



Review

Linking corporate climate adaptation strategies with resilience thinking

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ARTICLE INFO

Article history:

Received 13 November 2009

Received in revised form

19 October 2010

Accepted 31 October 2010

Available online 19 November 2010

Keywords:

Climate change

Food industry

Adaptation/mitigation strategies

Resilience

ABSTRACT

Within modern society, business organizations have a co-evolutionary relationship with society and ecosystems. Business organizations face highly diverse risks which they have to recognize, reflect on and handle. Climate change and its impacts clarify the need for managing overall system risk. Research has shown that climate vulnerability of business organizations in the German food industry is characterized by impacts that, in particular, affect business organizations indirectly. Indirect climate change caused impacts are complex, uncertain and characterized by a high degree of unpredictability. They focus on the derived social, ecological, economic and cultural consequences of the direct physical impacts from a worldwide perspective. This paper shows that introducing resilience thinking helps to identify strategic risks and opportunities coping with climate change caused impacts in sense of corporate climate adaptation strategies. Furthermore, it is shown from a strategic management perspective that mitigation is a profound element of long term adaptation strategies.

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1. Introduction

Business organizations face highly diverse risks which they have to recognize, reflect on and handle. Climate change and its impacts clarify the need for managing overall system risk. Considering human-environment-interactions, a resilience framework for business organizations aims to prevent the system from moving into undesirable configurations. Thereby, preserving the elements that enable the system to renew and reorganize itself after disturbances (Walker et al., 2004). Concepts of vulnerability and resilience are being more and more used in business management for analyzing and finding appropriate ways to cope with these impacts (Günther et al., 2007; Armitage, 2006; Sheffi, 2005; Starr et al., 2003). The resilience concept originates from ecosystem science. The ecologists Odum (1971) and Holling (1973) described how ecosystems by means of homeostatic mechanism organize themselves in order to reach an ecological balance. Holling (1973) developed a model that was designed to interpret the dynamics and resilience of complex ecosystems, which are thought to go through phases of an “adaptive cycle” (Peterson, 2000). In this context, the system’s resilience refers to the amount of change a system can undergo while maintaining its function and structure (Holling, 1973). Within literature there are two main types of understanding resilience: engineering resilience (Pimm, 1984) and ecological resilience (Holling, 1973). The former focuses on the

efficiency of function and therewith the time a system needs to return to a steady state after a disturbance. The latter is defined as the magnitude of disturbance that can be absorbed before the system restructures. This implicates a focus on maintaining the existence of function. According to that, Walker and Salt (2006) state that resilience is not about the time a system needs to rebound after a disturbance, but about the ability of a system to get back. Considering that business organizations play important roles within society and economy, having more resilient organizations is a key factor towards achieving more resilient societies because these organizations deliver essential functions and structures for society, especially in times of crises. Economic and societal implications of unprepared business organizations facing ad-hoc crises or discontinuities can have drastic consequences. The idea of resilience can give new stimuli facing these challenges.

However, our knowledge about the elements that promote resilience and practical information how business organizations can cope with increasing complexity and dynamics due to impacts caused by climate change are still rather limited (Smit and Wandel, 2006; Smithers and Smit, 1997; Toman, 1998). First results of a participatory vulnerability assessment give insights into needs for a resilience framework from a business management perspective. Business organizations face complex challenges now and in future to which they need to find economically, technologically and socially suitable answers. It will be shown that especially indirect impacts caused by climate change are difficult to handle. Indirect impacts are complex, uncertain and characterized by a high degree of unpredictability. They focus on the derived social, ecological, economic and cultural consequences of the direct physical impacts

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from a worldwide perspective. Indirect impacts can be also understood as imported impacts of global climate change for a certain business organization or sector. Assuming that indirect impacts are more complex but also of high relevance for the German food industry, resilience helps to handle these impacts. Coping successfully with impacts caused by climate change necessitates more than traditional strategic management instruments. The results are based on a German BMBF research project and will be presented in this paper.

