

## ADAPTATION TO CLIMATE CHANGE AS A PROCESS OF ORGANIZATIONAL LEARNING

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### **Abstract:**

As climate change has emerged as the most pressing sustainability issue, there has been an increase in corporate responses to the problem. They often involve changes to organizational routines, behaviours, procedures and are based on the process of organizational learning. In this article, we try to connect process of climate change adaptation with organizational learning. We present climate change issues through the prism of learning processes and draw attention to the importance of uncertainty, indirect signals and crisis management. In short we argue that adaptation to climate change has many similarities with organizational learning and this process (OL) can be used in the analysis of adaptation options. The paper identifies implications of climate change for routines, experimentation, knowledge acquisition, and dynamic capabilities.

*Keywords: climate change, adaptation, organizational learning.*

## 1. INTRODUCTION

The viability, development and sustainability of social, economic and environmental systems are determined by the ability of these systems to cope with and/or adapt to change. Historic climate variations and recent weather events (e.g. storms, droughts, floods, warming temperatures, and changing precipitation patterns) demonstrate the relative and continuing sensitivities of economic system to current climate (an existing adaptation deficit) and signpost that there will be a need to consider adaptation in the context of projected changes in climate.

With impacts already being observed, it is no surprise that some businesses have begun taking steps to adapt to climate change. A common objective of firms, particularly in sectors exposed to climate variability has been to reduce sensitivity to climate impacts, for example through crop diversification, water management, disaster risk management, and insurance. Other measures include the controls of the channels and flows of rivers or the configuration of the sea coast. However, while firms are equipped to deal with some form of variability, they are rarely equipped to deal with changes that occur more abruptly, and/or in greater scale and scope. Most of these actions are *reactive*—i.e., businesses are responding to climate change and impacts that have already occurred.

From theoretical point of view, while existing research on firm adaptation has been concerned with various forms of firm adjustment to competitive environments, researchers have only just begun to investigate the capacity of businesses to adapt to climate change impacts (Berkhout et al., 2006; Hoffmann et al., 2009; Linnenluecke & Griffiths, 2010). None of them explain the framework of adaptation process with reference to the concept of organizational learning. Meanwhile the aim of this study is to present the process of adaptation to climate change through the prism of corporate learning. Based on empirical research into processes of adaptation in three companies the paper sets out a framework for analysing adaptation to the direct impacts of climate change on business organisations.

## 2. THE IMPACT OF CLIMATIC CHANGE ON BUSINESSES

Climate change has become part of corporate reality as regulators, customers, and competitors start to take action. Today, we can observe many important areas in which climate change affects businesses, e.g. price increase for carbon output factors (e.g. emission allowances) and increasing insurance premiums (e.g. insurance against natural catastrophes). As such, in many industries the way companies approach climate change issues will be a major success factor for the future, as it holds potential for both competitive advantages and disadvantages (Sussman & Freed, 2008). Climate change may have direct effects on business production facilities, buildings, and sites. Physical structures and assets of the business may be at direct risk from weather extremes, requiring design and/or location changes, affecting asset values, or causing physical damage. Climate may directly influence the effectiveness or efficiency of production processes, the cost of operations and maintenance activities, or the quality of a product. In particular, organizations from sectors such as agriculture, insurance, or energy are highly vulnerable to the effects of climate change, especially to extreme weather events and potential abrupt climate change.

It has been argued that while firms can tolerate some variability in environmental conditions, such as seasonal changes, environmental changes that are more persistent and/or extreme can lead to vulnerabilities, especially if these changes are not anticipated and/or if capacities for

adaptation are limited (Wilbanks et al., 2007). There exists a dual issue here. Firstly, many of the potential future changes in climate and weather patterns may well lie outside the coping range of firms, that is, their capacity to accommodate variations in climatic conditions. Secondly, many of these changes are not on the strategic planning or risk horizons of firms—which traditionally operate in short-term financial reward cycles. As a consequence organizations are unprepared to these changes and are unable to quick adjustment.

