



POSSIBLE ROUTES TO IMPROVE ADAPTIVE MANAGEMENT OF FIRMS: THE BUSINESS AS A SOCIAL- ECOLOGICAL SYSTEM

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ABSTRACT

This study explores possible routes to improve the adaptive management of firms and proposes to view firms as social-ecological systems. We conceptualise three possible ways in which firms can frame their relation with the natural environment. The first is impact related: strategies for assessing and reducing the negative impact of business on the wider natural system. The second is dependency related: strategies in terms of dependency of the firms on the wider natural environment. The third is mutual dependency related: strategies that explicitly view firms as social-ecological systems, due to a mutual dependence between business and natural environment. Through a qualitative approach by means of ten case studies we analyse the current ways managers of firms frame their companies' vis-à-vis the natural environment. The last strategy is still in an early stage within theory as well as practice as shown among the firms. Therefore we formulate five principles that managers could use to stimulate the last frame: businesses as social-ecological systems.

Key words: corporate social responsibility, adaptive management, social-ecological systems, firm strategies, learning

INTRODUCTION

According to evolution theory, businesses are able to survive only if they change appropriately over time in response to changes, for instance in demand and technology (FitzRoy et al., 1998, Herbane, 2010). This ability to change is very important in cases of disturbances or shocks which can be described as relative discrete events in time that disrupt an organization (Janssen and Osnas, 2005). The ability of a firm to maintain its structural and functional capacity after a disturbance of the system is often defined as resilience (Perrings, 1998). Examples of system disturbances are radical policy changes, disease outbreaks, energy crises, breakdown in demand or severe droughts.

Over the last decades, several Corporate Social Responsibility (CSR) standards have been developed to guide and monitor the activities of firms towards sustainability and responsibility for the environment, consumers, employees, communities and stakeholders (Gilbert et al., 2011). There is a range of benefits that corporations may gain by 'greening' their businesses and make better use of the social and natural resources involved in their firms (World Business Council for Sustainable Development, 2008). New guidelines emerge that



aim to assist managers in managing business risks and opportunities arising from their firm's dependence and impact on ecosystems (KPMG, 2011).

This article argues that in order to be effective in developing resilience strategies, firms need to be framed as social-ecological systems. What was often framed as the natural (and social) environment of firms should be more closely integrated in the firm strategy instead of being seen as separate units. Berkes et al. (1998) started two decades ago to use the term social-ecological systems to stress that the delineation between social and ecological systems is artificial and arbitrary. Social-ecological systems are neither humans embedded in an ecological system nor ecological systems embedded in human systems but rather a different thing altogether.

As an approach for understanding the dynamics of social-ecological systems we use the resilience perspective following Walker et al. (2004). We refer to resilience as the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks. It includes the ability to self-organize, to learn from the disturbance and to adapt.

In this paper we investigate the present frames that firms use to take into account and maintain the natural environment (or ecosystem) on which they depend. Furthermore we explore how the relationship between firms and their natural environment can be improved through learning. The research questions of this article are (1) how do managers of companies frame the relation between their firm and the natural environment?

(2) what are their strategies to improve this relation between the firm and the natural environment? (3) how do they learn about this? And (4) what principles could firms use to develop the firm as a resilient social-ecological system?

To answer these questions, we first perform a literature study to understand better the three ways to frame the relation between firms and their environment. The first is impact related: strategies for assessing and reducing the negative impact of business on the wider natural system. The second is dependency related: strategies in terms of dependency of the firms on the wider natural environment. The third is mutual dependency related: strategies that explicitly view firms as social-ecological systems, due to a mutual dependence between business and natural environment. The first two frames are common among management theories, but this article argues that there is a literature gap as well as an empirical gap to understand the third frame. As a basis for this argumentation we use social-ecological systems theory and adaptive management theories. From the literature we derive an analytical framework that is used for analysing ten empirical cases. Based on our analysis we provide lessons for improving sustainability strategies of firms in the third frame: as social-ecological systems.

FRAMING FIRMS VIS-A-VIS THEIR ENVIRONMENT: A LITERATURE REVIEW

This article argues that there is a literature gap as well as an empirical gap to understand and frame the intimate dependency between firms and their environment. Past theories and approaches to management considered human and natural (sub)systems as separate units, to be treated independently (Resilience Alliance, 2010, Folke et al., 2005). The responses of ecological systems to actions of firms were often seen as linear, predictable and to be controlled. However, firms and their environment can be seen as one: a social-ecological system.