This paper is organized as follows. Section 2 gives an overview of the methodology that is used within the research project. Section 3 gives a profound reasoning for the coherence between climate change caused vulnerability and the strategic options of mitigation and adaptation strategies and highlights the results of the vulnerability assessment of representative German business organizations in the food industry. The results will be compared to current writings about resilience frameworks within business management literature in section 4.

2. Methodology

In this section the research methods used will be briefly explained. The presented results are based on two conducted workshops with representative business organizations from the Northwest German food industry. Different sectors of the food industry were represented, namely the fish sector, the meat and poultry and the vegetable/fruit sector. The workshops took place between Spring 2009 and 2010 with an average of 15 business organizations. Business organizations varied from conventional producing to organic, as well varying regarding the size: Varying from small to medium scale business organizations. The interviewees were either the CEO or the head of quality management.

The aim of both workshops was the evaluation of climate change impacts for the development of corporate climate adaptation strategies. According to Smit and Wandel, (2006) the workshops were structured in accordance with a vulnerability assessment. This paper discusses the results of exposure and sensitivity towards climate change. The workshops were conducted in a participatory way. All business organizations were actively involved and part of each step in the vulnerability assessment. The method allowed for the gaining of information directly from vulnerable experts. Both conducted workshops took place with all business organizations at once. Therefore, also links between different business fields and along different supply chains were analyzed. The workshop results were analyzed with qualitative content analysis according to Mayring (2008).

This participatory vulnerability assessment allowed for the identification of climate change caused impacts empirically from business organizations and therefore gaining practical information on the one hand; on the other hand a profound literature review (in this case key literature encompasses e.g. (Bruinsma, 2009; BMELV, 2009; Chmielewski, 2007; Easterling et al., 2007; FAO, 2008; UFZ, 2008; Parry, 2000)) needs to be accomplished for comparison and control because “a research challenge for practical adaptation work to characterize the exposure and sensitivity elements of vulnerability is to identify those processes of climate conditions and system occupancy dynamics that are considered to be problematic, risky and hazardous in some way to the community of interest. These are rarely known a priori” (Smit and Wandel, 2006).

3. Results and analysis

This section reports the results of two conducted workshops analyzing the vulnerability of business organizations in the German

food industry. First the theoretical basic will be presented and then the empirical results.

Mitigation and adaptation are two possible ways of coping with climate change – both on a governmental and on a corporate level. “Whereas mitigation refers to actions that reduce exposure to change, e.g. through regulation, location or technological shifts, adaptation on the contrary refers to the adjustments that population takes in response to current or predicted change” (Nelson et al., 2007). Up to now, mitigation is primarily a task of national governments in the context of international conventions. And adaptation has been primarily a matter on a regional and local scale (The Federal Government, 2008; UNFCCC). Main differences between these two strategies are divergent incentives and resulting benefits of them. Whereas mitigation efforts mainly produce public benefits – reducing GHG emissions without having a direct benefit in doing so, adaptation mainly produces private benefits (Tol, 2005). Moreover both strategies can be characterized by different degrees of uncertainty, effectiveness and efficiency, of concreteness and by their structure of responsibility. So is the degree of uncertainty regarding adaptation measurements higher because local forecasts of climate change are still rather limited and socio-economic consequences hard to predict and to value so far. Considering mitigation and adaptation strategies from a corporate perspective changes this logic. Understanding the role of business organizations in modern societies one firstly recognizes their importance in delivering essential functions and structures for society, especially in times of crises and secondly their role as contributors of GHG emissions, etc. Consequently, business organizations play important roles speeding up climate change on the one hand and on the other buffering impacts caused by climate change. Considering this and the fact that business organizations have divergent incentives for mitigation or adaptation than institutions or actors on a governmental level one should have a closer look on these two strategies, analyzing their specific potentials and inherent logic from a business management perspective.

