Resilience and Social Learning

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Abstract:

Resilience has been an often used term within the climate change debate recently. However, it is accused of being structurally conservative. A social learning perspective could respond to such criticism, since the inclusion of a learning perspective would allow for a more dynamic notion. There are already elements of knowledge and learning within existing approaches. Hence, the first purpose of this paper is, to provide an overview of previous research on the role of learning in resilience and adaptation, which is highly related to resilience. It shows that the interconnections are not fully explored yet. Likewise, within network theories, the discussion about learning's role for advancing sustainability has just been sparked off and possible linkages to resilience approaches are examined. Hence, in a second step a sketch of a social learning concept related to resilience of socio-ecological systems called resilience learning is presented. Resilience learning develops a novel approach towards conceptualising the role of learning in resilience by using the double-loop learning concept within the environmental sphere, since the values and beliefs human actions are based on have to be challenged. The central question whether and how resilience can be acquired through learning takes the centre of this approach.

1. Introduction

The term resilience has gained great prominence within the climate change debate, but only since recently, knowledge and learning are being discussed as influencing factors for resilience.[1] [2] [3] Furthermore, there is little understanding about linkages of these concepts. Therefore, the paper aims to detect and present elements of social learning within existing research approaches. While there are some remarkable leadoff contributions[4] [5], approaches investigating the connection of learning processes and adaptiveness are still rare and in an early stage of development. Furthermore, it is yet barely understood how adaptation related knowledge is created.

The paper develops a novel approach towards conceptualising resilience learning that draws on both dimensions, adaptation and social learning. It uses the double-loop learning concept within the environmental sphere, since the values and beliefs human actions are based on have to be challenged. The predominant questions this paper focuses on are:

- What elements of social learning have been used in resilience concepts so far?
- What are the processes and dynamics of resilience learning and how to promote these?

2. Resilience, Adaptation and Learning

Learning and social learning have been conceptualised and defined differently in various contexts and disciplines. Here, we apply a working definition, which conceptualises learning as processes of change in behaviour on the level of individual or collective actors or even in a society that is based on newly acquired knowledge, a change in predominant value structures, or of social norms which results in practically sizeable outcomes.

The resilience concept

Resilience is a widespread term in the recent climate change debate. However, there is no unanimous point of view about this approach's meaning and operationalisation. There are several related concepts (vulnerability, adaptation) based on a variety of even more interrelated terms, so that there is an impenetrable net of countless, barely distinguishable terms that are, in turn, objects to scientific debates as well.[6] Resilience has its roots in ecosystem theory as a counter-concept to the then prevalent perception of stable, single

[1] Folke et al. 2005.
[2] Adger et al. 2005.
[3] Biermann et al. 2009.
[4] Pelling and High 2005.
[5] Hertin et al. 2005.
[6] e.g. a dispute about the relation of sensitivity, exposure and vulnerability within the socio-ecological tradition.

equilibrium ecological systems. Thus, the central goal is to focus on the maintenance of ecosystems and their functions. In this view, resilience has been defined as the ability of a system to withstand stress and still provide pivotal services.

The extend of stress a system can undergo and still stay in the same domain of attraction (also stability domain) is called coping range/ vulnerability threshold/ band of tolerance/ damage threshold, whereas all of these terms have slightly different connotations.[7] Shifting stability domains can be faced with three different strategies a) wait and see b) try to get the system back into the desired stability domain c) adapt to the new system.[8] External pressure also offers opportunities for innovation.[9] However, resilience concepts focus on hazardous developments while fading out chances.

The concept of socio-ecological systems

The concept was then transferred to socio-ecological systems (SES). SES are based on the idea that socio-economic and ecological systems interconnected and mutually dependent.[10] However, in contrast to ecological systems, social systems are purposeful and can be designed to a certain extend. Due to the inseparability complexity rises significantly. Furthermore, ecological resilience develops a technocratic view on the analysed systems. This is assigned to social systems as well.

Box 1: Important Definitions

Engineering resilience (Primm)
How fast a variable that has been displaced from equilibrium returns to it.
Pimm 1991, 13.

Ecological resilience (Holling)
Resilience determines the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist.
Holling 1973, 17.

Socio-ecological resilience (Nelson, Brown & Adger.)
The amount of change a system can undergo and still retain the same function and structure while maintaining options to develop.
Nelson, Brown & Adger 2007, 396

Disturbances
Resilience demanding units of system external variable are called “doses”, “stresses”, “disturbances”, “events”, “hazards”, and “perturbations.”
Smit et al. 1999, 205.