This statement follows the trend of last years in Corporate Social Responsibility, that there is a complex interconnectedness between the natural and the social. New methodologies have been developed to grasp these dynamics and to understand and support firms in their



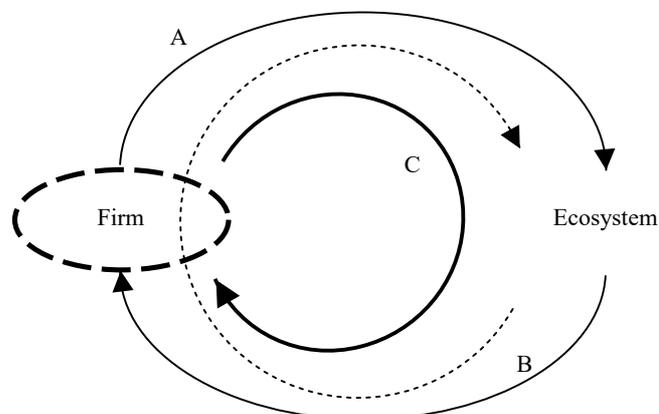
sustainable use of the natural and social environment. Several Corporate Social Responsibility standards have been developed with criteria by which the production, transportation and processing of firm resources can be assessed for environmental, social and other values. These standards frame the relationship of firms with their environments in multiple ways.

From the literature two frames can be found, but this article argues that a third frame needs attention that at present is still underdeveloped. The first frame of these Corporate Social Responsibility standards is impact related and outwards: what can the firm contribute to collective values such as biodiversity, social justice and environmental quality? The second frame of these Corporate Social Responsibility standards is dependency related and inwards: what do external developments in the social-ecological system mean for business continuity and the future of the firm? In our view, there is a third possible frame that focuses on the mutual dependency between the firm and its natural and social environment.

Framing the Perceived Relations between Firms and Environment

This article aims to draw attention to three ways in which the relation of the firm with its natural environment is framed, which are (a) the impact of the firm on the ecosystem, (b) the dependency of the business on its ecosystems and (c) a mutual dependency, which implies a role of the firm in maintaining the environment delivering services on which it depends (Figure 1).

FIGURE 1: FIRMS AS SOCIO-ECOLOGICAL SYSTEMS: THREE WAYS TO FRAME THE RELATIONSHIP BETWEEN FIRMS AND THEIR ECOSYSTEM



In Figure 1 we conceptualise the relationships between firms and their ecosystem and how they are framed by current Corporate Social Responsibility standards (and scholarly publications, e.g. Whiteman et al., 2004). Arrow A refers to the frame and accounting standards that focus on the effects of companies on their environment, such as GRI and LCA. In other words, the dominant frame is to look at the impact of firms on their ecosystems and ways to improve this relation. In this frame the focus is outwards: what can the firm contribute to collective values like biodiversity, social justice and environment? Arrow B refers to the frame that focuses on the dependence of companies on the environment as well as the external risks for the firm (which may impact the environment as well, hence the dotted arrow). This focus, also reflected in risk assessments is inwards, and addresses the question what external circumstances mean for business continuity and the future of the firm. We argue for a new



frame in which firms are portrayed as social-ecological systems. Hence the dotted boundary around the firm and a returning arrow in arrow C. We propose this frame for two reasons. First, elements of the firm are part of multiple systems. For instance personnel consists of people with a private life, with events that may in turn influence the firm. Second, the environment may be at the same time part of the firm, since external influences are constantly internalised and used as productive factors or sources of inspiration. As an example for a mutual dependence between a firm and its ecosystem, we make use of our own experience with nature-oriented farming (Westerink et al., 2015). In this no-input farming system, the farmer depends on the ecosystem for his produce and income. At the same time, he deliberately manages the ecosystem in order to optimize it for his purposes. The farming system is designed to enable him to combine farming with care for the farm ecosystem.

We further conceptualise 'environment' as 'ecosystem' because this enables us to consider the interrelationships between living organisms (including people) and the abiotic environment, forms of organisation among living organisms, networks and interdependencies. From this angle, a firm can be a socialecological system with many biotic and abiotic parts. Also, this frame enables us to introduce ecosystem services: in this case, the benefits of the ecosystem for the firm, including vital products and services. Ecosystem services that are vital to the functioning of the firm are of interest when one wants to improve on the firm's resilience.

