

# **Pathways to Regional Resilience** (draft)

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While the reduction of greenhouse gas emissions is considered to be a benefit for all of society, and hence a public good, adaptation to climate change is generally regarded as a private good. For businesses which implement adaptation measures as part of their business strategy and their organizational routines, this classification of adaptation measures is appropriate. These businesses bear the costs of such measures, and accordingly stand to profit from their own increased resilience to the effects of climate change. However, where adaptation measures involve not only businesses, but rather entire regions, adaptation to climate change should also be considered as a public good. Some products and services, such as the road and rail networks or the energy grids, are critical infrastructural systems that need to be sustained in times of climate change. This makes coordination between the private (e.g., businesses or chambers of commerce) and public sectors (e.g., governmental and non-governmental organizations) necessary. In the context of system theory, I would like to address the question of how to link different systems and subsystems in order to promote the resilience of regions.

*Key words: adaptation to climate change, critical infrastructure providers, regional resilience, private sector*

## **1. Introduction**

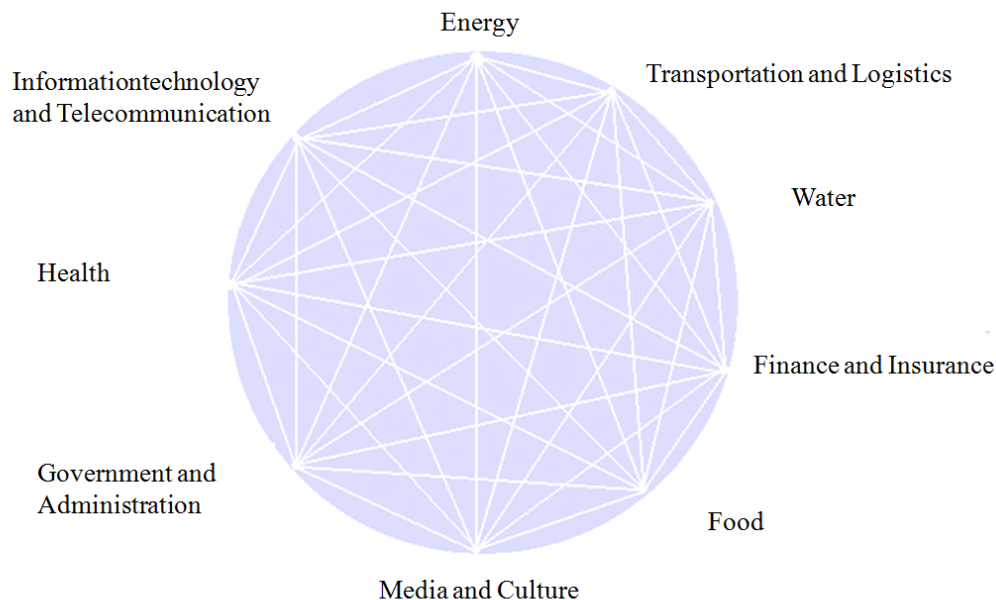
The economics literature only quite recently began addressing the issue of adaptation to climate change. Most articles on that topic address the damage of climate change at the macroeconomic level (STERN 2006). At the micro-level of businesses, research on adaptation to climate change is in its early stages. In the past three years, there has been a considerable increase in articles addressing both the perception and the strategic and operational processing of climate change in businesses (SHEFFI 2005; BERKHOUT et al. 2006; GÜNTHER 2009; WINN et al. 2010; FICHTER/STECHEER 2011). These significant findings are identified by an extensive journal review undertaken by FICHTER & STECHER (2010).

While mitigation is primarily framed as a public good, since all societies worldwide profit from reduced greenhouse gas emissions, articles addressing the micro level of businesses consider adaptation to climate change a private good, accruing in the form of reduced energy consumption through reduced energy costs. The research field “adaptation to climate change” has thus presumed that businesses will only profit from those adaptation measures which they have undertaken themselves. Accordingly, the remainder of society and other businesses are implicitly excluded from improved adaptation to climate change, inasmuch as they have taken no action themselves.

