>Company history; mission and values; competitive strategy and goals; sustainability strategy and the issue of nutrition.</td>
</tr>
<tr>
<td>Development &amp; Innovation Director</td>
<td>Marketing strategy at Barilla; sustainability and marketing.</td>
</tr>
<tr>
<td>Scientific Relations &amp; Sustainability Director</td>
<td>Company history; history of sustainability at Barilla (focus on environmental issues); history of BCFN; sustainable and integrated supply chains project; durum wheat and sustainability field projects; Barilla position on GMOs.</td>
</tr>
<tr>
<td>People, Safety, Environment &amp; Energy Unit Director</td>
<td>Company history; history of sustainability at Barilla (focus on environmental issues); sustainable and integrated supply chain project; analysis of LCA and EPD for durum wheat pasta; sustainable durum wheat project.</td>
</tr>
<tr>
<td>Durum Wheat Purchasing Director</td>
<td>Sustainable and integrated supply chain project; durum wheat purchasing strategy; sustainable durum wheat project.</td>
</tr>
<tr>
<td>Responsible for Europe and Turkey Durum Wheat Purchasing</td>
<td>Durum wheat purchasing strategy; sustainable durum wheat project.</td>
</tr>
<tr>
<td>Raw Material Purchasing Director</td>
<td>Sustainability strategy at Barilla (focus on environmental issues); sustainable and integrated supply chain project; raw materials purchasing strategy.</td>
</tr>
<tr>
<td>Agronomy Research Manager</td>
<td>Durum wheat purchasing strategy; sustainable durum wheat project; agronomic information on cropping techniques for durum wheat.</td>
</tr>
<tr>
<td>Packaging Design and Standards Director</td>
<td>Sustainable and integrated supply chain project, packaging and sustainability at Barilla.</td>
</tr>
<tr>
<td>Group Communication and External Relations</td>
<td>Sustainability at Barilla (integration of the three dimensions: economic, social and environmental); sustainability reporting.</td>
</tr>
<tr>
<td>Barilla Learning &amp; Development</td>
<td>Company history; mission and values; sustainability at Barilla. Key informants to plan the interviews and access archival documents.</td>
</tr>
</tbody>
</table>

**Observations and archival documents.** Direct observation provided another important source of data for the realization of this study. I attended two international fora on food and nutrition organized by the Barilla Center for Food and Nutrition (BCFN) in November 2012 and 2013, and I had the opportunity to attend other presentations by Barilla’s managers as part of other events. I further participated in a highly interactive two-day workshop organized by Barilla involving around 30 participants including company managers, several suppliers and other
stakeholders. The topic of the workshop was sustainability at Barilla, with a focus on sustainable supply chains and sustainable reporting.

Multiple archival documents have been collected and analyzed. This broad range of materials includes annual reports, sustainability reports, more than 20 working papers published by the BCFN, and several documents prepared for internal meetings and official presentations, including technical papers such as LCAs and EPDs of Barilla’s products. Moreover, I examined around 650 articles linked to Barilla and published in databases like Factiva, LexisNexis, Web of Science, EBSCO. To do the search I have used the following keywords associated with Barilla: sustainability, supply chain, nutrition, and durum wheat; materials from this search provided rich information of the research context and helped clarify the challenges associated with sustainability in the agro-food industry.

4.3.2 Data analysis
The data have been collected and stored in a systematic manner in a case study database (Gibbert et al., 2008; Yin, 2003). The interview transcripts, field notes and other company documents were coded using NVivo software. At the end of data collection, I compiled a descriptive case history of Barilla of about 12,000 words, which includes a chronological list of the main events related to environmental sustainability and a detailed description of the durum wheat project. The write-up of the case was circulated to the interviewees to be validated, which strengthens the reliability of the case study. I then proceeded analyzing the data, identifying key elements and patterns. Triangulation among different sources was carried out to increase the validity of the findings. Lastly, I examined the findings with the literature in light of the research problem stated earlier.

4.4 Research findings
The Barilla Group is one of the most important Italian companies in the food industry. It is a global leader in the pasta business, as well as a market leader in ready-made sauces in Europe, in bakery products in Italy, and in crispbreads in Scandinavia. The company was founded when Pietro Barilla opened a small bread and pasta shop in Parma (Italy) in 1877, and was managed by a single family. Today the company is under the leadership of the fourth
generation of family business. In 2013, the Barilla Group employed 8,106 people, and had revenues of EUR 3.198 million in four primary geographical areas: 50.3% in Italy, 29% in Europe, excluding Italy; 15.5% in the Americas, and 5.2% in Asia, Africa and Australia. The group’s factories produced about 1,700,000 tonnes of products, which reached the dining tables of more than 50 million people around the world and were distributed in more than 100 countries (Barilla, 2014). As of the end of 2013, the group owned 30 production sites (14 in Italy and 16 outside of Italy) and had a portfolio of 1,000 products (Barilla, 2014).