The vast amount of literature on ecosystem services represents a growing understanding of what ecosystems mean for society and economy. Ecosystem services are the direct and indirect contributions of ecosystems to human well-being (TEEB, 2010). Ecosystem services describe how people *benefit* from ecosystems: a subcategory should describe how people (and businesses) *depend* on ecosystems. Identifying those ecosystem services may determine the priority by which actors will be willing to invest in well-functioning ecosystems. Generally, the following types of goods and services from ecosystems are distinguished, of which the supporting functions provide the basis for the other functions (Millennium Ecosystem Assessment, 2005):

- Supporting (e.g. primary biomass production, soil formation)
- Provisioning (e.g. food, water, fibre, fuel, medicine)
- Regulating (e.g. climate regulation, flood prevention, pest regulation, water purification)
- Cultural (e.g. spiritual, aesthetic, recreation, education)

Indicators to assess whether and where firms depend on ecosystem services are for instance: the need for raw materials, water usage, energy provision/ security, air quality, microclimate (cooling), employees' health and well-being, protection against natural disasters and inspiration from natural processes for technological or social innovations.

Adaptive Management of Firms

Practitioners within firms as well as with developers of Corporate Social Responsibility standards should integrate this third focus better. Therefore the mutual dependencies should be made explicit. Many businesses fail to make the connection between the health of social-ecological systems and corporate performance. Companies often are not fully aware of the extent of their dependence and impact on ecological systems and the possible ramifications (Hanson et al., 2008). However, evidence is accumulating that natural and socio-economic systems behave in non-linear ways and that these social-ecological systems act as strongly coupled, integrated systems (Crona and Parker, 2012, Berkes et al., 1998, Gunderson and



Holling, 2002). Conceptually, socialecological systems are largely based on complex adaptive systems theory (ibid): portraying systems not as deterministic, predictable and mechanistic, but as process-dependent, organic systems with feedbacks across multiple scales that allow these systems to self-organize.

Actors' capacity to manage resilience, intentionally, determines whether they can avoid the system crossing into an undesirable system regime, or succeed in crossing back into a desirable one (Walker et al., 2002). The twin aims of resilience management are: (a) to prevent the system from moving to undesired system configurations in the face of external stresses and disturbance; and (b) to nurture and preserve the elements that enable the system to renew and reorganize itself following a massive change (Walker et al., 2002). Resilience management therefore involves both being prepared for risks and shocks, and being able to adapt to new situations. Tarrant (2010) links risk management strategies to organisations being effective, transformational and adaptive.

Literature on social-ecological systems, resilience and adaptive governance (or adaptive management) is closely related. Within adaptive governance theories (Dietz et al., 2003), social-ecological systems gain attention, and adaptive governance of social-ecological systems has become a research topic in itself (Folke et al., 2005, Olsson et al., 2004, Armitage et al., 2009). The knowledge gap in adaptive management in our case is the capacity of actors in firms to influence their resilience as social-ecological systems. Over the last decades, adaptive management of firms has increasingly been promoted (Espinosa and Porter, 2011, Tarrant, 2010, Akgün et al., 2014) but practical experience and tools to influence this relationship is still lacking.

Adaptive management increases the capacity to adapt to changing relationships within social-ecological systems. Part of this relationship influencing the resilience of firms, requiring adaptive management, is the occurrence of natural disasters, e.g. as a result of climate change (Parsons, 2010, Weinhofer and Busch, 2013). Because of the complex and poorly predictable dynamics of social-ecological systems, characteristics of adaptive management include experimentation, monitoring and learning (Armitage et al., 2008, Olsson et al., 2004). Dynamics in the social-ecological system, experimentation, monitoring and learning lead to adaptation in a continuous and iterative process. Adaptive management strategies may include new policies for socialecological system management; novel approaches to collaboration and relationships within and among agencies and stakeholders; diversification; new ways to promote flexibility; and new institutional and organizational arrangements. Adaptive management encourages flexibility, autonomy and responsibility of teams, as well as interconnectedness, diversity, and innovation (Akgün et al., 2014). Therefore, adaptive management strategies aiming for resilience need to address the culture of the organisation. Resilient organisations are diverse and efficient, are willing to learn, welcome change and have a unity of purpose (Parsons, 2010).