## 2. Businesses as critical infrastructure

Due to the definition of organizational adaptation as an exclusively private good, the vital importance of businesses that provide services to the public is not accounted for in the economics literature. Service providers in the areas of water and energy supply, transportation facilities, security etc., are all providers of critical infrastructure. If inadequate adaptation to climate change impacts such providers, they run a great risk of high losses, both direct and indirect. Moreover, a breakdown of the critical infrastructure would have severe consequences for a large number of stakeholders, in terms of public security and food, energy and water supply, because of the lack of alternative suppliers. Finally, any entity can be considered as critical infrastructure with regard to the natural environment, if it produces or processes harmful substances or hazardous waste, e.g. lead and cadmium, which has the capability to contaminate the natural and built-up environment seriously (LEWIS 2006; TAGAREV/PAVLOV 2007; VAN DER LEI et al. 2010).

Every nation has a critical infrastructure, including its energy supply and water supply, its transport system etc., and must address the issue of how to adapt this infrastructure to the impacts of climate change. The German Ministry of Internal Affairs for example, has developed an overview of the sectors which constitute the critical infrastructure of Germany (see Figure 1).



**Figure 1: Sectors of critical infrastructure of Germany.**

Source: German Federal Ministry of Interiors (2009).

Each sector identified as a part of the critical infrastructure is linked with numerous other critical infrastructural entities, as mentioned above. Hence in case of black-outs or delays in one sector, there is a high risk that other sectors too will face delays or even interruptions in the supply of goods and/or

services. For example, in case of the destruction of transport infrastructure due to such extreme weather events as storms or flooding, not only the transport sector itself, but also such other sectors as food supply or medical care will be affected. Moreover, energy supply is the bottleneck in most industrialized countries. Black-outs for several hours or even days can cause great losses and ultimately the threat of civil insecurity. As a result, the understanding of adaptation to climate change as a private good to businesses ought to be supplemented by the perception that it is also a public good. The research field “governance in transformation” further indicates why climate change adaptation of businesses is not merely a private good, but should rather be seen as a public good.

Until a few decades ago, services of public utility, including the critical infrastructure, were generally provided by public entities, particularly in Europe, while today most utility services are provided by the private sector. This transfer of the old utilities to the private sector is seen as part of the conversion from the model of state provision of services to one of an enabling state, which was mainly caused by the need for cost reduction and by the insufficient competence of the state entities (SCHUPPERT 2009). Even though former state tasks have been taken over by businesses, the state still holds the ultimate responsibility in case of failure of the private sector (GENSCHEL/ZANGEL 2007, 10). Therefore, businesses that supply formerly public services can be considered “providers of governance”, since they create governance in cooperation with the state.

“I suggest that we think of governance as a good produced by the state in association with other actors. There are abundant examples in which states – whether intentionally or not – outsource the provision of basic functions to external actors.” ZUERCHER (2007, 14-15).

Since the monopoly of responsibility for service provision by the state has not been replaced, but rather supplemented by the private sector (SCHUPPERT 2009, 288), the coordination and equalization of interests remains a public task, requiring the close and intensive interaction between public and private stakeholders. In the United States, some 85 to 90% of the national assets are owned or provided by the private sector. In times of climate change, the question arises as to how the services of the critical infrastructure, as the most vulnerable entities of society that are provided by businesses, can be adapted to meet this change successfully.

### **3. Adaptation of businesses as providers of governance at the regional level**

The economics literature offers a number of climate change adaptation strategies for organizations, e.g. postponing adaptation until the next decades while waiting for new research findings, or adapting organizational assets reactively. Another approach is to not adapt directly, but rather to cover damage by insurance, and thus transfer the risk to a third party. None of these approaches are suitable for providers of critical infrastructure, as the default costs would be much too high. For this reason, adaptation to the impacts of climate change upon the critical infrastructure needs to be initiated in advance, as a precautionary measure. Within this context, it is necessary to take the constantly

changing knowledge base into account when selecting adaptation measures. Hence, flexible adaptation measures which permit modifications retrospectively are preferable (FRANKHAUSER et al. 1999, 69).