Implementing mitigation strategies from a business management perspective can cover several motivation patterns, e.g.:

- Saving energy and therewith costs (e.g. in operational processes, trading emissions)
- Improving the environmental performance (e.g. against the background of sustainability reports, reputation and legitimation)
- Development of new energy-saving products or production processes and therewith gaining market benefits
- Advantages of pioneer position (e.g. being prepared for new regulations)

Corporate incentives for developing and implementing of adaptation strategies can cover following aspects:

- Part of risk or crisis management
- Saving costs due to pro-active risk preparations and measurements
- Development of new products (e.g. technological innovations) and therewith gaining new market sales

Consequently, benefits for business organizations investing and implementing mitigation or adaptation strategies are on an organizational level primarily saving costs (from a tactical and strategic point of view) and increasing the return on investment. Trade-offs similar to those on a governmental level do not exist. Governmental trade-offs can consist of national vs. international interests as well as of economical vs. political interests. The main difference between mitigation and adaptation are the resulting benefits and

the underlying interests of governments implementing a certain strategy. Whereas mitigation efforts mainly produce public benefits (that might generate competitive disadvantages for the home country), adaptation measurements mainly produce private benefits (that can include a high degree of uncertainty regarding cost-benefit-analysis, etc). But up to now, the separation of these two strategic ways of coping with climate change is common in theory and practice (e.g. German strategy for adaptation to climate change) (The Federal Government, 2008; UNFCCC; Tol, 2005). Combining mitigation and adaptation measurements can be fruitful, in particular if it is assumed that successful strategies regarding climate change necessitate more than passive responses to change. As Rosenthal and Kouzmin (1996) point out: "In crisis situations, organizations will attempt to learn and to adjust, to return to the original state of operations as soon and as resolutely as possible. They become involved in reactive learning instead of learning how to prevent the critical incidents which precipitate the crisis". Climate change can lead to turbulent and discontinuous environments and therefore to unstable states. In many regions of the world, climate change impacts have led to regime shifts (Rockström et al., 2009) that make adaptation necessary. As Rosenthal and Kouzmin (1996) indicated, systems in crisis situations tend to only react in a passive, reactive way, rather than pro-active. Therefore, adaptation needs to include elements of transformative change. Considering that mitigation can help to not increase the level or existence of unstable system states, mitigation efforts are a key factor for climate adaptation.

Reviewing the literature of adaptation strategies for business organizations Frankenhauser et al. (1999) distinguishes four types of adaptation:

- Reactive adaptation: Measures that are taken in response to climate change, after the fact
- Anticipatory adaptation: Deliberate decisions to prepare for potential effects
- Autonomous adaptation: Natural or spontaneous adaptation in the face of climate change
- Planned adaptation: Requires conscious intervention

Being aware of the increasing pressure to act regarding climate change and the evaluated results (especially from a societal point of view) mitigation needs to be a profound element of corporate adaptation strategies. From a business management perspective combining mitigation and adaptation strategies can develop financial benefits and strategic advantages. Considering the importance and nature of indirect impacts from a strategic management perspective a fifth type of adaptation in addition to Frankenhauser et al. (1999) can be added:

- Pro-active adaptation: Building resilience and robust system designs while considering mitigation and adaptation requirements

Pro-active adaptation involves the resilience idea in sense of ecological resilience. Ecological resilience focuses on maintaining system relevant functions and structures in turbulent and discontinuous environments and can give possible options for coping with climate change. Consequently, contrary to anticipatory adaptation, pro-active adaptation copes with change not in terms of switching to alternative stable states but rather in terms of retaining essentially the same function, structure and therefore identity and gives options for new and creative responses. Gunderson and Pritchard (2002) emphasize that "resilience allows a system to withstand the failure of management actions. Management is necessarily based upon incomplete understanding,

and therefore ecological resilience allows people in resource systems the opportunity to learn and change".

In the long term, adaptation measurements can only be successful if mitigation efforts are combined. Climate change is constantly proceeding and economic and societal costs are rising. Combining mitigation and adaptation helps to lower the adaptation need and at the same time adaptation measurements give organizations more time to assess impacts and costs caused by climate change. The author therefore suggests linking resilience to adaptation. It is proposed to take resilience into consideration as an analytical category for building corporate adaptation strategies. Considering mitigation and adaptation requirements at the same time (but not in terms of a balance of investments) but in terms of considering that climate change is a process that cannot be handled only with adaptation or only with mitigation efforts. Rather options for strategic combinations of adaptation and mitigation measurements need to be considered in future. More research is needed to develop corporate synergies between these two strategies while considering the idea of resilience.