4.4.1. Sustainability management and sustainability-oriented knowledge at Barilla

Barilla’s approach to sustainability is strongly linked to the company’s values. The words of one of the Deputy Chairmen, fourth generation of the Barilla’s family, provides a clear description of this concept: “This approach, today defined as ‘sustainable’ by many, for us has simply always been the way in which we run our business. If we think of our family’s way of doing business, we cannot imagine it as being non-sustainable.” Other interviewees underlined this idea and its links to the long-term survival of the company. Moreover, several informants associated this concept with multiple meanings: “One meaning [of sustainability] is strictly related to the long-term survival of the company. Over the years, new requests emerged from society, such as quality, food safety, nutrition and environmental protection and the concept has become more complex since all the previous characteristics remain, but you add on other things.” Another interviewee described this process of continual transformation as follows: “First, the company had a product to satisfy the market’s needs, second it satisfied needs in terms of food safety, and then in terms of nutrition … sustainability is the way of doing business today and in the future. It is the only way of doing business!”

This holistic view of sustainability, which links quality, food safety, nutrition and environmental protection, is embedded in Barilla’s business approach. At the same time, each of these dimensions can be considered a repository of specialized technical and organizational

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9 In this paper, I use the term “tonne” referring to the metric tons, a unit of mass equaling 1,000 kilograms.
knowledge, generated and cultivated by the company over the years (see Table 4.2 for examples).

**Table 4.2. - Corporate sustainability and sustainability-oriented knowledge at Barilla (examples)**

<table>
<thead>
<tr>
<th>Sustainability dimensions</th>
<th>Contents of sustainability – oriented knowledge</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food quality</td>
<td>Knowledge about food manufacturing</td>
<td>Since 1996 the company is using a manual on Good Manufacturing Practices. The company has adopted a Quality Management Systems that allows the control and efficient traceability of raw materials and products throughout the supply chain. The company has developed its own variety of high-quality seeds, like Svevo, Normanno and Aureo durum wheat, with a specialized breeding company (Produttore Sementi Bologna) through traditional technique of cross-breed (non-GMO).</td>
</tr>
<tr>
<td></td>
<td>Knowledge about raw materials</td>
<td></td>
</tr>
<tr>
<td>Food safety</td>
<td>Knowledge about crop diseases</td>
<td>Barilla R&amp;D unit has developed specialized knowledge to avoid the generation of mycotoxins (caused by fungi), a potential major disease in durum wheat. The company provides farmers with advice for preventive intervention through manuals and cultivation specifications guidelines.</td>
</tr>
<tr>
<td>Nutrition</td>
<td>Knowledge about the effect of food on human wellbeing</td>
<td>In 2008 Barilla developed a set of nutritional guidelines to assess the quality of new products and to favor the reformulation of old products. In 2009 the Barilla Center for Food &amp; Nutrition, today a multidisciplinary and independent foundation, was established with the aims to produce and share knowledge on issues related to food and nutrition by leveraging on global experts active in different scientific fields.</td>
</tr>
<tr>
<td>Environmental protection</td>
<td>Knowledge about environmental management systems</td>
<td>In 2013 integrated Health, Safety and Environmental (HSE) management systems extends to more than 83% of the firm’s production, and are certified by independent body in accordance with the international standards (OHSAS 18001 and ISO 14001). In late 1990s the LCA was first tested to analyze the impact of the entire pasta supply chain. This methodology in 2013, involved about 80% of Barilla’s global production.</td>
</tr>
<tr>
<td></td>
<td>Knowledge about environmental performance measurement</td>
<td></td>
</tr>
</tbody>
</table>

In the approach of Barilla, sustainability-oriented knowledge reflects a broad concept that entails multiple areas: from the manufacturing of high-quality and safe products, to the understanding of the impact of farming on ecosystems, and the relation between food and the
well being of consumers. Several points of evidence show that the company is trying to integrate these dimensions through organizational mechanisms and structural procedures. One fundamental step is the decision to establish a Sustainability Unit in 2011, along with the creation of the Sustainability Steering Committee (SC) to coordinate different functions with regard to sustainability competencies. The SC contributes to defining Barilla’s future strategy, and supports the Board with innovative ideas and proposals. At the same time, this committee is tasked with integrating environmental and social knowledge. On this topic, one of the informants observed: “Within this group [the SC], we have managed several strategic processes: collecting the data and information, defining the goals, and defining specific KPIs. Moreover, we have defined the next steps towards achieving sustainability (e.g., the way we want to approach retailers, the way we want to improve the cultivation of durum wheat) ….” This knowledge has been recently consolidated into the new strategy for 2020, named “the Lighthouse for the Future” and launched in 2013 with the motto “Good for You. Good for the Planet” (GYGP). GYGP represents the unifying approach that integrates the dimensions of nutrition and environmental protection while taking care of the communities where Barilla operates: Good for You stands for the commitment to produce a product range which is tasty, safe and nutritionally correct; Good for the Planet reflects the goal to reduce the environmental impact of the products along the entire life cycle and to inform people about responsible consumption.