It is to be expected that climate change will generate novel phenomena in terms of opportunities (e.g. new markets and services for adaptation measures, such as flexible water pipelines), but also in terms of risks (e.g. new pathogens and pests). In addition to the new phenomena, already existing developments (e.g. land-use conflicts, change in demography, or the invasion of new species as a result of dislocation) have the ability to generate new dynamics. Therefore climate change impacts should be understood as a significant piece of the puzzle of complex hazards (see Figure 2) (WORLD ECONOMIC FORUM 2011; TERMEER et al. 2011, 163). SMIT & WANDEL (2006, 289) conclude that:

“Successful climate change adaptation and vulnerability reduction is rarely undertaken with respect to climate change alone, and vulnerability reduction appears to be most effective if undertaken in combination with other strategies and plans at various levels.”

The following chapter will focus on the complex interplay of existing and novel developments in climate change impacts, in which climate change is addressed as one factor in a wider context. This will be specified using the concept of resilience, which originates in ecosystem theory.



**Figure 2: Global risks 2011.**

Source: World Economic Forum (2011).

### **3.1. Resilience – more than adaptation to climate change**

According to Adger's (2000) definition, resilience is defined as "the ability of groups or communities to cope with external stresses and disturbances as a result of social, political and environmental change." (ADGER 2000, 374) The ability to cope with external stress and disturbances depends on a number of factors, which can be broken down into three categories (GUENTHER 2009, 148; FICHTER/STECHE 2011, 88):

1. Capabilities (e.g. learning capacity, flexibility)
2. Structures (e.g. redundancy, networks)
3. Resources (e.g. financial capital, stocks, credibility).

This definition of resilience will be specified in the following chapter and applied to service providing businesses at the regional level. The goal is to create a deeper understanding of how private-public interaction should be shaped so that resilience of service providing businesses can be combined with public interests, in accordance with PORTER'S hypothesis of a win-win strategy (PORTER/VAN DER LINDE 1995). However, it needs to be noted that the economics literature shows a deficit not only in framing climate change adaptation as a public good, but also in applying the resilience perspective to the climate change adaptation of businesses in general.

### **3.2. Resilience entangled**

To date, the analysis has focused on the national level only. In fact, most businesses provide critical infrastructural services at the regional level. In this article, regions are understood as units intermediate between the local and the national levels, which have been shaped by social interaction. Regions have proven to be the effective level for the implementation and monitoring of societal objectives, such as sustainability and climate change mitigation. Increasingly, the focus has shifted to the regional level as regions engage in the national and international competition, which results both in advantages and in increased prosperity risks (BENZ/FUERST 2003, 20). CHRISTOPHERSON et al. (2010, 6) define regional resilience as a unique path characterized by long-term economic success which can be measured by such indicators as past and current economic growth, employment rates, standards of living and quality of life. According to this definition, the question arises as to which role businesses play in terms of their special role in the critical infrastructure.

FICHTER & STECHER (2011, 91) define resilient businesses as enterprises which must maintain their solvency and ability to deliver products and services in times of crisis in order to retain their operating license. Due to the ultimate responsibility of the state, the operating licenses of businesses delivering critical infrastructures can be withdrawn if they fail to comply with legal requirements, or if they disregard overriding societal interests. However, the withdrawal of operating licenses from businesses

providing services in connection with the critical infrastructures is hardly ever possible in times of crisis, as substitutes are lacking.

In the case of precautions involving goods, mandatory reserve stocks (e.g. stock of oil) currently exist in most countries, so that regions are prepared in case of severe events. At the same time, considerable gaps in reserves may exist in times of climate change. For example, if there were a power black-out in Germany, the country would come to a complete standstill in less than four days, because the stock of oil and other energy sources, including batteries and other emergency power supplies, would have been exhausted. After approx. 12 to 14 days, such a power black-out crisis in Germany would become a catastrophe. Therefore, it is imperative to evaluate the impacts of climate change on the critical infrastructure, and to assess how climate change impacts can best be met in businesses.