METHODOLOGY AND CASE SELECTION

This research follows a comparative case study approach. We choose for a qualitative approach because we are interested in the learning processes of these firms rather than in the share of managers of firms who are actually aware of the relation between their firm and its natural environment. We investigate how these interdependencies are perceived by managers of companies and how they learn in order to adapt their firm strategies. First, the respondents were asked what they understood as the natural environment of the firm, at what scale their firm has relationships with the natural environment and if they could mention examples of these



relationships. Second, the respondents were asked which risks they perceived regarding the firm's dependence on the natural environment. For the risks that they mentioned, further questions were asked regarding the extend of the risk, scale, impact, response options, actions aimed at prevention and mitigation, and actual experiences with this risk. Third, the respondents were asked about the ways that resilience and sustainability are addressed in the organisation, and which standards are being used. Concluding questions concerned the learning strategy: what the respondents wanted to learn about resilience and if they were interested in joining a Community of Practice (Wenger et al., 2002) about this topic.

The data were collected through interviews by telephone, which were recorded for analysis. Respondents were typically responsible for communications/ marketing and/or sustainable strategy development. The interviews were done with a structured questionnaire, aimed at the respondent formulating their own answers. For instance, respondents were not confronted with a full list of ecosystem services, but were asked to mention perceived risks. The term ecosystem was avoided: instead, 'natural environment' was used.

FIGURE 2: INTRODUCTION TO THE FIRMS

	Business activities	Website	Number of employees (2010)	Turnover (€) (2010)
Ahrend	Workspace interior design	www.ahrend.nl	1262	190 million
AkzoNobel	Producer of paint and coatings and specialty chemicals	www.akzonobel.com	55.000	13 billion
Albron	Food catering	www.albron.nl	6000	290 million
Eneco	Energy firm	www.eneco.nl	6545	4.92 billion
Experience Island	Outdoor Recreation	www.experience-island.nl	9	950.000
Gulpener	Beer producer	www.gulpener.nl	59	15,8 million
InterfaceFlor	Modulair floors	www.interfaceflor.nl	3500	961 million
Menzis	Health insurance	www.menzis.nl	2074	4.7 billion
Van Gansewinkel	Waste processor and energy supplier	www.vangansewinkelgroep.nl	58000	1.1 billion
Wessanen	Organic food producer	www.wessanen.nl	2200	712 million

We tested our hypothesis on the interdependencies between firms and their environment in ten case studies of Dutch firms that are frontrunners/pioneers in environmental responsibility. Nine of these ten are founding members of the Dutch business network 'De Groene Zaak' (which means both 'the green firm' and 'the green case'). The firms range from 50-55.000 employees and represent different sectors (chemical industry, food, insurance, energy, recycling, production, leisure).

CASE ANALYSIS



How Do Managers Frame The Relation Between Their Firms And Social-Ecological Systems?

We were interested in the ways managers of firms frame the relations between their firms and their socioecological systems. Below we analyse the three frames as outlined in the earlier theoretical section.

Frame 1: The Impact Of Firms On Social-Ecological Systems

The respondents often frame the relation between their firms and the environment in terms of impact of the firm on the environment. The firms use a range of sustainability concepts in their vocabulary to indicate this impact: biodiversity (e.g. Akzo Nobel), reducing carbondioxide emission, cradle to cradle (e.g. Van Ganzenwinkel, Akzo Nobel, Interface Flor, Ahrend), Corporate Social Responsibility (Gulpener), closing energy cycles (Ahrend), reducing environmental impact (Experience Island), natural step (Interface Flor), and corporate social responsiveness (Albron). The respondents can sum up a multitude of negative impacts. They use terms like pollution, noise, waste and carbondioxide emission. However they also mention positive impacts. For instance one firm tries to contribute to soil improvement through its compost.

For most firms, addressing the impact of the firm on the environment is no longer a big deal as sustainability has already for some years been part of the firm's strategy. Corporate responsibility is extended along the entire product chain of the firm as 'cooperation in the chain is a prerequisite to sustainability achievements'(Interface Flor). Reducing the firm's environmental impact is often done by improving the environmental performance at the supplier side. Sustainable management is seen as strategic: it makes the firm more resilient (Interface Flor) and it attracts larger customers (Experience Island).

The respondents extend the impact of the firm not only to the natural environment but also to the social world. Their environment includes, according to them: customers and market, the social environment, direct neighbours, and the working conditions for their own personnel. To them, distinguishing the social and the natural environment within this frame may be unlogical.

Frame 2: The Dependence Of The Firm On Its Ecosystem

Framing the relation in terms of dependence of the firm on its ecosystem is less common than framing in terms of impact on the ecosystem. Some of the firms experience a strong dependence on their ecosystem, especially the firms in the food sector. Albron describes this dependence as 'huge'. Wessanen says to treat the earth with respect, because the firm extracts products from it.