### 3. ABOUT ADAPTATION

United Nations Development Program has stated that adaptation is a process by which strategies to moderate, cope with and take advantage of the consequences of climate events are enhanced, developed and implemented (UNDP, 2004). Whereas the terms of reference expresses adaptation as ‘action’, other definitions describe adaptation as an ‘adjustment’, ‘process’ or ‘outcome’. Differences in definitions sometimes reflect the context in which the definitions are to be used — technical publications tend to adopt relatively broad definitions whereas policy documents are often more focused and specific. Definitions also sometimes differentiate adaptation based on the timing of the adaptation decision (anticipatory or reactive), the economic sphere in which the adaptation takes place (private or public) and whether or not adaptation is facilitated by institutions (autonomous or planned). In this paper the process of adaptation is defined as ‘action taken by organisations to respond to the impacts of climate change that cannot be avoided through climate change mitigation efforts’ (Barriers, 2011). Adaptation can take numerous and varied forms. It can be as simple as buying an air conditioner in response to warmer weather, or as complex as an insurance firm changing the way it forecasts the likelihood of extreme weather events. It should be underlined that in many cases adaptation can only help to reduce the impacts of climate change, not ameliorate them completely. Secondly, there may be many circumstances where a firm may prefer to bear some, or all, of the impacts of climate change rather than fully offset the impacts in advance. That is, in some cases adaptation may involve action after an event in preference to action in anticipation of an event, or even just an attitudinal change in what is considered ‘normal’.

The first major challenge in current adaptation work is to understand and demonstrate how adaptation functions as a process, and the wider implications of such a process for resilience. Adjustment to climatic changes, includes moderating potential damage, taking advantage of opportunities, and coping with the consequences. The latest emphasis on “climate proofing” implicitly assumes that once appropriate adaptation measures (typically technological in nature) are identified and implemented, plans and practices can be shielded against adverse climate impacts (Brooks & Grist, 2008).

A resilience perspective on adaptation emphasizes learning, self-organization, and flexibility as crucial ingredients for navigating complex feedbacks, thresholds, and system changes (Berkes, 2009). McGray et al. (2007) stress the significance of decision making for adaptation efforts that evolve and improve with newly emerging conditions and information. They specifically refer to processes of “learning as we go,” checking and rectifying possible maladaptation, exchanging information, and making trade-offs based on public values. Along the same lines, Osbahr (2007) views successful adaptation as a learned process in which appropriate communication channels constitute a crucial part. Enhancing adaptive capacity to climate change implies paying explicit attention to learning about past, present, and future climate threats.

## 4. ORGANIZATIONAL LEARNING IN THE CONTEXT OF CLIMATE CHANGE

Learning within the organization has been a feature of the theory of the firm since Cyert and March (1963) first explained it. Over the past 40 years OL has been identified as a means of development of organization. A substantial academic literature has developed on organizational learning (Argyris & Schon, 1996; Templeton et al., 2002; Small & Irvine, 2006). Two common approaches to view organizational learning are from the individual and organizational level. At the individual level, learning is viewed in terms of styles or preferences. The two most prominent models which have emerged in the OL literature are single-and double-loop learning. According to Senge (1990) learning takes place by observing data, using individuals' experience, selecting, giving meaning, sketching assumptions, concluding, adapting beliefs and then taking actions ensuring these beliefs. Organizations learn only through individuals and without them no organizational learning occurs. The organizational level of learning, or collective level of organizational learning can be traced back to Durkheim's "group mind" thesis that began with the observation that humans live and act in groups. According to Durkheim there are collective ways of acting and thinking that exist outside the individual; group of individuals may house knowledge about issues in a way that transcends the cognitive facilities of any one of them.

Cyert and March (1963) viewed organizations in the context of behaviour and called organizations as adaptive systems. This adaptive behaviour is based in routines and routines include the form, rules, procedures, conventions, strategies and technologies through which organizations operate. It is known that routines are rules, procedures, conventions, strategies. Organizational learning from the point of view of climatic change involves the encoding in organizational routines of lessons learnt from past climate change and leads to changes in organizational behaviour. This is a process referred to understanding of how organizations have responded to climatic extremes (e.g., floods and droughts), what concrete decisions managers have made in the face of changing conditions, and what strategies were most and least effective and for whom (Tschakert & Dietrich, 2010).