On the basis of an extensive screening of management measures HASENMUELLER (2009, 189) concludes that risks caused by climate change could be managed by means of measures currently already in place. Notably, the concept of resilience has features analogous to those of Business Continuity Management (BCM). BCM is closely linked to risk management measures and focuses on the continuation of central organizational functions and performances in times of crisis. As shown above by the example of the oil stock in Germany, limitations to continuity exist.

On the basis of all these considerations, it can be stated that regional resilience mainly depends on the consolidation of the existing measures (e.g., mandatory stock maintenance, BCM). There is however manifestly a considerable need to integrate climate change as a further wild card in the interplay of numerous risks. In addition, a general rethinking of conventional efficiency strategies is necessary, because, while redundancies may be inefficient in the short-term, they could have great impact on regional resilience, and hence on future prosperity of regions.

### **3.3. Pathways to regional resilience**

In the quest for responses on how to design resilient regions in times of climate change, the literature on civil security and critical infrastructures has been examined. This review shows that climate change impacts have largely been neglected in the literature on civil security and the critical infrastructure (LEWIS 2006; TAGAREV/PAVLOV 2007; VAN DER LEI et al. 2010). Theory, policy and practical implementation all focus on the security threats known from real life past experience, such as terrorist attacks, floods or earthquakes. To date, climate change impacts have been absent, although climate change is an essential driver for a variety of hazards and transformation processes. Only a few examples can be found which address security issues involving the entities which provide services through the critical infrastructure, and take adaptation to climate change at the regional level into account. Cases from the European Union (with a focus on Germany), Australia and the USA, which

have been addressing civil security and adaptation to climate change for some years, are presented below. In addition, multilevel perspective will be illustrated. Finally, key actors at the international level of networks and markets are taken into account.

**a. The European Union:** In the EU, two domains, security of the critical infrastructure and adaptation to climate change, have already been institutionally anchored. However they are assigned to different subsystems. The institutions of justice and internal affairs are primarily concerned with civil protection, whereas issues concerning climate change adaptation are addressed by environmental policy institutions. Moreover, this fragmentation is also observable at the national level. Indeed, climate change impacts are rarely addressed in the context of policy on civil security, whereas questions of the resilience of entities involved with the critical infrastructure are not included in climate change adaptation programmes (EU COUNCIL DIRECTIVE 2008; COMMISSION OF THE EUROPEAN COUNCILS 2009; GERMAN FEDERAL MINISTRY FOR THE ENVIRONMENT, NATURE CONSERVATION AND NUCLEAR SAFETY 2008; GERMAN FEDERAL MINISTRY OF INTERIORS, 2009). Although these businesses and public institutions are called upon to develop risk analysis and innovation potentials in collaboration with security institutions, primarily known hazards are taken into account, while climate change impacts are framed in terms of already known natural hazards. The emergence of novel and unforeseen dynamics are not considered. On the other hand, climate change adaptation measures are applied to all business without differentiation. To date, entities involved with the critical infrastructure have not been prioritized, although they deserve particular attention. One example worth mentioning from Germany, however, is a transfer project for incorporating the results of climate change research into lectures of the German Academy for Crisis Management, Emergency Planning and Civil Protection.

The assignment of responsibility for addressing climate change adaptation has not yet been resolved at the regional level. A number of research projects have explored ways for how to frame and implement climate change adaptation in the private sector at the regional level, e.g. through mainstreaming adaptation, the top runner approach, the agency approach, or organizational representatives. The main emphasis has been on regional characteristics, but to date, their practical effect has been spotty. Moreover, these research projects have predominantly focused on businesses in general and their economic value for regions, without addressing the special role of certain businesses as part of the critical infrastructure in a comprehensive approach regarding the regional level.

**b. Australia:** Australia is far ahead with regard to defragmentation of civil security and climate change adaptation. In accordance to the National Strategy for Disaster Resilience (NEMEC 2009), climate change adaptation is to be reflected in all policies and programmes (“mainstreaming climate change adaptation”). Climate change adaptation is framed as Australia’s major security task,

not only in the short term, but also in the long term. In this context, the role of businesses for regional resilience of communities is particularly stressed.