Adaptation
Adjustments in ecological-social-economic systems in response to actual or expected climate stimuli, their effects or impacts.
Smit et al. 2000, 225

[7] Smit et al.1999.
[8] Gunderson 2000.
[9] Folke 2006.
[10] Adger 2006.

Despite initial opposition, the assumption of a world of constant change became widely accepted at least within ecological resilience science.[11] The diversity of approaches is not always perceived as being a defect.[12] However, this constrains a higher efficiency in the political area because policy actors who are dependent on concise information are rather confused by this disorder than being assisted.[13] Another important aspect of scientific theories that try to have an influence on „real life politics" is the question of applicability. Therefore, it has to be operationalisable. How to measure resilience is controversial as well, e.g. when does a system lose its functional capability?

The pivotal position of knowledge has been reflected in SES-approaches since recently. Folke et al. highlight the importance of groups and linked institutions that accumulate knowledge, which can diminish the effects of external stimuli on resilience. This knowledge is fed by the experience of changes and crises. Even if a crisis is only perceived and has not occurred (yet), knowledge may evolve. Hence, knowledge is pivotal and needs to be generated processed and diffused. It is thus rather a process than a static phenomenon. This dynamic component of knowledge is often referred to as learning.[14] [15] [16] However, the concept of learning in SES is weak in terms of operationalisation.[17] Building on the findings of ecological memory Adger et al. use the term social memory, attributing importance for resilience to it. It is build up by past disturbance and (governance-) mistakes. Successful adaptation then requires mobilization of social memory.[18] Yet, this would mean knowledge cannot be generated without or before disturbances appear.

According to Nelson, Brown and Adger[19] and likewise Folke[20] the capacity of learning is a subcategory of resilience. Yet they emphasise the translation of present knowledge to actions and therefore cannot address the question of how new knowledge is created and spread.

Summing up, a resilient system must be able to learn. However, we argue that a general learning capacity might be insufficient, since this concept is too static to fully capture the dynamic process of learning and change.

[11] Folke 2006.
[12] Gallopín 2006.
[13] O'Brien et al. 2004.
[14] Folke et al. 2005.
[15] Walker et al. 2006.
[16] Folke et al. 2005.
[17] Folke 2006.
[18] Folke et al. 2005.
[19] Nelson, Adger & Brown 2007.
[20] Folke 2006.

Adaptation

Adaptations are specific measures in response to external actual or projected disturbances. Resilience is a system property that enables the system to adapt to a wide range of stressors. Hence, resilience is much more complex.

There have been other attempts to connect (social) learning to questions of climate change. Several approaches draw on inherent knowledge mobilisation. Lately the importance of place-based knowledge for building resilience has been stressed. Local strategies to deal with environmental challenges sometimes are fed from over hundreds of years of experience. Yet this ignores the fact that climate changes might bring up new kinds or at least new magnitudes of old threats. Hence, this knowledge might support adaptation strategies or might even be starting point to develop such, but it cannot be a sole solution. Novel responses will often be needed.[21] In some cases they can even be a hindrance to adaptation (see chapter 3.1).

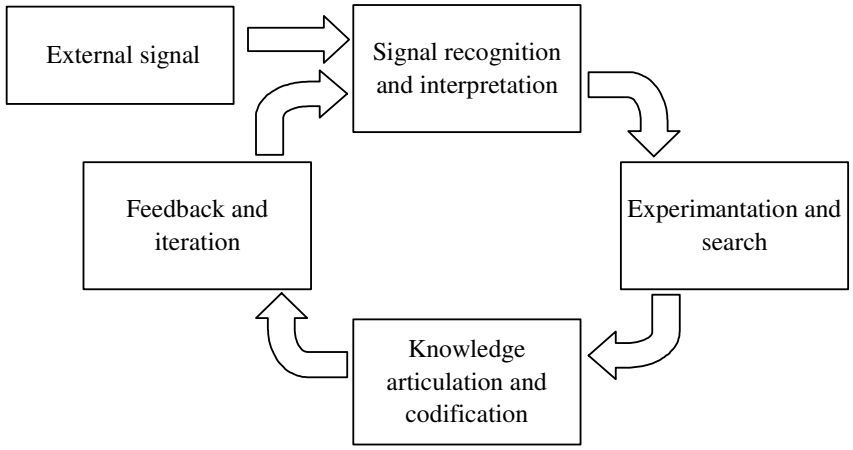
An interesting approach is presented by Pelling and High who choose social capital as initial point for their concept of social learning theories and adaptation. It consists of norms and values, interpersonal relationships and formalized self-organisation. Informal (shadow) networks influence the behaviour of individuals and therefore can be used for accelerating learning processes. However, it should be refrained from attempts to formalise networks, since this might destroy their original structure and hence result in a total loss of influence. Informal structures on the other hand lack reliability, are hard to recognise, and complicate and protract network creation. Within this concept Pelling and High connect different learning theories. Organisational learning takes the centre stage, but individual learning theories are considered as well. Collective and individual learning are not identical, nevertheless they are two sides of a coin, because adaptation requires learning on different hierarchy-levels. Furthermore, adaptation itself is seen as a learning process. This approach is rather pessimistic in terms of governing these processes.