Against this theoretical background it is assumed that climate change effects business organizations in varying ways, depending on the complexity of supply chains and on the degree of interconnectedness and dependency of other business fields. Assuming that indirect impacts are more complex and difficult to cope with successfully, resilience (as analytical category) can give new stimuli. Following, the empirical results are presented.

For analyzing the vulnerability of business organizations in the German food industry two workshops were conducted. The predicted climate change impacts according to WETTREG scenarios (UBS, 2007) for the Northwest region of Germany were shown before the exposure analysis started. The WETTREG scenario states following impacts for the Northwest region of Germany:

- Marginal average increase in temperature for the coastal region of the North and Baltic Sea to the end of the 21st century
- Drought and heat waves during summer
- Increase of heavy rainfall events during winter
- Increase of gale-forces
- Rise of the global average sea level: 20–60 cm. In the North Sea the sea-level rise will be 15–20 cm higher
- Storm tides may be 60–80 cm higher

Fig. 1 shows the results of identified factors of corporate vulnerability regarding the expected climate change impacts. Some impacts had been compressed by the interviewees (extreme weather events = drought and heat waves, increase of heavy rain falls, increase of gale-forces, storm tides). Additionally the rise of sea temperature has been included.

During the evaluation process with the participated business organizations, climate change impacts were characterized in direct and indirect impacts. Direct impacts were interpreted as the physical consequences of climate change for a certain geographical region. Direct impacts contain uncertainty concerning the probability of occurrence. This is expressed within the ranges of different scenarios depending on different assumptions. Direct impacts can be changing weather conditions, increase in extreme weather catastrophes or the rise of the global average sea level. The exposure to climate change is expressed by these direct impacts. As Smit and Wandel (2006) state, are "exposure and sensitivity almost inseparable properties of a system and are dependent on the interaction between the characteristics of the system and on attributes of the climate stimulus". The sensitivity of a system is therefore determined by its exposition. Fig. 1 shows the direct and indirect impacts. Indirect impacts focus on the derived social, ecological, economic and cultural consequences of the direct

Direct Impacts	Fish Sector	Meat/Poultry Sector	Vegetable/Fruit Sector
Rise in Temperature	0	+	++
Rise in Average Rainfall	0	+	++
More Extreme Weather Events	0	+	++
Rise of Sea-Level	+	0	0
Rise of Sea Temperature	++	0	0
Indirect Impacts			
Change of Transport Conditions	+	+	+
Risks for Supply Chain Management	+	+	+
Rise of Production Insecurities	++	+	++
Changes in Demand	++	++	+



Fig. 1. Vulnerabilities within the German food industry caused by climate change, Source: Antoni-Komar et al. (2010).

physical impacts from a worldwide perspective. Indirect impacts can be also understood as imported impacts of global climate change for a certain business organization or sector. Indirect impacts determine one part of the sensitivity analysis. As seen in Fig. 1 German food business organizations are vulnerable to indirect climate change impacts. Worldwide interconnections of economies and supply chains of business organizations lead to a highly interdependent network which can be very vulnerable regarding climate change, even if the impacts do not take place in Germany or do not have an impact simultaneously in time and space. Therefore handling indirect impacts gains in importance for German food business organizations. Indirect impacts can result in social destabilizations concerning land use and allocation practices as well as in climate migration which lead to changes within societal and cultural processes (WBGU, 2007). From a business perspective interviewees identified changes in transport conditions, rise in production insecurities, risks for the supply chain management or changes in demand as relevant indirect impacts.