The firms mention several risks, especially related to provisioning ecosystem services. Unsure supply of foodstuffs, in quality and quantity are mentioned by the food sector firms. Also in relation to food production some firms mention water shortages. Some respondents mention the depletion of fossil fuels (oil, gas). In other words, the provisioning role of ecosystem services, e.g. providing food, fuel, materials and water, are of importance to these firms. Some see also opportunities in the field of provisioning ecosystem services. Eneco sees the issue of depleting resources as an opportunity for companies who are front-runners in



renewable energy, and VGG turns scarcity of raw materials into business models, for instance for regaining phosphorus from waste.

In addition, the firms list risks related to some regulating ecosystem services: again, the relation to food production is important here. Albron for instance sees a risk in climate change leading to unpredictability of crop yields. Crop yields and product quality of Gulpener are threatened by fungal infection in barley. Wessanen mentions pests and diseases in crops, and refers to the example of EHEC which caused a severe drop in demand for fresh vegetables in 2011. Regulating ecosystem services, mitigating climate change and natural pest and disease regulation are of great importance to these companies.

Cultural ecosystem services are not often referred to. Menzis fears a shortage of green space for recreation, sports and leisure, and relates this to increasing human health problems and health care costs. Interface Flor also sees an opportunity in cultural ecosystem services, in the form of learning from natural processes in order to improve management practices. This type of biomimicry makes use of educational ecosystem services.

Frame 3: Mutual Dependency: Firms Are Social-Ecological Systems

Some of the respondents are well aware of the two-way relationship with their environment. For example Gulpener monitors its environmental impact (water use, energy use and waste production), and is at the same time aware of its dependence on nature because 'beer is a natural product'. The respondent states that the firm has established 'a covenant with nature'. Ahrend pays much attention to reducing its environmental impact, which includes the waste water that is released into the Dommel river, while the factory also uses water from this river in its production processes.

However, to see a two-way relationship is not the same as experiencing the relationship as a loop. A *mutual dependency*, in the sense that impact on the environment may affect the firm because of its dependence on the ecosystem, is a rare viewpoint among our respondents. The Albron sustainability manager delivered the only quote that could be interpreted as such:

'In time all of us will have to face the results of dealing uncarefully with the environment.' (Albron).

Another loop-type relationship is much more common in the framing by the respondents: the negative effect on the firm's reputation because of negative impact of the firm on the environment. This risk for the firm's reputation is mentioned by most firms, and the source of this risk is mainly sought earlier in the supply chain.

Summarizing, only one firm frames the relation with the ecosystem as a mutual dependency. Framing the relationship between the firm and its ecosystem in terms of impact of the firm on the ecosystem is much more common among the interviewed firms. A large part of the firms also mentions the frame of dependency of the firm on the environment. Several companies see risks in the influence of the ecosystem on the firm. Most risks mentioned are related to provisioning ecosystem services: food, water, timber, fuel and other materials. Also, regulating ecosystem services are touched upon: risks involving pests and diseases were mentioned by two of the food companies. Also climate change is mentioned thrice, but more in general terms and with little direct threat to the firm. Cultural ecosystem services are mentioned twice:



Interface Flor uses natural processes as sources of inspiration for the management processes and Menzis sees green space for leisure as essential for human health.

What Are Firm Strategies To Improve The Relations Between Firms And Their Social-Ecological Systems?

Strategies To Decrease The Impact Of Firms On Social-Ecological Systems

The companies use various strategies to decrease the impact on the ecosystem. Importantly, the firms use a range of standards, labels and methods for analysis to identify, monitor and decrease these impacts, such as standards from ISO (International Organisation for Standardization), GRI (Global Reporting Initiative) and OHSAS. Also other methods for analysis are used, such as backcasting, risk inventory, footprint analysis and Life Cycle Analysis. Some firms use a number of standards in order to address complementary issues (such as ISO 14001 for environment and OHSAS for working conditions) or standards that are tailored to their branche (such as 'Green Key' for the tourism sector). Use of these standards leads to targets to reduce impact, for instance with respect to energy use, water consumption and waste. In addition, standards can be strived for earlier in the supply chain. Wessanen and Albron for instance choose for certified products, such as organic and fair trade products, to ensure sourcing with a low impact on the environment. Recycling is another important strategy to reduce impact. Interface Flor and VGG have a far-reaching strategy on this, even trying to close cycles of materials. Also Gulpener developed a strategy to valorise one of its waste products, selling it as cattle feed.