Berkhout, Hertin and Gann developed a behaviourist view on climate change adaptation and organisational learning. They argue that these processes have much in common, e.g. adaptation requires changes of organisational routines, which are the means by which organisations carry out their activities. This process is understood as the implementation of "suitable and legitimate" procedures than a rational choice between alternatives. It occurs when organisations face new situations for which adequate schemes do not yet exist, existing ones prove unsuccessful or new ones promise to be more successful. There are two types of

[21] Gunderson 2000.

organisational capabilities and two types of environment. With the help of operational capabilities, organisations conduct their routine activities. Dynamic capabilities qualify organisations to change operational activities. Environments can either be stable or unstable. Within stable environments, especially operational capabilities to improve existing procedures and therefore efficiency are necessary; dynamic capabilities are less important and even costly to maintain. Within unstable environments dynamic capabilities are essential to discover new routines. However, it is difficult to detect new routines or the failure of established ones, since evidence might be scarce, its relevance might be uncertain or decision makers might be blind to it. Basically, there are two different ways of gaining information towards adaptation: trial and error and search. Alternative options are evaluated and subsequently selected modified routines have to be codified, so that the behaviour within the organisation can change. This codification process is particularly expensive. The effects of modified routines are evaluated and therefore create feedbacks as well.[22]

Figure 1 Scheme of a learning cycle



Berkhout, Hertin & Gann 2006, 140, adapted from Zollo, M. and Winter, S. G.: 2002, 'Deliberate learning and the evolution of dynamic capabilities', Organization Science 13 (3), 345.

Whether an external signal launches learning processes depends on the organisation's subjective sensitivity to (climate) change. Signals can either be direct (e.g. damage) or indirect (scientific assessments). Berkhout, Hertin and Gann detected four modes of adaptation: commercial adaptation, technological adaptation, financial adaptation, and informational and monitoring. Furthermore, they identified four strategies of organisations:

- Wait and see
- Risk assessment and options appraisal

[22] Berkhout, Hertin & Gann 2006.

- Bearing and managing risks
- Sharing and shifting risks

The choice depends on the dynamic capabilities, organisational culture, the core competencies and core business (and the degree to which it is affected). Interestingly, they found that most of the adaptation strategies they investigated rather build on knowledge already available to the organisation than on the exploration of new options. The lack of determination towards adaptation to climate change might result from the unclear signal. Direct signals are still rare or hard to assign to climate change; indirect signals from scientific assessments are often indefinite and fuzzy. Furthermore, learning cycles are faster than climate change dynamics. Hence, the latter might be overlooked.[23] This concept may help to understand adaptation processes following external stimuli. A stimulus does not need to be direct. Hence, preventive measures might be explained as a reaction to projected climate change (indirect stimuli). Still, these concepts focus on the enhancement of adaptation, not on resilience. Hence, the next chapter will continue in the latter direction.

3. From Social Learning to Resilience Learning and Adaptation Learning

3.1. Learning and Knowledge

The objective of this paper is the integration of resilience, adaptation and learning theories. In doing so, the fragmentation of these concepts is both: opportunity and risk. An integrated approach will always evoke objections from different directions, since some aspects of either theory have to be unconsidered. On the contrary, it is possible to combine the most promising aspects of both. The central question therefore is whether and how resilience can be acquired through learning.

Learning and knowledge

Learning according to our initial definition goes beyond the accumulation of knowledge, even though the latter is a basic requirement. Nevertheless, the acquired knowledge shall be applied to the actions of the actor. Thus, it does not need to result in positive effects.

For some time, academics and experts see knowledge apart from the scientific world. Thereby, *lay knowledge* takes the centre of attention. It describes practical knowledge gained through experiences. However, lay knowledge might have negative impacts, since it can lead to deadlocks. Residents of river basins, who never experienced or heard of floods affecting their houses might declare new protection measures as nonsense and refuse to cooperate.

[23] Berkhout, Hertin & Gann 2006.