“...businesses can and do play a fundamental role in supporting a community’s resilience to disasters. They provide resources, expertise and many essential services on which the community depends. Businesses, including critical infrastructure providers, make a contribution by understanding the risks that they face and ensuring that they are able to continue providing services during or soon after a disaster.” (NEMEC 2009, iii)

In order to enhance the resilience of businesses which are part of the critical infrastructure at the national and regional levels, an intermediate organization has been constituted as an agent of change, based on an educational civil security institution launched in 1956. Through information brochures, management consulting, and workshops, businesses in general and those organizations involved with the critical infrastructure in particular receive support in adaptation to climate change, which is here seen as closely related to BCM.

**c. USA:** Climate change adaptation has not been prioritized in the USA as it has in Australia. However, the concept of resilient critical infrastructures is implemented at the regional level with respect to climate change impacts. At the initiative of key persons, non-governmental organizations, and research institutions at the regional level have, in cooperation with the Department of Homeland Security, established an intermediate organization called the Community and Regional Resilience Institute (CARRI). The goal of the regional pilot project is to develop regional resilience through multi-stakeholder collaboration at the regional level. At present, a web-based tool is being developed at the community level in order to increase resilience in ten American regions (CUTTER et al. 2008).

**d. The international level:**

- *Regional resilience through networks:* Such international networks as transition.org are in process of being developed, with the goal of interconnecting local and regional projects all over the world, and allowing them to learn from one another. The climate change adaptation of providers of critical infrastructure is integrated into the broader process of transition. To date, key persons and institutions from 34 nations are listed on the website as network members.
- *Regional resilience through market solutions:* At the international level, both NGOs and market actors promote regional resilience with respect to providers of critical infrastructure. Such products and services for business adaptation as business consulting and adaptive architecture are now to be made available in emerging markets. In this context, the consulting institution “Acclimatise – Building Climate Resilience” should be mentioned, which bases its business model on consulting sectors mainly involved with the critical infrastructure. One of the key issues is providing risk management tools for adaptation to climate change. Although market solutions



have primarily focussed on adaptation to climate change as a private good, the improved resilience of businesses involved with the critical infrastructure contributes to regional resilience.

#### **4. A systemic view on pathways to regional resilience**

The above theoretical considerations and case studies show that a number of actors, structures and processes which foster the resilience of businesses involved with the critical infrastructure at the regional level are already in place. With the exception of Australia and USA, however, no connection between the numerous scattered actors, structures and processes yet exists at the regional level. In the following, I will examine this fragmentation in the light of system theory, so as to conclude with recommendations for further research and for political strategies at the regional level.

Basically, the fragmentation of processes and structures regarding resilience of the providers of critical infrastructure at the regional level can be defined as sub-processes in an overarching process of the existing structure of societies and their subsystems. Increasing specialization causes the connectivity between subsystems to decrease. Thus, it results in the creation of a variety of specialized communications arenas. Through the interaction of actors, the question of who communicates – explicitly or implicitly – with whom, and about what, is negotiated within and between the systems and subsystems. Communication is understood as a crucial precondition for actions (LUHMANN 1994, 191; LUHMANN 1999, 63; LUHMANN 2000, 383; SCHNEIDEWIND 1998).

With regard to climate change adaptation, it is notable that the regional resilience of providers of critical infrastructure is institutionally assigned to the policy realms of Justice, Internal Affairs and the Environment. Regarding the EU and the USA, the institutions of Economics and Technology are rarely involved in questions of the adaptation of the critical infrastructure to climate change. As shown in the Australian and US case studies, such agents of change (ROGERS 1962) as CARRI bear the potential to foster the defragmentation of the unconnected communications arenas, provided they are equipped with substantial resources and competences. The defragmentation may be initiated top-down from the national level, as in the Australian case, or bottom-up, at the initiative of multiple stakeholders, as in the case of the change agent CARRI. In addition, non-governmental networks and market based organizations act as intermediaries.

## 5. Conclusions

Due to the framing of organizational adaptation as an exclusively private good, the vital importance of private providers of services to the public has not yet been adequately addressed in the economics literature. Given the evidence of such research fields as “governance in transformation”, the understanding of adaptation to climate change as a private good should be supplemented by viewing the climate change adaptation of businesses as a public good.