4.4.2 Knowledge about environmental management tools at Barilla

Environmental protection represents a specific chapter of corporate sustainability at Barilla. As already mentioned, the company was among the pioneers to investigate the application of the Life Cycle Assessment (LCA) methodology. In the late 1990s, this tool was first tested to analyze the impact of the entire pasta supply chain, in a period when LCA utilization was still limited (Rex & Baumann, 2008). From this first experimental phase, LCA formally made its way into Barilla’s strategy in 2008, when the company started to use it to thoroughly analyze the supply chain to understand and measure the most substantial environmental impacts of its products (Barilla, 2010; Ruini et al., 2013). These studies allowed Barilla to develop specific knowledge on LCA and build a methodology that led to the publication of the EPD for semolina pasta in 2010. The guidelines
in the LCA methodology, according to the ISO 14040:2006 standard, specify the system boundaries to include all phases of the pasta life cycle: from durum wheat cultivation to the cooking of the pasta in consumers’ homes (Barilla, 2010). The analysis involved the evaluation of three main environmental indicators: the carbon footprint, which captures the total amount of greenhouse gases produced by the system under assessment; the water footprint, which refers to the water consumption of the system in terms of the volume of water evaporated by plants, consumed, or polluted; and the ecological footprint, which measures the amount of biologically productive land and water surface an activity requires to produce all of the resources it consumes and to absorb the waste it generates (Barilla, 2010).

As pointed out by one of the managers, applying LCA showed – to Barilla’s surprise – that the two stages with the greatest impact on ecosystems were those at the beginning and at the end of a product’s life cycle: namely the raw material cultivation and cooking. “With regard to pasta production, distribution, and packaging, we have been working for more than ten years to reduce the environmental impact and the amount of materials utilized. Given this picture, if we want to obtain better results, we have to work on the raw materials and on the cooking phase. This is why we have started to work outside the normally directly managed boundaries of the company.”

The evidence about the sources of the environmental load guided Barilla towards the generation and acquisition of new knowledge about crop cultivation techniques. Specialized knowledge about environmental management tools was critical to guide the development of the sustainable farming strategy (Schaltegger et al., 2012; Hörisch, et al., 2014).

### 4.4.3 Generating and integrating knowledge about sustainable farming

The LCA prompted a two-phase pilot study in 2010 to explore ways of improving the sustainability of the firm’s agricultural practices. It is important to note that farming is an activity that occurs outside the organizational boundaries of Barilla, which is a food manufacturing company. A detailed description of the project provides insights useful for understanding how the company developed new knowledge about complex agro-social-ecosystem dynamics, and how the integration of this knowledge into the organization has revealed strategic opportunities.
The first phase: 2010-2011. In 2010 a first pilot study was launched to understand whether it was possible to reduce the environmental load of durum wheat cultivation. Italy was the first cultivation area considered, since at that time around 40% of the semolina necessary for Barilla’s entire pasta production came from Italian regions. Different types of crop rotations were undertaken. The project was started in collaboration with two specialized suppliers that have been working with Barilla for several years: Horta Srl (a spinoff of the Università Cattolica of Piacenza aiming at transferring research results and technological innovation to practical agriculture), and Life Cycle Engineering Srl (an Italian consulting company focusing on environmental sustainability research and services with particular regard to LCA, eco-design, and EDP). These partners collaborated with an inter-functional team of Barilla managers from the purchasing and R&D departments, with the goal to identify sustainable agricultural systems that could subsequently be tested in the various national territories. Thirty-six farms were selected in the Lombard and Venetian plains, and the Emilia-Romagna region (northern Italy); in Tuscany, Marches, and Umbria (central Italy); and in Puglia, and Basilicata (southern Italy). Rather than choosing monoculture or cultivation based on cereal grains only, the cropping system selected was a four-year rotation in which different crops were cultivated (e.g. maize, chick pea, tomato, sunflower, sugar beet). Six indicators were used to measure the different cropping systems (see Table 4.3).

**Table 4.3 - Indicators used for the pilot study**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon footprint</td>
<td>Expresses the total amount of greenhouse gases (GHG) produced by the system; usually expressed in kg of CO2 equivalents.</td>
</tr>
<tr>
<td>Water footprint</td>
<td>Water consumption of the system in terms of volume of water evapotranspired by plants, consumed, or polluted, per unit of time.</td>
</tr>
<tr>
<td>Ecological footprint</td>
<td>Measures how much biologically productive land and water the system requires to produce all of the resources it consumes and to absorb the waste it generates using prevailing technologies and resource-management practices; measured in global hectares (gha).</td>
</tr>
<tr>
<td>Net income</td>
<td>The difference between direct costs of cultivation (in field activities and technical tools) and gross marketable production.</td>
</tr>
<tr>
<td>Nitrogen index</td>
<td>Nitrogen availability determined by the previous crop’s residue, the contribution of chemical fertilizers, and the time required to biologically degrade the organic substance of the preceding crop.</td>
</tr>
<tr>
<td>DON index</td>
<td>Expresses a safety aspect of cultivation: the risk of generation of molecules toxic to human health through the proliferation of pathogenic fungi producers of secondary metabolites called deoxynivalenol mycotoxin (DON).</td>
</tr>
</tbody>
</table>