In the article we try to connect process of climate change adaptation with organizational learning. We refer to the five-stage process of learning, which comprises: (a) information acquisition including congenital learning, experiential learning, vicarious learning, grafting and searching and noticing the environment; (b) information distribution – the process of sharing information that leads to understanding; (c) information interpretation – the process of giving meaning to the distributed information and developing shared understandings; (d) organisational memory – the process of storing mental and structural artefacts and retrieving information. We present climate change issues by prism of learning process, draws attention to the signalling, interpretation, knowledge codification, feedback. We further argue that organisational learning can be seen as a cycle which begins with a stimulus leading to the generation of variation through experimentation and search, articulation and codification, followed by introduction of new routines across the organisation.

## 5. STUDY METHOD

The case study research was designed to be theory-generating. The goal was to explore adaptive behaviours mechanisms and to interpret the findings using concept from theory of learning in organizations. The case studies included the three organizations (A, B, C). A choice was made to include companies expected to demonstrate high degrees of adaptive

capacity. These businesses are regarded as market leaders in their approach to innovation and several had demonstrated interest in climate change problems.

The response process began with an initial orientation interview to collect organizational information and to investigate attitudes to climate change and adaptation. Next, we conducted in-depth interviews. A semi-structured questionnaire was developed and used in all interviews. The goal was to collect alternative perspectives from different members of organizations about responses to climate stimuli. The respondent group comprised top executives (owner, president of the board, director) as well as middle management responsible for ensuring continuity of production:

## 6. DESCRIPTION OF THE ANALYSED COMPANIES

Company A has many years of experience in providing services to the mining and power industry in southern Poland. The range of services offered by the company includes:

1. Collective disposal of saline water drained from mining facilities,
2. Intake and supply of industrial water,
3. Rehabilitation of waste disposal sites and degraded industrial sites.

Annually, the company discharges approximately 9 million m<sup>3</sup> of saline water into the environment by means of its retention/dosage reservoir system “Olza”. The dosage method allows to minimise the negative impact of mining water disposal on the river Oder. The company processes approximately 5 million m<sup>3</sup> of industrial water a year, which is collected at its own intake stations and supplied to mines and CHP plants. The discharge of saline mining water into the river requires constant monitoring and regulation of the outflow of saline water. The natural fluctuations of the river flow are utilised in the process.

Company B is one of the leading construction companies active in the property development industry. The company strives to erect quality apartment blocks in line with the most current trends observed on the construction market. Their business strategy is to focus their efforts on the Polish market. The company’s key objectives include:

- improving profitability by increasing control and minimising construction risks;
- focusing the company’s business potential on the Polish market;
- developing economic presence on the market of railway and industrial construction;
- solidifying the strong position on the national property development market.

Company B’s policy is “We build well, safely, and without harm to environment”. The company’s care for the natural environment and work safety is exercised by:

- diligent performance of all obligations in terms of quality while maintaining the principles of work safety and environmental protection as superior to production efficiency,
- adherence to the applicable legal regulations, particularly those related to environmental protection and work safety,
- requirement that the contracted suppliers maintain the necessary standards in terms of quality and safety as well as systems of environmental management.

Company C is in the business of:

- natural gas and oil mining,
- import of natural gas to Poland,
- natural gas storage,

- distribution of fuel gas.

The company's main objective is to provide a reliable and safe supply of clean and environmentally friendly energy. Despite being involved in a broad spectrum of environmental protection initiatives, the company's activities do have a considerable impact upon the natural environment. Of pollutants emitted by the company, approximately 88% is carbon dioxide from fuel burning processes. In the course of technological and emergency ventilation of natural gas pipelines and installations, as well as during borehole siphoning by exploration companies, methane is released into the atmosphere. The most polluting technological processes include technological ventilation of natural gas pipelines/installations and welding.