Firm culture and motivation of people is seen as an important factor for achieving sustainability by many of the firms. The Akzo Nobel has sustainability targets for the firm as a whole and for employees and directors, aided by financial incentives. Interface Flor has an ambitious target (100% sustainable production in 2020). The firm offers training to its employees to become 'ambassadors of sustainability' that are capable of bringing sustainability 'within his/her sphere of influence'. Ahrend has such 'ambassadors' 'to make the organisation breathe' and to develop a 'sustainability feeling' on the work floor. Employees of Wessanen have to commit to a 'code of behaviour', according to which they have to strive for sustainable development and to prevent pollution. Not only within the own organisation motivation and personal commitment are seen as key, also with partners and suppliers. Wessanen for instance has a code of conduct for employees and suppliers: they are both expected to be 'passionate' and 'corporate citizens'. Interface Flor actively works on commitment both with suppliers and customers according to the respondent.

Strategies To Decrease Risks For The Firms Emerging From The Dependence On Social-Ecological Systems

To analyse the strategies of firms to cope with these risks, we follow below, in line with the terminology of business continuity standards, the categorisation of prevention, preparedness, mitigation and recovery.

The respondents mention a number of *prevention* strategies. Most important are strategies related to the supply chain. Albron for instance aims for developing good relations with its suppliers, to improve cooperation and trust, in order to secure product quality, security



of deliverance and desirable production ethics. In addition, formal checks are built in, often done by external auditors. Some of the firms check the supply chain two steps backwards: Wessanen (suppliers and suppliers of the suppliers).

In order to prevent problems with supply from other countries, especially related to water shortages, Albron has a strategy to 'source' as much as possible within The Netherlands. In this way, Albron reduces its dependency on global social-ecological systems. Sourcing locally has additional benefits for Albron with respect to the transparency of their supply chain. In addition, the firm has chosen to spread risks by working with more than one wholesale unit.

Another prevention strategy is the use of renewable resources. Eneco for instance develops renewable energy production because the firm anticipates on the depletion of fossil fuels. All these prevention strategies deal with improving the supply chain or with developing alternatives in order to reduce the dependency of the firm. However, prevention could also imply taking care of the social-ecological system on which you depend. Insurance firm Menzis is developing a strategy in that direction. It considers investing in green space to improve human health.

Wessanen and Gulpener have developed strategies to be *prepared* for disruptive events and for adequate response. Wessanen has protocols for responding quickly in case of contamination of the food products, taking out the products from the shops. Gulpener is able to change its brewery technique in order to deal with differences in quality of the locally produced ingredients, for instance as a result of fungal infection of the barley.

Mitigation and *recovery* strategies are not mentioned by the respondents. Apparently, the risks related to the firm's dependency on its social-ecological system are not seen as 'shocking'. The respondents seem not to expect the continuity of their firms to be in real danger in the face of shocks or events related to their socialecological systems.

Strategies To Act Upon Mutual Dependency: Firms Are Social-Ecological Systems

Apart from the Menzis strategy mentioned above, strategies aimed at maintaining the ecosystem on which the firm depends, were not found. This may not be surprising, since the respondents do not frame the relationship of the firm with its ecosystem in terms of mutual dependency. Even Albron and Gulpener, whose respondents do express an awareness of mutual dependency, do not mention a strategy in this respect.

However, several companies have developed strategies aimed at the *social* part of the environment. These strategies aim to prevent risks related to a negative reaction from the social environment on the negative impact of the firm on the ecosystem. They include strategies to reduce the risk of reputation damage and strategies for positive environmental branding.

Standards and norms are not only helpful to decrease the firm's impact on the environment, but they also reduce risks with respect to environmental regulations and loss of reputation. Some companies are anticipating on stricter legal norms in future, by applying stricter norms already (VGW, Ahrend). In addition, some firms actively use the standards and certificates in their public communication. Sometimes this takes the form of benchmarking: a good position in national or global ranks is then used both for internal motivation and for external branding.

Some of the firms very actively try to develop and sustain a good relationship with their social environment. For instance, Ahrend developed a walking trail through its premises and a place for people to sit down, with its own furniture. Brewery Gulpener chooses to purchase its barley from local farmers, even though the quality may not always be optimal. Menzis made an alliance with a nature organisation and uses that in its branding strategy.