Source: Barilla’s archival data and interviews
As observed by several informants, the results of this pilot study were surprising. With the introduction of the right rotation it was possible to reduce CO2 emissions by up to 40-50% and to reduce the other environmental impacts of the agricultural practices, while improving the quality of the final product and profitability for the farmers. Another important outcome of the study was the finding that the characteristics of a plant species—in this case, durum wheat—vary as a result of the agricultural setting in which it is cultivated. When that setting changes, all of the indicators change substantially (environmental, economic, and agricultural), including the final quality of the crop. On this point, one of the informants observed: “It is interesting that we can significantly reduce the CO2 per tonne of durum wheat, while increasing the yield and the money that the farmer can save. From the agronomic point of view, this is normal. If you adopt proper rotation, you can reduce sharply the fertilizer, which reduces costs and has an environmental benefit. On the other hand, it is not so simple—in the last 30 years, we have developed a habit of adding fertilizers to undertake the cultivation that we want and to obtain the results that we want.”

The benefits raised by the introduction of rotation were identified by another manager: “First, you can improve the soil’s productivity. You can make better use of your pesticides because you do not have a specialization of the pests. Then you have a beneficial effect on biodiversity. If you crop different plants from different families the micro-flora and micro-fauna also show an improvement (biodiversity), and you make the structure of the soil more complex and resilient. This increases the productivity and reduces the need to improve it artificially adding chemicals.”

Moreover, the study had another important outcome. In order to consolidate these results, a series of recommendations for the sustainable cultivation of durum wheat was developed and summarized in a document entitled “Handbook for sustainable cultivation of quality durum wheat in Italy.” This document provided guidelines for farmers, and was intended as a tool for disseminating knowledge and practical suggestions.

The second phase: 2011-2012. A second pilot study was undertaken between 2011 and 2012 involving 25 farms located in the most important areas of durum wheat cultivation in Italy. This project aimed to integrate crop rotation with the Handbook and with another important
and innovative tool for in-field experimentation: a Decision Support System (DSS). Farmers were provided with software (developed by Horta Srl) and based on an internet platform that allows them to link information on weather patterns, soil conditions and crop characteristics so they can optimize the amount of fertilizers to use, reduce food-safety risks, and increase productivity. As one of the interviewees commented: “The difference between the Handbook and the web system is that the Handbook gives strategic directions—for example, what crop would be better in a certain year due to the rotation or information on the amount of seeds to use. The web system gives tactical information—for example, it tells when it is time to fertilize or when there is a risk of an attack from a certain type of pest.”

The results of this second phase of the project were even more interesting for Barilla (see Table 4.4). On the one hand, correct crop rotation reduced the environmental impacts and optimized production costs. On the other hand, the integration of the DSD and the Handbook guidelines favored an increase in production yields and further reduced the environmental loads. As a result of the field experiments a global project named Barilla Sustainable Farming (BSF) was introduced in order to promote proper and sustainable agriculture practices. BSF is built on the collaboration with selected farmers and with the Horta Srl.

**Table 4.4 - Benefits found in phase two**

<table>
<thead>
<tr>
<th>Benefits of crop rotation</th>
<th>Benefits of the utilization of DSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Reduction in production costs (-31%)</td>
<td>- Reduction in direct costs of production (-10%)</td>
</tr>
<tr>
<td>- Reduction in the consumption of fuels</td>
<td>- Reduction in carbon footprint (-10% CO2/ton)</td>
</tr>
<tr>
<td>- Reduction in carbon footprint (-36% CO2/ton)</td>
<td>- Increase in nitrogen use efficiency</td>
</tr>
<tr>
<td>- Increase in the efficiency of nitrogen use</td>
<td>- Maintain high yields</td>
</tr>
<tr>
<td>- Increase in yields (+20%)</td>
<td></td>
</tr>
</tbody>
</table>

Source: Barilla (2013), Sustainable durum wheat in Italy. Farming Barilla – 2010/13

The outcomes from the experimental phase clearly indicate that in terms of improving the sustainability of durum wheat cultivation, one key issue is the development of structured, well-attended and trusting relationships with the farmers. In addition to the elements discussed above, the Barilla Sustainable Farming project includes agreements signed by all supply chain partners with the goal of optimizing the selection of varieties, wheat cultivation, and preservation protocols. These “Planting Contracts” are part of the introduction of high-quality varieties of durum wheat selected by Barilla through the years (see Table 2) with the
objective of increasing the percentage of locally cultivated durum wheat. These special varieties are particularly suitable for cultivation under specific geographical conditions, and lead to a decrease in the company’s environmental impact with regard to its water and carbon footprints. In 2013, the BSF project was extended to other countries where Barilla operates (North America, France, Greece, Turkey, Germany and Sweden), as well as to other crops (e.g., soft wheat and rye).