## **7. CLIMACTIC CHANGE EFFECTING BUSINESSES**

This study will focus on two climactic events of random character that have in recent years affected the analysed companies: the flood of 2010 and the hurricane of 2007. The 2010 flood was one of the worst ever recorded in Poland. During the culmination of the freshet wave the water levels were the highest in 160 years. As a result of heavy rainfall (between 14<sup>th</sup> and 18<sup>th</sup> May) the water levels in the lower basin of the Vistula were highly elevated (the Śląskie, Małopolskie, and Podkarpackie Voivodships). Water burst the levees in the Lubelskie, Podkarpackie, and Mazowieckie Voivodships. Dangerous levels were also observed on the river Oder. In the aftermath of the flooding, over 1,300 landslides occurred. The original culmination lasted for several days. As the intensive rainfall continued (June 1<sup>st</sup> and 2<sup>nd</sup>) the water once again reached dangerous levels on the rivers Vistula and Oder, resulting in flooding in southern Małopolska and Podkarpacie. Rivers burst their banks in the Małopolskie, Podkarpackie, Świętokrzyskie and Lubelskie Voivodships – flooding approximately 554,000 hectares in 2175 localities. Over 30,000 people had to be evacuated. On 18th January 2007 gale force winds swept over Poland. The hurricane was accompanied by downpours, hailstorms, and violent thunderstorms. Hailstorms were most intensive in Dolny Śląsk, Opole, and Małopolska. At night, wind speeds locally exceeded 150 km/h. The highest speeds were recorded at the peak of Śnieżka mountain where the instruments' scales proved insufficient (the maximum recordable speed was 250 km/h).

## **8. RESULTS**

In order to adjust to the changing environment and to take appropriate action, organisations must be aware of climatic changes. Many businesses are located in areas where changes are occurring with the intensity or frequency of extreme events, such as storms, droughts, or flooding. These businesses are more likely to have concerns about the physical effects of climate change. Each of the analysed companies (A, B, C) utilise infrastructure which is potentially vulnerable to weather conditions. The same is most evident in the context of a construction company conducting its activities on a national scale. It is bound to be directly affected by violent weather (flooding, gale, hail), also in terms of the changing stability of the soil.

The process of learning begins with identifying environmental signals. In the context of climatic changes, the purpose of the screening (signal identification) is to determine whether the organization might be at risk, what aspects are at risk, what, if any, actions are needed. The goal of the screening is to classify/screen risks into one of three categories: take action, wait and study, and take no action. Climatic changes can impinge the studied businesses

either directly or indirectly. This study focuses on direct impingement. As perceived by the respondents, direct signals are identified as perceivable climatic turbulences, consequently their identification is conducted on an ad-hoc basis. Due to the geographical location of the companies, the turbulences they may have experienced in the past would include snowstorms, floods, partial inundations, or local hurricanes. The suffered effects of the 2010 flood included: inundations, interruptions of the production process, destruction of machinery, destruction of vehicles, destruction of products and raw materials. Apart from the above, the respondents in company C also listed: closure of several facilities, landslides, destruction of levees, delayed deliveries, and destruction of IT equipment. Apart from causing damage to the companies' infrastructure, in economic terms the flood was also a factor leading to "economic shock" (company B). In the aftermath of the flooding and inundation, the risk factor of conducting economic activities in the affected areas increased significantly, particularly in terms of the cost of doing business, delayed deliveries, and payment gridlock. As far as the 2007 hurricane is concerned, the main effects included: blown off roofs, damaged buildings, toppled trees, and flooded basements. Due to the fact that such events had occurred repeatedly in the preceding years, their interpretation was not problematic for the analysed companies. Based on previous experience, they prepared for the forecasted weather turbulences by physically securing their respective infrastructure, taking appropriate precautionary measures and erecting protective structures.