Moreover, it has been shown that climate change adaptation must be included as a supplementary factor in the complex interplay of global risks and opportunities. The concept of resilience can be used to better understand the adaptation measures that need to be taken into account at the regional and organizational levels. The three case studies show a distinct need to connect actors, processes and structures, first and foremost between the systems of civil security, the environment (adaptation to climate change) and economics, as has been done in Australia. The case studies also demonstrate the potential of change agents as intermediate organizations for connecting fragmented subsystems. However, further research is needed to address the following questions:

1. What impact do agents of change have on regional resilience and on the providers of critical infrastructure?
2. What differences are there between systems with agents of change which operate top-down, as in Australia, and bottom-up initiatives, as in the USA?
3. What role can NGOs and private actors play in pushing regional resilience forward?

## References

- Adger, W.N., 2000. Social and ecological resilience: are they related? *Progress in Human Geography* 24, 347-364.
- Benz, A., Fuerst, D., 2003. Region – Regional Governance – Regionalentwicklung. In: Adamaschek, B., Proehl, M. (Eds.), *Regionen erfolgreich steuern*, Guetersloh, 11-66.
- Berkhout, F., Hertin, J., Gann, D.M., 2006. Learning to adapt: organizational adaptation to climate change impacts. *Climatic Change* 78, 135-156.
- Christopherson, S., Michie, J., Tyler, M., 2010. Regional resilience: theoretical and empirical perspectives. *Cambridge Journal of Regions, Economy and Society* 3, 3-10.
- Cutter, S.L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., Webb, J., 2008. Community and regional resilience: perspectives from hazards and emergency management. In: CARRI Research Report 1. Retrieved 11 February 2012 from [http://www.resilientus.org/library/FINAL\\_CUTTER\\_9-25-08\\_1223482309.pdf](http://www.resilientus.org/library/FINAL_CUTTER_9-25-08_1223482309.pdf).
- Commission of the European Communities, 2009. Whitepaper on adaptation to climate: Adapting to climate change: Towards a European framework for action. Retrieved 11 February 2012 from <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0147:FIN:EN:PDF>.
- European Council Directive, 2008. On the identification and designation of European critical infrastructures and the assessment of the need to improve their protection. Retrieved 29 February 2012 from <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:345:0075:0082:EN:PDF>
- Fichter, K., Stecher, T., 2011. Resilienz als Ziel. In: Pfriem, R., Karczmarzyk, A. (Eds.), *Klimaanpassungsstrategien von Unternehmen*, Marburg, 87-98.
- Frankhauser, S., Smith, J.B., Tol, R.S.J., 1999. Weathering climate change; some simple rules to guide adaptation decisions. *Ecological Economics* 30, 67-78.
- Genschel, P., Zangel, B., 2007. Die Zerfaserung von Staatlichkeit und die Zentralitaet des Staates. *Aus Politik und Zeitgeschichte* 20-21, 10-16.
- German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2008. *Combating Climate Change, German Adaptation Strategy*, Berlin. Retrieved 29 February 2012 from [http://www.bmu.de/files/english/pdf/application/pdf/broschuere\\_dem\\_klimawandel\\_begegnen\\_en.pdf](http://www.bmu.de/files/english/pdf/application/pdf/broschuere_dem_klimawandel_begegnen_en.pdf).
- German Federal Ministry of Interiors, 2009. *Nationale Strategie zum Schutz Kritischer Infrastrukturen, KRITIS-Strategie*. Retrieved 11 February 2012 from <http://www.bmi.bund.de/SharedDocs/Downloads/DE/Themen/Sicherheit/SicherheitAllgemein/kritis.html>.
- Günther, E., 2009. *Klimawandel und Resiliencemanagement*, Wiesbaden.
- Hill, E.W., Wial, H., Wolman, H., 2008. Exploring regional economic resilience. Working paper 2008-04, Macarthur Foundation Research Network on Building Resilient Regions Institute for Urban and Regional Development, Berkely.
- Lewis, T.G., 2006. *Infrastructure Protection in Homeland Security. Defending a network nation*, New Jersey.