To summarize, this project has prompted the generation and the integration of different types of knowledge about the sustainable cropping techniques and agro-social-ecological systems where the durum wheat is cultivated. The types of knowledge, traditional and local (in the case of rotation techniques), scientific and technical (the DSS software), have uncovered new and unexpected benefits for Barilla, its stakeholders and the natural environment.

4.5 Discussion

This study aimed at achieving a better understanding of the relevance of knowledge in addressing environmental sustainability challenges. Through an in-depth exploration of the leading practice by Barilla, the case under study, I found support for the idea that organizations that develop deep knowledge about sustainability, both organizational and technical, can increase their capability to innovate, improve their performance, and significantly reduce their environmental impact. Extending the KBV approach to corporate sustainability, I see that sustainability-oriented knowledge can also provide the company with a ‘platform of options’ for future strategies (Kogut & Zander, 1992), as well as increase the financial sustainability and competitiveness of the company.

The evidence from the case shows that Barilla has developed deep knowledge of LCA. This environmental management tool had been utilized for several years and helped the firm understand the environmental impact of its main product categories. The company has experimented with, and learned about, this instrument and the opportunities related to its application. This confirms research on the relations between knowledge and environmental management tools, which observes that when the knowledge about tools increases so does their application (Schaltegger et al., 2012). Barilla applied the instrument to the most important product in its portfolio, durum wheat-based pasta, and the results led to the decision
to pursue this area further. The firm decided that it was important to determine whether it was possible to change the way in which raw materials are cultivated in order to reduce the environmental impact generated in the upstream phase of the product life cycle. Importantly, Barilla’s holistic approach to sustainability appears to have supported the decision to launch and the implementation of field experiments on sustainable farming. Integrating repositories of sustainability-oriented knowledge through inter-functional teams, in fact, allowed a continual exchange of information between R&D and purchasing departments, and the Environmental Health and Safety unit – thus prompting ongoing revisions and adjustments to the firm’s evolving knowledge. The firm thus successfully addressed the challenge of transforming agricultural practices around durum wheat to increase sustainability, thanks to the broad and growing knowledge platform that the company had developed over the years. The findings also show that this environmental knowledge has been developed through accessing external specialized suppliers (e.g. Life Cycle Engineering Srl and Horta Srl) with whom the company’s managers, over time, have developed a tight collaboration that has led to several publications (e.g. Ruini et al., 2012 and 2013) and to the formalization of a methodology for the EPD of pasta (Barilla, 2010). These findings are in line with previous research on the importance of external stakeholders, like environmental professionals, for transferring technical expertise and support the development of a credible environmental strategy (Aragón-Correa & Sharma, 2003; Etzion, 2007; Siebenhuner & Arnold, 2007).

As previously discussed, the perspective of SES (Berkes & Folke, 1998), and more specifically ecological knowledge (Berkes & Folke, 2002; Pretty, 2011), until now has attracted little interest from corporate environmental sustainability scholars. In this study, I have built on the notion of ecological knowledge: understanding the complex dynamics of SESs can help manage sustainability at the corporate level (for example, by radically reducing environmental impacts, by improving social conditions, or both) and it can contribute to increasing the resilience of relevant SESs. I further studied how this knowledge can be coupled with organizational and technical (whether explicit or tacit) knowledge to generate value for the firm and its stakeholders.

The in-field pilot study (2010-2011 and 2011-2012) carried out by the company demonstrates the relevance of understanding and learning about local agro-social-ecological systems conditions in order to select the most suitable type of farming practice in term of
sustainability. Introducing crop rotation, which is a traditional way of cultivating, led to discovering unexpected benefits on multiple levels. As one of the interviewees points out: “during these pilot studies we have found that rotation, a traditional way of producing, provides a lot of benefits to the crops: you can improve the productivity of the soil, you can make better use of the pest control chemicals because you don’t have a specialization of the pests, you have beneficial effects to biodiversity.” The company had to uncover and retrieve this type of old or traditional ecological knowledge - once well-known by farmers, but no longer applied today. To generate this knowledge, field experiments are used that combine several types of variables with the objective to understand the most sustainable and convenient cropping practice for the local SES. Examples of these variables are regional/geographical conditions (including weather and soil characteristics), types of crop rotation, farming practices (e.g. minimum tillage vs. hard soil cultivation), types of irrigation, and types of fertilizers. Barilla has effectively re-developed old and generated new knowledge by leveraging a network of relations that include carefully selected farms, farmers’ cooperative organizations, and specialized suppliers.