The interpretation of environmental signals facilitates assessing the actual risk and identifying what actions are available and should be taken in response to the risk. It will be prudent to take climate change into account if it materially affects a company's operations, its value chain, or its broader commercial environment. Consequently, understanding whether adaptation is necessary—and what adaptation can accomplish—requires taking a closer look at the dimensions of possible impacts on business. Adaptation procedures in response to random changes fit within the pattern of adaptation space. The obtained results suggest that companies opt for well-established options which they had been satisfied with previously. The same is in line with earlier studies which indicated that shared knowledge and experiences from past climate events can raise awareness, spur resourcefulness, and provide a sense of agency among the poor to feel prepared for future climate shocks (Nelson, Adger & Brown, 2007). Novel, not explored options are only adopted when necessitated through external influence. The choice of adaptation solutions is related to the force of influence exerted on the organisation by the extreme situation. In company A, which had already experienced inundations in previous years, a suitable schedule was prepared. It comprised three stages of action, of which two were actually deployed. Stage one stipulated that once the water level reached 600 cm, an emergency team would be established to manage particular precautionary tasks. The second, emergency stage involved securing all vulnerable equipment by elevating it by 1.5 meters or placing it on special platforms. The ground floors and basement areas of the facilities were emptied. The final stage, to be introduced in a situation of immediate danger, would involve the evacuation of employees from the facility. In the case of company C, the water that penetrated into the company's premises was removed with the use of water pumps. The area was secured with the help of the army and volunteer workers. Company C's premises are located in an area surrounded by levees. The threat of flooding came mostly from the direction of a nearby residential area. The preventive efforts focused on a two kilometre section of the levee which separated the company's buildings as well as the residential area from the flood waters. In several areas the levee was additionally strengthened with the use of special nonwoven put in place by scuba divers.

In company B, the process of removing the flood water involved the use of:

- suction barrels,
- 14 m<sup>3</sup> capacity pressure vehicles,
- sludge gulpers,
- pumping units,
- power generators.

The range of available solutions is limited by the available know-how. Only in the case of company B did the prevention of the negative consequences of future climatic changes include an analysis of available courses of action involving the use of more up-to-date technical solutions: avoid areas at risk, build to new standards, use modern materials.

In the light of the obtained results, the primary importance at the stage of adaptation activities must be attributed to coordination. Organizations can be coordinated by plan or by feedback. In general, climate change causes organizations to move in the direction of coordination by feedback. Disaster creates extreme environmental uncertainty for organizations and thus makes coordination by feedback more probable. As indicated by one of the company B respondents “one way to understand coordination is to see it as a process whereby a high volume of communication of information is processed relevant to the work of the organization”. The feedback involves information from different parts of the organization. In the case of climatic turbulence, coordination is therefore based on immediate transfer of information, organization of work and assignment of resources.

The conducted study confirmed that changes in terms of organisational procedures have been introduced in the aftermath of climatic change. In company A, the process of supplying industrial water has been optimised. A more precise system of monitoring parameters was introduced along with pumping units controlled by frequency converters. In company C the climatic footprint of the performed operations was assessed. Although the assessment itself was a one-time initiative, based on the obtained results the management decided to offset the emissions caused by the company’s operations by planting trees, an activity which continues to this day.

It should be pointed out, however, that all of the analysed companies failed to account for the problem of climatic change in their strategic plans. Consequently, no recommendations were made and no action stipulated with the aim of minimising climatic risks. Also we did not find any examples where companies had received significant positive feedback on the implementation of climate adaptation measures.

## 9. CONCLUSION

Based on empirical results the article presents a framework for analyzing adaptation to the direct impacts of climate change on organizations from the learning process point of view. It argues that adaptation takes the form of organisational learning. The paper identifies implications of climate change for routines, experimentation, and knowledge acquisition. The analysis leads us to conclude that the way in which firms respond to pressures from climate change is in many ways similar to conventional (market) adaptation. The capacity to cope with surprises depends largely on openness to learning, the willingness to accept change as inevitable, and the ability to engage in interventions/experiments. Therefore coping with non-linearities and uncertainties is seen as a key element of learning in the context of climate change.

The process of organisational learning with respect to climatic change takes a form analogous to those observed in other areas. It is based on the cycle of information acquisition, information distribution, information interpretation, and organisational memory. The key elements in this respect include correct interpretation of input signals, proper choice of adaptative solution, coordination and feedback.