Even experience does not need to result in learning. Fatalism and wishful thinking can be a psychological coping strategy as well.[24]

Local knowledge can be divided in traditional knowledge that was handed down from previous generations, empirical knowledge, which is acquired through observations and revealed knowledge, which is of spiritual origin.[25] Nevertheless, academic and expert knowledge is still important. Additionally, Argrawal argues that the separation of scientific and non-scientific knowledge is not helpful.[26]

Another distinction of knowledge differentiates explicit and tacit (implicit) knowledge. They dissent in the area of codification: the former is codified, the latter is non-codified and even non-codifiable, disembodied expertise that is acquired via the informal take-up of learned behaviour and procedures.[27] Tacit knowledge describes "invisible cognitive repertoires that underlie competent behaviour"[28] Something we know, but cannot tell and therefore cannot be easily transferred to others. It is controversial whether consciousness has access to this knowledge at all. [29] [30] In addition, it is sometimes difficult to draw the line between implicit and explicit knowledge. Furthermore, implicit learning should not be overrated. It is a supplement to conscious learning, but it cannot replace it as the form of learning with the biggest impacts. To be good medicine, it is not sufficient to study facts from books, but it is a precondition.[31] Furthermore, empirical evidence has shown that people can also learn even if they are not up to. However, they at least need to try solving tasks to implicitly learn. Therefore, it is a learning-by-doing process, which is unselective in nature. Furthermore, there needs to be the will to do so especially in inter-actor relations[32]

Social learning

Within different conceptual approaches social learning has various meanings depending on the discipline using the term. Social psychologists have been examining learning for a long time. Though they have found different definitions, they generally point out changes in behaviour and changes in the capacity to behave in a certain way. Psychological and pedagogic theories focus on individual learning[33], e.g. social learning is often referred to

[24] Grothmann, 2005.
[25] Castellano, 2000.
[26] Agrawal 1995.
[27] Howells 1996.
[28] Neuweg 2004.
[29] Reber 1993.
[30] O'Brian Melone 2000.
[31] Neuweg 2004.
[32] Howells 1996.
[33] Siebenhüner & Müller 2003.

learning of individuals within a group. Other theories, e.g. organisational learning, apply individual learning theories to collective entities. Thereby, collective learning is more than the sum of the individual contributions, since there are dynamics that go beyond the scope of individual learning.[34] Notwithstanding, individuals are still important in learning processes since they can play an important role by influencing a group's behaviour.[35] In this paper, we apply the collective learning view.

Organisational learning theories argue that within organisations learning is a competence and knowledge a resource.[36] A change of the latter is a prerequisite for learning and change of behaviour.[37] Thereby learning is neither impartial nor does it automatically lead to improvement,[38] even though this might be the goal.[39] Redundancy and variety might be sacrificed for specialisation on alleged resilient products or behaviour. However, negative effects of learning have been hardly examined yet.[40] Still this has to be discussed later in this article. In addition, learning cannot be equated with change, since it can be used in a preservative way as well. Furthermore, there is no best way of learning, different kinds and levels can be appropriate.[41]

3.2. Key questions of Resilience Learning

Is increased resilience desirable?

The term resilience is normatively uncommitted. Deserts can be classified as resilient, since their basic functions can hardly be changed due to climate change. System transformation might be a better solution than keeping the current state. Thus, resilience learning aims at *desirable states.* This is a strictly normative category and will therefore cause discussions. In the case of a desert, there might be agreement on not to increase resilience and even decrease it to transform it, since the current state might be assessed undesirable. Nevertheless, there surely are much more controversial cases. Different actors might be driven by different motives. Due to economic reasons Russia is not interested in keeping the methane storage function of the permafrost soil in Siberia, since transformation offers a new function: agricultural use. In this case resilience learning is impossible, since it is not desired by a pivotal actor. If resilience learning is desired (by crucial actors), the current state must be

[34] Siebenhüner 2005.
[35] Arnold & Siebenhüner 2006.
[36] Berthoin Antal 2001.
[37] Siebenhüner & Müller 2003.
[38] Berthoin Antal 1998.
[39] Siebenhüner 2008.
[40] Berthoin Antal 2001.
[41] Berthoin Antal 1998.

valued higher than the expected transformation the system would undergo if resilience was too little. Hence, resilience learning requires a basic agreement of a SESs basic functions and the desirability to keep them. Resilience learning is thereto normative and hence interpretive dominance matters as well this leads to the problem of power and legitimacy. Nevertheless, resilience learning only makes sense, when resilience itself is desired.