Furthermore Fig. 1 shows the sector specific vulnerability within the food industry in detail. Problematical for the fish sector is the rise in sea temperature, because some species cannot grow or survive under warmer conditions and migrate to new areas (Dodman et al., 2009; FAO, 2009). This affects supply chains and can result in changes in offered products (processing of new fish species) and demand (changing eating habits) as well as in insecurities concerning certain production processes (UNEP, 2009). Generally, these adaptation measurements can lead to higher costs. In contrast, the vegetable and fruit sector is more vulnerable to rapidly changing weather conditions that can lead to crop failure or extreme variability in harvest (Zollitisch et al., 2007; Olesen and Bindi, 2004). For the meat and poultry sector, however, the indirect impacts are more afflicted with risk, for example the global development of prices for animal feeding and changes in the

consumer demand towards more Mediterranean eating habits in times of rising outdoor temperature. Furthermore, impacts of rising temperature can also affect the supply chain, because hygienic problems in stables can lead to inefficiency and epidemic plague (Parry, 2000).

The results show the different degrees of vulnerability regarding indirect and direct impacts of climate change and their variations amongst certain sectors of the German food industry. The certain degree of vulnerability is dependent on the specific impacts on certain production systems and sector specific structures. The results give first indicators that the complexity of supply chains plays an important role regarding the degree of vulnerability due to indirect impacts.

Secondly, the sensitivity of the participating business organizations were analyzed in more detail. Against the background of identified vulnerabilities, interviewees had to reflect the potential consequences of the identified direct and indirect impacts asking themselves whether these changes contain new chances or risks. Firstly all ideas had been collected in sense of a brainstorming and secondly superior items had been compressed in a group process. The following sector encompassing potential chances caused by climate change were identified:

- Need for intensified innovations: Keeping the market position
- Acquisition of new business markets according to product, service, technological and institutional innovations
- Preferential treatment of certain sectors due to changing weather conditions, e.g. certain agricultural sectors
- Building new business cooperation's with countries that need technologies or services that have not been needed before, e.g. renewable energy, water management systems

The following potential risks were identified:

- Changes in demand: Changes in societal and cultural preferences, e.g. eating habits, demand for certified products (e.g. carbon foot print)
- Economic exposure of regional firms: Increase in foreign competitors, anticipation of higher world prices for resources (e.g. energy, raw materials)
- Increase in production insecurities: Collapse of up- and downstream production stages, insecurities concerning planning processes and logistics, long term outsourcing of production lines
- Fluctuations in product quality and quantity: Rise in prices, time and quality concerning delivery problems, rise in production prices (e.g. due to higher energy and transaction costs)

Generally, the interviewees stated that identified risks can include chances if change is identified at an early stage in the sense of an early warning. This depends on the business organizations' method of coping with change in general (Chegini, 2005). The sensitivity analysis revealed a positive relation between sensitivity and propensity to invest. Furthermore, interviewees from the fish sector stated that their degree of flexibility and of the whole sector is characterized by a cluster structure (Porter,) which is highly networked. These circumstances influence their way of coping with change in general in a more open and challenging way. Within their sector change is more likely perceived and taken as chance. The results give first indications for the assumption that the complexity of supply chains and therewith the sector specific structure play a relevant role regarding the degree of vulnerability towards indirect impacts caused by climate change. But more in depth research needs to follow to verify this assumption. So far there has been

a quantitative survey for the German fish industry conducted. Results will be published in the near future.

The results of exposure and sensitivity revealed first insights into the vulnerability of the German food industry. The small sample does not allow for transfer of the results to other sectors or countries. More research needs to follow, looking at the different sectors of the food industry separately. However, the participatory vulnerability assessment showed the important difference between direct and indirect impacts which emphasize the need for integrating the vulnerability assessment into supply chain management. The management's attitude towards changes in general is a key factor for coping with climate change impacts successfully. Further research is needed for identifying factors that promote the adaptive capacity of business organizations in the food industry considering the concept of resilience as analytical category. Furthermore, the vulnerability assessment indicated the importance of indirect impacts which are characterized by a high degree of unpredictability and complexity. Finding appropriate instruments for business organizations handling these form of impacts necessitates a system overall approach. The identified chances and risks not only reflect options for adaptation but also for mitigation measurements. The empirical data underlines the introduction of the idea of pro-active adaptation because the items mentioned cannot be exclusively traced back to adaptation or mitigation requirements. Finding synergies between these two strategies for an appropriate coping with the indicated risks and chances can gain cost-effectiveness.