As outlined above, the firms developed more their thinking in the sense of reducing the firm's impact on the environment than thinking about dependence on social-ecological systems. Relating the dependence on the ecosystem to the firms' resilience is not yet observed with the interviewed firms. Nonetheless, seven out of ten respondents do mention aspects of general resilience thinking. Akzo Nobel says, that there is no guarantee that the firm exists tomorrow: it needs to move with the global developments. Wessanen has a crisis management system, to be able to respond quickly in case of problems with food safety. With Eneco, 'being ready for the future' is part of the internal vocabulary. VGG carries out disaster exercises and develops scenarios to prepare for risks and shocks. Gulpener composed a masterplan for future business security. According to Interface Flor, aiming for sustainability makes the firm more resilient: it releases an innovative power that gives an advantage to survive as a firm. Albron aims to be an adaptive, flexible and open organisation; according to the interviewee this can only be achieved though cooperating with partners in a network structure.

How Do Firms Learn About The Relations Between The Firm And Their Social-Ecological System?

Most interviewed firms are interested in learning about the relationship between the firm and its socialecological system and about resilience. The three ways to frame the relationship are also visible here.

Frame 1: Learning On Impact

Although most firms have the feeling that they control their impact on the environment, they want to improve their performance in this. Developing new technologies and anticipating on new legal developments are important strategies:

'We want to keep up with new guidelines, new laws, developments and plans developed by the government.' (Experience Island)

Being in the frontline of these developments will give the firm an advantage and the outside world will look at the firm having the power to be innovative. So, further reduction measures on the impact of the environment will bring the firm a sustainable reputation.

Frame 2: Learning On Risks

All firms want to learn on the anticipation and reduction of risks. Some firms want to learn how to deal with the risk of depletion of raw materials:

'It is cheaper now to produce energy with coal, but in the long term it is no longer efficient. How to bridge the gap between short and long term electricity production?' (Eneco)

Other companies want to know how to deal with a changing environment. How to judge a potential threat: what will be a real threat and how to transform it into an opportunity? Therefore, different firms do have different needs. For example Van Gansewinkel needs more



information for the worldmarket prices on raw materials. Akzo wants to do research on the relation between biodiversity and the risks for their production process. In the Corporate Sustainability standards, the topic of biodiversity is not addressed yet: so, new theories and methods needs to be developed. Menzis is interested in the effect of the environment on health. Therefore the firm wants to know the economic value of the green environment in terms of the beneficial effect that nature has on human health.

Frame 3: Learning On Mutual Dependency

The respondents had difficulties in explicating direct learning questions related to mutual dependency strategies. Gulpener is the most explicit in formulating a question on resilience:

'How can we create a flexible production system, which can anticipate on a changing environment?' (Gulpener)

Other learning questions on the topic of resilience are more implicit. Some respondents see a challenge in incorporating the resilience in the 'market economy'. Questions that arise are: What circumstances need to be created to incorporate a more 'resilience thinking' in the firm strategies? and: What role should be given to the government and the firm itself to improve upon the mutual dependency?

CONCLUSIONS AND RECOMMENDATIONS

Companies can use three different types of frames to understand and act upon their relationship with their socialecological systems. The first, most common, way to frame the relationship is in terms of the impact of the firm on the ecosystem. The ten firms use a variety of ways within this frame and they use standards to monitor their strategies. The second frame is in terms of dependence on the ecosystem. The firms express the need to integrate knowledge about this into their resilience and learning strategies.

However our proposed third frame that stresses the mutual interdependence between the firm and the ecosystem is still in an early stage. Many firms see that their behaviour towards the ecosystem has an effect on the firm's reputation. However, firms do not yet see how their own behaviour towards the ecosystem has an effect on the firm as a result of their dependence on the ecosystem. As a result, no explicit learning questions were formulated by the firms in relation to this mutual dependency.

A strategy to increase the sense of urgency for understanding and recognizing the three frames could be by learning in a network. What is of crucial importance is branche-specific knowledge. The focus on this branche orientation can be efficient, because the members of the network have shared problems. Moreover, the subject of 'sustainability' is interpreted differently in different branches. This would lead to a lot of talking time and no specific results. A suggested objective of such a learning network or Community of Practice (Wenger et al., 2002) is exchanging knowledge on the subjects coming from the three frames: 'impact', 'environment' and 'dependency'. An outcome could be a branche specific manual on the topics of sustainability and resilience, distinguished by branche. Another outcome could be a platform which can be used to reflect on eachother and to act as eachothers' peers on the topics of sustainability and resilience.



We formulate five principles that firms could use to work on their firm resilience as social-ecological system. In this way we want to stimulate the implementation and learning process of firms as social-ecological systems. Our recommendations are partly inspired by Hanson et al. (2008) who provide a structured methodology to help managers proactively develop strategies to manage business risks and opportunities arising from their firm's dependence and impact on social-ecological systems.