The project has also leveraged another type of knowledge, namely scientific and technical knowledge resulting from the expertise of practitioners and competencies of scientists at Horta Srl and the Università Cattolica of Piacenza. This scientific and technical knowledge about sustainable agriculture practices, combined with knowledge of communication and information technologies, has guided the development of the DSS software to help farmers optimize their cultivation practices (e.g. internet based information on weather patterns, soil conditions, crop characteristics). Both, traditional and local knowledge about crop rotation, and scientific and technical knowledge for optimizing farming practices were cultivated through experimenting, observing and learning about agro-social-ecological system dynamics.

Finally, this knowledge has been transformed and codified in the Handbook that Barilla prepared to disseminate sustainable farming practices. The guidelines contained there represent the result of a carefully managed process of learning and codification of the knowledge generated and developed through the field study, and converted into explicit knowledge that can be passed on to and easily applied by the farmers.

These findings provide evidence that knowledge about SES dynamics (both traditional and scientific-technical knowledge) is not only a potentially powerful source of inspiration for
sustainable solutions. It is also a critical resource to dramatically reduce the environmental impact of business and can simultaneously lead to economic and social benefits for the company and the local communities. This type of knowledge is located outside traditional organizational boundaries and the knowledge networks usually referred to in management and organization literature (Eisenhardt & Santos; 2002; Powell, et al., 1996). It is knowledge that, therefore, requires a novel and carefully managed process of generation and cultivation (the field experiments in the case of Barilla), and it needs to be accessible; it also produces dedicated knowledge networks that encompass the multiple stakeholders or agents operating in the SES. In the case under study, this knowledge network involves the farmers, farmers’ organizations, specialized suppliers, the scientific community, and local authorities. The collaboration has been guided by Barilla, which has aggregated different types of know-how and the multiple competencies about agro-social-ecological systems around the Sustainable Farming project.

4.6 Conclusions and future research
The case of Barilla highlights the critical importance of knowledge related to corporate environmental sustainability and sheds light on the critical of different and diverse types of knowledge on the protection of ecosystems and natural resources that a company can generate internally or beyond its organizational boundaries. I have introduced the term ‘sustainability-oriented knowledge’ to capture two critical aspects: (1) the multiple types that such knowledge can encompass and (2) the integration of such knowledge in the company’s strategic process. I further leveraged the notion of ecological knowledge to analyze Barilla’s strategy to reduce the environmental impact of its most important product, pasta.

This study offers researchers at the interface of business and the natural environment a fresh look at the potential importance of using a knowledge perspective, specifically when studying environmentally sustainable strategies and innovations. Importantly, it also offers a previously understudied perspective: knowledge as a critical concept of sustainable management provides a promising framework for studying organizations within the SES in which they are embedded; this opens up opportunities for research on how companies can benefit from a
better understanding of the ecosystems dynamics and the production of services and resources they depend upon.

Generalizing these early results requires some caution. First, the methodology of a single case study has limits that are well analyzed and documented (Yin, 2003; Siggelkow, 2007). Like Barilla, several other companies that are using natural resources and ecosystem services as raw materials (e.g., Unilever, Illy and Nestlè in consumer goods, UPM in forestry and cellulose-based products, IKEA for wood and cotton), have extended supply chains that are grounded into agro-social-ecological systems. These companies face similar challenges with regard to sustainability, and like Barilla, they are moving “up-stream” towards farming and raw materials cultivation processes to reduce their environmental impact (Winn & Pogutz, 2013). Adding other case studies will help to confirm or disconfirm the findings from this study: whether and how sustainability-oriented knowledge provides opportunities for innovations; whether ecological knowledge (for example, traditional or indigenous knowledge about tea or coffee cultivation, or about forestry) can be drawn, leveraged and integrated to develop sustainable sourcing strategies and to preserve the social-ecological systems; and whether such strategies can provide social and economic benefits in addition to environmental improvements.

A second limitation which is due to the early state of this research, relates to whether the findings can be extended or generalized to industries less dependent on ecosystem services, such as mining, energy, automotive, information and communication. Future research will need to investigate which types of knowledge can drive the development of sustainable innovation, and how ecological knowledge (e.g. knowledge about climate change) is addressed, generated and integrated into the company strategy and operations.

The current study points to promising areas of future research in the field of corporate sustainability, and for MOS more broadly. First, further investigation of how business organizations generate and consolidate sustainability-oriented knowledge is an interesting and, to my knowledge, underexplored avenue: Which type of knowledge is critical for developing strategies that are both sustainable and profitable? Where is this knowledge accumulated and organized? Is it primarily located and utilized by the sustainability departments or units, or can it generally be dispersed and more fully integrated into
organizational processes, such as in the Barilla case? How can companies access and draw on such knowledge?

Second, the ecological knowledge approach offers a novel perspective for investigating how companies strategize and innovate with regard to sustainability, linking organizations to SES and to ecosystem services (Winn & Pogutz, 2013). Ecological knowledge is knowledge from outside the usual organizational boundaries and the traditional knowledge networks. How can companies generate and access ecological knowledge? What types of network structure are most conducive to access such knowledge? How can companies integrate knowledge about SES dynamics into their strategy and operations? What are the barriers to and the benefits stemming from utilizing this type of knowledge? If such knowledge is collectively generated, or if it is in the public domain or shared (Siltaoja, 2014), as is often the case with local or indigenous knowledge: can and should it be privatized in order to generate competitive advantage?