The obtained results indicate that many of adaptative actions are *reactive*—i.e., businesses are responding to climate change and impacts that have already occurred. They adopt the position of deferral, based on scepticism or uncertainty about the possible impacts of climate change. The strategy could be described as wait and see. The action taken by the analysed companies was limited by what was already known. Companies tended to draw upon the repertoire of responses already open to them, rather than invest in the identification of new options. Feedback mechanisms demonstrating the benefits of an adaptation option or strategy will usually be weak. As a consequence, adaptative action is limited to securing property and ensuring operational continuity.

Admittedly, the conducted research was somewhat limited. Firstly, it pertained to only three companies. Secondly, it only considered specific instances of climatic turbulence (flood, hurricane) of random character. It did not pertain to other meteorological extremes or non-random events. Considering the above, the conducted research may only constitute an introduction to a more in-depth study.

## REFERENCE LIST

1. Argyris, C., & Schön, D. (1996). *Organizational learning II: theory, method and practice*. Addison Wesley Reading: Massachusetts, USA.
2. Barriers to effective climate change adaptation (2011). Australian Government, Productivity Commission, Issue Paper.
3. Berkes, F. (2009). Evolution of co-management: role of knowledge generation, bridging organizations and social learning. *Journal of Environmental Management*, 90, 1–11.
4. Berkhout, F., Hertin, J., & Gann, D. (2006). Learning to adapt: organizational adaptation to climate change impacts. *Climatic Change*, 78, 135–156.
5. Brooks, N., & Grist, N. (2008). Development futures in the light of climate change: creating new insights into the past, the present and global futures. In: *Policy Forum: International Development in the face of Climate Change: Beyond Mainstreaming?* Background paper for Development Futures Discussion. Department for International Development (DFID)/DSA Policy Forum, University of Greenwich: London, UK.
6. Cyert, R. M., & March, J. G. (1963). *A Behavioral Theory of the Firm*. Prentice-Hall: Englewood Cliffs, NJ.
7. Hoffmann, V. H., Sprengel, D. C., Ziegler, A., Kolb, M., & Abegg, B. (2009). Determinants of corporate adaptation to climate change in winter tourism: an econometric analysis. *Global Environmental Change*, 19, 256–264.
8. Levitt, B., & March, J. G. (1988). Organizational learning. *Annual Review of Sociology*, 14, 319–340.
9. Linnenluecke, M. K., & Griffiths, A. (2010). Beyond adaptation: resilience of business in light of climate change and weather extremes. *Business & Society*, 49, 477–511.
10. McGray, H., Hammill, A., Bradley, R., Schipper, E. L., & Parry, J. E. (2007). *Weathering the storm: options for framing adaptation and development*. World Resource Institute Report: Washington, D.C., USA.

11. Nelson, D. R., Adger, W. N., & Brown, K. (2007). Adaptation to environmental change: contributions of a resilience framework. *Annual Review of Environment and Resources*, 32, 395–419.
12. Osbahr, H. (2007). *Building resilience: adaptation mechanisms and mainstreaming for the poor. Fighting climate change: human solidarity in a divided world*. Background paper for UNDP Human Development Report 2007/2008, New York, USA.
13. Senge, P. (1990). *The fifth discipline*. Double Day: New York.
14. Small, A., & Irvine, P. (2006). Towards a framework for organizational learning. *Learning Organization*, 13(3), 276–299.
15. Sussman, F., & Freed, J. R. (2008). *Adapting to climate change: a business approach*. Pew Center.
16. Templeton, G. F., Lewis, B. R., & Snyder, C. A. (2002). Development of a measure for the organizational learning construct. *Journal of Management Information Systems*, 19(2), 175–218.
17. Tschakert, P., & Dietrich, K. A. (2010). Anticipatory learning for climate change adaptation and resilience. *Ecology and Society*, 15 (2), 11.
18. UNDP (United Nations Development Program) (2004). *Adaptation Policy Frameworks for Climate Change: Developing Strategies, Policies and Measures*. Cambridge University Press: Cambridge.
19. Wilbanks, T. J., Romero Lankao, P., Bao, M., Berkhout, F., Cairncross, S., Ceron, J. P., Kapshe, M., Muir-Wood, R., & Zapata-Marti, R. (2007). Industry, settlement and society. In M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden and C. E. Hanson (Ed.). *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press: Cambridge, UK.