Think of the firm as an open (social-ecological) system and identify the social and ecological components of the firm. Part of this principle is to identify the social and ecological components of the firm. Hanson et al. (2008) stress to choose the "scope" or boundary of the firm to implement this principle. It can be helpful to do this exercise for a specified part of the firm e.g. a business unit, product, market, corporate landholdings, and infrastructure project and so on. The overview of the Millennium Ecosystem Assessment can be useful to identify specific ecosystem services related to the firm. Consider the natural environment, suppliers, customers and neighbours. However, these ecosystem services might be identifiable, but they cannot easily be parsed for either analytic or practical purposes (Berkes et al., 1998).

Enhance diversity in the firm. The second principle is to enhance the diversity within the firm (Bélair et al., 2010). Biodiversity plays a crucial role by providing functional redundancy. Likewise, a diverse organisation will be able to better respond to change and to adapt. Diversity can be sought in natural resources (e.g. species of flora and fauna, genetic diversity, water qualities) human resources (local knowledge, skills, age, gender, culture), in activities (specialisation may be a poor resilience strategy), markets and in the quality of the ecosystem.

Encourage experimentation in the wider firm. A third principle is to encourage active experimentation. Active adaptive management whereby management actions are designed as experiments encourages learning and novelty creation among a diverse group of actors, thus increasing resilience in socialecological systems (Berkes et al., 1998, Olsson et al., 2004). Firm culture and motivation of people are important factors for achieving sustainability. Offer training to employees to become 'ambassadors of sustainability' that are capable of bringing sustainability 'within his/her sphere of influence'. Not only within the own organisation motivation and personal commitment are key, also partners and suppliers are important partners in improving commitment and experimentation.

Stimulate different learning networks within the firms. Successful transformations towards adaptive governance seem to be preceded by the emergence of informal, open and loose networks that help to facilitate information flows, identify knowledge gaps, and create relevant knowledge and expertise of significance for social-ecological system management (Olsson et al., 2004). To emphasize the role of (codification of) knowledge, scholars refer to these networks as epistemic networks in which action research can play a central role (Berkes et al., 1998, Olsson et al., 2004, Folke et al., 2005, Wittmayer et al., 2014), i.e., a set of actors sharing a common set of subjects, concepts and issues. Actors in epistemic networks also share a common goal of knowledge creation (Haas, 1992). These networks often arise from scientific or technical groups whose focus is on learning. Their power comes from questioning assumptions and synthesizing information with little or no constraints. Epistemic networks require a heterogeneous set of knowledgeable participants bringing in different perspectives. These ingredients allow new integrative knowledge to emerge (Cohendet et al., 2001). Individuals who are part of an epistemic network store social-ecological memory representing not only knowledge but also an infrastructure of social norms and a memory of conflict resolution (Gunderson et al., 2006).



Set objectives, identify thresholds and monitor and evaluate the feedback loops in the firm as a socio-ecological system. According to Walker et al. (2002), identifying thresholds is key in developing a resilience strategy for social-ecological systems. Resilience is then defined by thresholds for vital components of the firm (which includes vital ecosystem services). The system can no longer return to its original state if it is pressed beyond these thresholds. Knowing the thresholds can help management aiming at (i) staying below the threshold (prevention), (ii) shifting the threshold itself (preparedness, mitigation) or (iii) guiding the system towards another situation of balance (response, recovery) (Walker et al., 2002). An example of a strategy for staying below a threshold (i) was found in the Menzis case. A critical threshold for Menzis could be, for instance, a certain share of insured persons with basic health problems, leading to costs of the insurance firm surpassing the income. A strategy for staying below this threshold could be to try to improve the conditions influencing this basic health, like providing better green space. For shifting the threshold itself (ii) we found an example in the Gulpener case. A critical threshold for Gulpener could be a certain percentage of infected barley: beyond this threshold the quality of the beer would make it unfit for the market. Gulpener shifted this threshold by adjusting its brewing procedure and by informing its customers about its preference for sourcing its barley in the region. Eneco renders us an example of a strategy aimed at guiding the firm to a situation beyond the threshold (iii). A critical threshold could be the availability of fossil fuels. By developing sustainable energy technology, the firm is preparing for future depletion. In line with this, effective monitoring and evaluation of these thresholds will improve the firm's resilience as a social-ecological system. For measuring the performance of an implemented plan it is important to set clear objectives. Progress and outcomes are then measured through the process of evaluation and monitoring against those objectives.

ENDNOTES

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