While these are only a few possible questions for future studies, they are meant to offer a sense of the potential for new and exciting research directions on the role of knowledge in developing sustainable business practices.

It was not my intent to build new theory in this in-depth exploratory case study of Barilla and the firm’s efforts to collectively generate new sustainability knowledge and practices for its industry. I do hope, however, that I have provided strong arguments for shifting management-scholarly attention toward developing a knowledge-based perspective for the study of organizations and their relations to social-ecological systems. Engaging more deeply with both modern ecology and local knowledge to learn about nature dynamics and processes might hold significant potential to advance research on business and the natural environment.
References


Chapter 5

Conclusions

5.1 Overview
In the introduction, I described the purpose of this work as both ambitious and challenging. My ambition was to provide the basis for a more inter-disciplinary (or trans-disciplinary) research in MOS and particularly in the sub-field of B&NE. Twenty years after the call by Paul Shrivastava (1994) to re-conceptualize the way in which scholars in management think about organizations and acknowledge their biophysical foundations and material linkages with the “eco-sphere,” that necessity is undiminished. In fact, I feel that the urgency for such a re-conceptualization has dramatically grown over these past two decades, as the scale and the speed of the environmental crisis have increased day after day.

At the same time, this work has been challenging, since looking outside our disciplinary boundaries (the boundary of management and organization studies) has been complex, multifaceted, and time- and energy- intensive. I began by investigating modern ecology and ecological economics: their principles, their frameworks, and their key concepts. I discovered knots of sub-disciplines, intimately related but—at the same time—having independent and even opposite ontologies and epistemologies: conservation ecology, political ecology, human ecology, and environmental sociology, just to cite a few. Understanding the assumptions of these disciplines/fields and their views of the world has been important for developing this thesis and for selecting the main frameworks and concepts that I have illustrated in these papers. Additionally, I needed to develop my specialized and technical knowledge about ecosystems, ecosystem functioning, ecosystem services, biodiversity, social-ecological-systems, ecological resilience, etc. This has been possible in part thanks to a number of exchanges and dialogues with scholars rooted in ecology, and through participation in seminars, workshops, and the summer school that I attended in 2013 at Capracotta, Molise, Italy, titled: “Analysis and governance of ecosystem services”.
5.2 Main findings

The contribution of this work to management and organization studies, and especially to the business and the natural environment field, can be organized into the following arguments.

Exploring the barriers and prioritizing nature. Paper 1, and to some extent Paper 2, seek to analyze and understand the reasons, ontological and epistemological, that have obstructed the domain of MOS from acknowledging the biophysical foundation of organizations and incorporating the relations between business and nature into their view. Drawing on the studies from other fields, in particular environmental sociology and the works of Demeritt (2002) and Carolan (2005), we take their view that nature and society are at once ontologically asymmetric and mutually constitutive. Ontologically asymmetric refers to the fact that, while physical environments can exist without social environments, the reverse is not possible—nature is ontologically a priori. Mutually constitutive refers to the bidirectional impacts of nature upon human society and of human society upon nature. In doing so, we recognize the ontological priority of bio-physical environments over social realities—while also acknowledging that both are mutually constitutive. Acknowledging the ontological asymmetry of the bio-physical world to the social—and thus organizational—is a critical step towards conceptualizing nature differently, and therefore to providing theoretical foundations for more holistic theorizing about business-natural environment relations.

Offering a new theoretical platform for research. One of the aims of this thesis was to establish the basis for a new foundation for the field. The perspective discussed above opens new directions for theoretical and empirical research by acknowledging the complex relationships between organizations and nature. In particular, notions of recursive causality, mutual causation, and emergence of natural and social spheres and the mechanisms effecting causation and co-evolutionary processes have been captured in the conceptual framework of social-ecological systems (SES) developed by modern ecology (Berkes & Folke, 1998; Levin et al., 2013) and in the assumptions of complexity theory (Anderson, 1999; Boisot & McKelvey, 2010). An important contribution, therefore, in order to provide further opportunities to develop new theorizing and intriguing research in MOS, is represented by the
introduction of the SES View and by the analytical examination of the distinctive properties of SES as complex adaptive systems.

_Acknowledging a dynamic business reality._ This work offers a review of illustrative mini-cases and examples of organizations engaged in a number of strategic and tactical initiatives to manage ecosystems, protect biodiversity, and attempt to enhance ecosystem services. These examples reflect a dynamic business reality that has acquired a certain level of awareness with regards to organizational dependence on ecosystems’ functioning and services. Paper 3, dedicated to analyzing the Barilla case, provides an interesting illustration of how companies can successfully transform their supply chains, invest in practice to sustainably manage SES, and address ecosystem challenges.