- Luhmann, N., 1994. Die Gesellschaft und ihre Organisation. In: Derlien, H.U., Gerhard, U., Scharpf, F. (Eds.), *Systemrationalität und Partialinteresse*, Baden-Baden, 189-201.
- Luhmann, N., 1999. Oeffentliche Meinung und Demokratie. In: Maresch, R., Werber, N. (Eds.), *Kommunikation-Medien-Macht*, Frankfurt, 19-34.
- Luhmann, N., 2000. *Organisation und Entscheidung*, Opladen.
- National Emergency Management Committee (NEMC), 2009. National Strategy for Disaster Resilience (COAG). Retrieved 11 February 2012 [http://www.coag.gov.au/coag\\_meeting\\_outcomes/2011-02-13/docs/national\\_strategy\\_disaster\\_resilience.pdf](http://www.coag.gov.au/coag_meeting_outcomes/2011-02-13/docs/national_strategy_disaster_resilience.pdf)
- Porter, M., van der Linde, C., 1995. Towards a new conception of the environment-competiveness relationship. *The Journal of Economic Perspectives* 9, 97-118.
- Ramlogan, R. and Metcalfe, J. S., 2006. Restless capitalism: a complexity perspective on modern capitalist economies. In: Garnsey, E., McGlade, J. (Eds.), *Complexity and Co-Evolution: Continuity and Change in Socio-Economic Systems*, 115–146.
- Rogers, E.M., 1962. *Diffusion of innovations*, New York.
- Schneidewind, U., 1998. *Die Unternehmung als strukturpolitischer Akteur*, Marburg.
- Schuppert, F.G. (Eds.), 2009. Von der Ko-Produktion von Staatlichkeit zur Co-Governance von Governance. Eine Skizze zu kooperativen Governance-Strukturen von den Condottieri der italienischen Renaissance bis hin zu Public Private Partnerships. In: Botzem, S., Hofmann, J. Quack, S., Schuppert, G.F. Straßheim, H. (Eds.), *Governance als Prozess. Schriften zu Governanceforschung* 16, 285-320.
- Sheffi, Y., 2005. *The resilient enterprise*, Cambridge.
- Simmie, J., Martin, R., 2009. The economic resilience of regions: towards an evolutionary approach. *Cambridge Journal of Regions, Economy and Society*, 1-17.
- Smit, B., Wandel, J., 2006. Adaptation, adaptive capacity and vulnerability. *Global Environmental Change* 16, 282-292.
- Stecher, T., Fichter, K., 2010. Anpassung an den Klimawandel als betriebswirtschaftliche Herausforderung: eine Journalauswertung. *Umweltwirtschaftsforum* 18, 53-60.
- Stern, N. (2006): *The economics of climate change*. The Stern review, Cambridge.
- Tagarev, T., Pavlov, N., 2007. Planning Measures and Capabilities for Protection of Critical Infrastructures. *Information and Security* 22, 38-48.
- Termeer, C., Dewulf, A., Van Rijswick, H., Van Buuren, A., Huitema, D., Meijerink, S., Rayner, T., Wiering, M., 2011. The regional governance of climate adaptation: A framework for developing legitimate, effective, and resilient governance arrangements. *Climate Law* 2, 159-179.
- Van der Lei, T.E., Bekebrede, G., Nikoloc, I., 2010. Critical infrastructures: a review from a complex adaptive systems perspective. *Journal of critical infrastructure* 4, 380-401.

Winn, M. Kirchgeorg, M., Griffiths, A., Linnenluecke, M.K., Günther, E., 2010. Impacts from climate change on business organizations: a conceptual foundation. *Business strategy and the environment*.

World Economic Forum, 2011. Global Risks 2011. Retrieved 10 February 2012 from [http://riskreport.weforum.org/#data-explorer-landscape/?re\\_layout=0&re\\_IDs=](http://riskreport.weforum.org/#data-explorer-landscape/?re_layout=0&re_IDs=).

Zuercher, C., 2007. When governance meets troubled states. In: Beinsheim, M., Schuppert, G.F. (Eds.), *Staatszerfall und Governance*, Baden-Baden, 11-27.