In the following section, first approaches as to how the concept of resilience can be transferred to business organizations will be introduced.

4. Discussion

A first step for the development of corporate adaptation strategies must be a vulnerability assessment which encompasses the analysis and identification of exposure, sensitivity and adaptive capacity (Smit and Wandel, 2006). The vulnerability assessment ends with the development of one or more adaptation strategies for the business organization as a whole or for certain business fields or processes. After analyzing and sampling of information the key element is the assessment of the overall vulnerability. But many variables or identified coherences are hardly measurable. Quantifying the vulnerability is therefore often not possible. The high uncertainty regarding the probability of occurrence and the intensity of impacts makes it very difficult to make final decisions. Therefore the concept of pro-active adaptation can give fruitful stimuli for the assessment process integrating resilience as an analytical category. The resilience idea indicates that the system's design has to be pro-actively changed in advance of turbulences or shocks. Criteria for a resilient system's design can be building feedback mechanisms, diversity (Levin et al., 1998) as well as redundancies, flexible structures, modularity and buffering capacities (Miller and Page, 2007). Furthermore, the way business organizations perceive change in general as shown by the empirical results can be a crucial element of promoting resilience. Current concepts of resilience management partly underline these results. In Günther et al. (2007) published a conceptual framework for resilience management. Assuming that climate change causes ecological impacts that are unpredictable and discontinuous, the authors suggest focusing on building adequate adaptation strategies. The dominance of outside-in-effects in comparison to inside-out-effects therefore necessitates a resilience management. "A resilient organization can improve its system-resilience by means of the adaptive capacity, which encompasses all those capabilities that can deal with crises, disruptions or external shifts" (Günther

et al., 2007). The author's focus on internal capabilities of a business organization dealing with external shocks and discontinuities. According to that, Günther et al. (2007) assume that resilience has three components: resistance in terms of precautionary measures, short-term adaptation in terms of returning to a defined starting point and (re)innovation in terms of taking advantage of new circumstances due to discontinuities. The first components have close links to classical risk management and early warning approaches. Short-term adaptation signalizes that resilience is understood in the sense of engineering resilience. Returning to a defined starting point presumes, unlike ecological resilience that only certain system states exist to which the system has to return. Ecological resilience in contrast assumes that systems contain multiple states and that resilience is not about searching for an optimal state. The third resilience component draws attention to a crucial element of resilience management: innovation. The resilience idea tends towards a change of perspective: Resilience implies that the future changes too rapidly for an immediate response. Innovation draws attention to the nature of change. Change can involve risks as well as chances. As the workshop results have shown the corporate way of coping with change is a crucial factor for handling discontinuities and building adequate strategies.

Other resilience management frameworks like one of the Resilient Organizations (2007) have a divergent understanding of resilience. The Resilient Organizations definition which likewise reflects the frameworks structure is: "Resilience is a function of an organization's situation awareness, management of keystone vulnerabilities and adaptive capacity in a complex, dynamic and interconnected environment". This definition reflects within literature well described elements of resilience, namely: vulnerability and adaptive capacity (Nelson et al., 2007). The adaptive capacity according to Resilient Organizations (2007) is understood as "the measure of the culture and dynamics of an organization that allow it to make decisions in a timely and appropriate manner both in day-to-day business and also in crises." Considering that coping with impacts caused by climate change necessitates pro-active and innovative coping, clarifies the passive character of adaptive capacity according to Resilient Organizations. According to Schumpeter (1934) successful strategy building and long term viability of organizations need creative solutions. Building adaptive capacity also means creating new business models, products, ways of planning and producing and so forth. Improving organizational resilience therefore means to innovate new ways of coping with change and going beyond stable states. Furthermore, resilience is understood as a buffering capacity, which allows fluctuations but the scale and amount of fluctuations is dependent on the context and on value-laden aspects.