_Introducing new frameworks and concepts from other disciplines._ One of the main contributions of this thesis refers to the attempt to bridge knowledge domains by introducing key concepts from ecology and ecological economics to MOS and B&NE. Paper 1, as mentioned above, proposes the SES view and discusses the features of complex adaptive systems as a new foundation for theorizing on organization and nature relations. Paper 2 draws on four concepts playing particularly important roles in prompting breakthrough in our understanding of social-ecological interdependencies: ecosystems, biodiversity, ecosystem services, and ecological resilience.

_Understanding the embeddedness of organizations and their dependence upon nature._ A “fil rouge” of this work is its focus on the concept of organizational ecosystem embeddedness and its investigation of the multiple linkages between business and nature. In particular, Paper 2 introduces an in-depth and novel analysis of corporate dependence upon ecosystems and ecosystem services. This perspective opens several theoretical and practical implications, ranging from strategies to risk management, from supply chain management to partnership and collaborations with other companies, agencies, and NGOs.

_Introducing a knowledge perspective on business and nature relations._ Finally, Paper 3 seeks to contribute to the literature on B&NE by exploring the role of knowledge in developing new
ways of producing goods that both capture business opportunities and are grounded in the principles of sustainability. The link with the thesis’ research problem relates to the attention paid to knowledge of SES dynamics, and how knowledge generated outside the company’s boundaries and termed “ecological knowledge” in the specialized literature, can be accessed, developed, and transformed into, and blended with, organizational knowledge. I show that profound knowledge about sustainability, both organizational and technical, can (1) increase organizational capabilities for innovation, (2) improve organizational performance, and (3) significantly reduce organizational environmental impact. Extending the Knowledge-Based View to corporate sustainability, sustainability-oriented knowledge also provides the company with a “platform of options” for future strategies (Kogut & Zander, 1992), and can increase a company’s sustainability and competitiveness. Moreover, the findings provide evidence that knowledge of SES dynamics (both traditional and scientific) is fundamental to finding innovative solutions that dramatically reduce the environmental impact of businesses and generate economic and social benefits for the company and farmers. This perspective allows delineation of both preliminary implications for research and practice related to knowledge boundaries, knowledge repositories, and sources of knowledge in order to target real environmental sustainability and increase competitiveness.

5.2 Limitations of the study

It is common in a thesis to discuss its main limitations. The three papers included in this work attempt to set a foundation for new theories, but do not develop these theories themselves. Like the case of farmers who are required to prepare and till the soil before sowing the seeds, it was necessary to prepare the ground in our disciplinary field before attempting the complex exercise of developing new theoretical contributions. In this sense, these papers are contributing toward developing a new platform for research that identifies multiple avenues linking managerial and organizational theories and approaches with key concepts taken from modern ecology and ecological economics. At the same time, this attempt to bridge disciplinary boundaries in order to re-conceptualize organizations as embedded into a biophysical systems might face the same “risk of rejection” of some of the ground-breaking papers of the 1995 AMR special topic forum on the
ecologically sustainable organization. The distance between the ontological and epistemological assumptions of modern ecology and MOS might obscure the opportunities rooted into these new research perspectives, reducing the potential impact of these papers.

A second limitation relates to the organizational ecosystem embeddedness approach developed in this work (Introduction and Paper 2). This model, in fact, simplifies the complex network of relations between organizations, ecosystems, and the other stakeholders in the SES. For example the dependence on ecosystem services is not the same for all companies and all industries. Typically, some organizations base their business model on the use of natural resources provided by ecosystems’ functioning, like in the case of agro-food, pulp and paper, textile (e.g., cotton), tourism. Other industries—such as energy, chemical, automotive or mining—are environmentally intensive and heavy polluters, but less dependent on ecosystem services and less exposed to environmental resource scarcity. A critical distinction that requires further research is that between direct dependencies and indirect dependencies (Boones, 2013), the latter mediated by the pressures of stakeholders like local communities, governments, or suppliers. The model, therefore, might be enriched to better represent stakeholders in SES, along with the type of relations these actors have with ecosystems services and with the focal organization.

A final observation refers to the methodological approach. Paper 1 discussed how adopting an SES perspective to analyze the organization-ecosystems relations likely require the development of new methodological approaches for conducting research in MOS, for example methodologies fundamentally rooted in collaboration between researchers from different fields, and based on the development of measurable constructs capable of acknowledging the complexity of the system(s) where organizations are embedded. Similarly, it would be important to develop common methodologies to map, assess, and evaluate the typologies of ecosystem services and the benefits provided to business and stakeholders. In the Barilla case study, I have highlighted this complexity by investigating the different types of sustainability-oriented knowledge developed by the company and its process of knowledge creation, in particular with regards to ecological knowledge and agro-social-ecological system dynamics. Further research could try to map, assess, and evaluate the ecosystem services used by Barilla within its business activities, and then measure the effects of the sustainable farming strategy on these services in terms of value generated.
References