Furthermore, it leads to another crucial difference between the idea of pro-active adaptation and this resilience management framework that can be expressed by Dalziel and McManus (2004) who stress "resilience management shifts the focus from what could make the lights go out? to it does not matter what makes the light go out, how we are going to deal with it if they do" and how can we avoid that the lights go out? Classical risk and crisis management approaches focus primarily on the external environment and therewith having a view from the outside to the inside of the business organization. According to that, Starr et al. (2003) suggest understanding enterprise resilience as a continuous process that encompasses the identification of greatest risks across the enterprise and their interdependencies and the generation of a program for mitigating risks. Whereas risk management approaches give operation guidelines after a disturbance has taken place (Wildavsky, 1988), considering the resilience idea regarding ecological resilience implicates that the system's design has to be

pro-actively changed in advance. Certain concepts of crisis management deal with similar questions: How to prevent crises in advance? Jacques (2010) stresses a new process approach within crisis management focusing on crisis prevention instead of crisis response. Concluding that crisis prevention “necessitates moving responsibility from the operational to the executive level”, he introduces a nonlinear model to explore how crisis management activities can be clustered together and integrated to optimize organizational effectiveness. This approach has similar assumptions regarding the model of pro-active adaptation. Further research needs to be done to analyze potential synergies between these approaches. In contrast to current resilience management approaches (Günther et al., 2007; Armitage, 2006; Sheffi, 2005; Starr et al., 2003) are crisis prevention and crisis preparedness characterized by a more innovative, open and creative way of coping with change and a higher degree of applicability.

Generally, the discussed resilience management concepts give insights into how resilience can be transferred for business management concerns. Finding appropriate ways of integrating resilience thinking as analytical category for building corporate adaptation strategies, current resilience management concepts mainly lack of practical information and a low level of applicability. Consequently, information regarding system boundaries and scales are often lacking as well as indicators how to identify and to measure resilience. Existing concepts are based on different theoretical assumptions and therefore no common resilience definition for business organizations exists to this point. Furthermore, there is only little consideration of existing models and criteria within resilience thinking (e.g. Walker and Salt (2006), Resilience Alliance). The empirically evaluated importance of indirect climate change caused impacts and the challenge of identifying relevant dynamics and global interconnections between supply chains have not been considered so far. In addition, there exist no precise instruments for handling climate change impacts from a business management perspective. Further research is necessary for either integrating climate change specific challenges in existing resilience concepts or to test options for integrating resilience as an analytical category in early warning and crisis management approaches.

In the context of climate change, adaptation strategies are constrained by social/cultural characteristics and individual/organizational behaviour. Challenges caused by climate change therefore appear among others as societal and cultural challenges. Climate change influences societal and cultural processes, on the one hand, but likewise climate change is intensified by societal and cultural processes. In this regard, cultural processes and path dependencies within society and the reactions to the market also have to be considered in a resilience concept (Kirchhoff et al., 2010). Impacts caused by climate change can reinforce the need for an interactional and recursive view of business organizations, considering the importance of building capacities for adaptation strategies while catching up with cultural processes like technological transformations of society, specialization of production, and social acceleration (Beermann and Schattke, 2009).

5. Conclusion

Climate change is characterized by impacts, which can result directly and indirectly. Indirect impacts are highly unpredictable and complex because of their close interrelation with societal and cultural processes. Therefore, social sciences and business studies are more and more becoming a substantial part of climate research. This paper presents impacts caused by climate change as diverse and complex phenomena that express themselves as risks and as chances. Linking adaptation and mitigation strategies led to the

insight into pro-active adaptation that focuses on building resilient and robust strategies while considering mitigation and adaptation requirements. Furthermore, resilience management concepts are described and represented according to Gunderson and Pritchard (2002) that improving the adaptive capacity of business organizations implicates developing creative solutions which not only respond to short-term challenges but rather to consideration of resiliency in the long term.

Acknowledgements

The work presented here is based on the German BMBF research project “Northwest 2050: Perspectives for Climate Adaptive Innovation Processes in the Metropolitan Region Bremen – Oldenburg”, <http://www.nordwest2050.de>.

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