Still, it has to be clarified what increased resilience means. What are the indicators? It is difficult to measure a system's resilience to all (climate change related) stimuli at the same time. Furthermore, there are predictable and non-predictable disturbances. A resilient system needs to persist in both cases. Hence, it is necessary to take a look at the system's properties like redundancy, variety, buffers, back-loops, instead of eying disturbances. However, such an approach might be useful though still complicated for technical systems like electricity grids. SES on the contrary are of even larger complexity that seems to elude from such an approach. Therefore, it could be useful to take a look at specific disturbances and investigate issue-specific resilience. This paper aims at resilience towards climate stimuli. Several authors have developed concepts on the identification of resilience issues.[42]

Who are the actors?

Different actors are affected by resilience learning: private organisations, governmental institutions, networks of different scale and scope. Nevertheless, which ones are important for social learning? Who is able to detect problems and who has the authority to set them on the agenda? Who accelerates and who decelerates the process of learning? Are there change agents? However, the state as one of the most influential players should not be forgotten.

This paper applies a systemic view and therefore uses a layered structure. Learning can occur on different levels. Accordingly, it is useful to use a multilevel approach of systems and subsystems to dissolve the web of interaction and interdependence. First, it has to be clarified how a system is defined. A system is a useful cutout of the real world and their division in objects and (inter)relations of these objects. Thereby the observer determines the level of abstraction. It is characterised by emergent properties, i.e. properties that can be identified as belonging to the entity by an observer. Systems furthermore have layered structures, i.e. they have sub- or hyperentities that can be identified as system as well. In addition, lasting systems need to have processes of communication and control, either automatically or set up by human beings. Systemic thinking, at least in the last 30 years thereby does not claim that

[42] Resilience Alliance 2007.

systems cannot be contemplated in a mechanical way and therefore cannot be engineered and with that achieve goals.[43]

Systems, whether socio-economic, ecological or socio-ecological are constantly changing. Consequently, there have been attempts to control their development, especially in the field of social systems. Within the first generation social system design approaches, design was developed by experts and then imposed on the system, which generated serious problems of acceptance. The second generation acknowledged the importance of stakeholder integration. However, the design development was still led by experts. The third generation pleas for a designing process that has to take place within the system and therefore has to be led by the all or at least by all relevant stakeholders.[44]

Another interesting point seems to be the role of governmental policy makers. Governmental organisations can contribute to creating structures by emphasizing education and research. Policy makers can influence learning process through intervention by providing general infrastructure in order to support learning processes. [45] The coordination of networks needs a host, which does not necessarily need to be but can be a governmental actor. Within regional governance theories it can serve as animator, identifying strengths and weaknesses of the regions actors and pay special attention to skills formation.[46] Furthermore, this concept is concerned with tacit knowledge since this explains why and how regions can remain successful in worldwide competition.

One basic problem that has not been solved so far is how to detect system borders without being arbitrarily? However, although system thinking represents an attempt towards holistic understanding instead of partial research, a line has to be drawn somewhere due to practical constraints. SES are the basic systems in this context. This concept connects socio-economic and ecological systems. This holistic view is both a blessing and a curse. On the one hand, it acknowledges the interconnections and overcomes the artificial schism. On the contrary, on the analytical level it causes difficulties, since it is hardly tangible. Resilience on SES level can only be approximated through indicators. Resilience deals with maintaining basic system functions. However, while some basic ecosystem functions might be allocable, socio-ecological functions have to be identified by stakeholders. System services are functions of a system that are useful for its environment, whereas useful is strictly normative. In general, it describes resources that are usable for outsiders. Some actors might stress their importance

[43] Checkland 1999.
[44] Banathy 2006.
[45] OECD 2001.
[46] Morgan 1997.

for a system's resilience, since they hope for a strategic advantage. Powerful actors might be more successful in such a process. However, collective problem solution can create benefits for all. Beyond, governance processes always raise questions of legitimacy.[47] Does everybody who is affected have access to the decision making process? How are actors legitimised?

A general rule for setting borders is impossible. In many cases this will be done using political borders, since they are fundamental for the socio-economic factors. However, it has frequently be shown that political borders are not in line with ecosystem borders, e.g. in the case of river basins. [48]

Furthermore, resilience learning might make a system more resilient than before though it is not resilient in general. In addition, there is not only one resilience for a system and all subsystems. System level resilience is no accumulation of subsystem resilience since resilience on the subsystem level might mean something very different from resilience on the system level. Learning processes might make a company more resilient but if all firms of sector develop within the same direction there might be a decrease in diversity and redundancy. Resilience augmentation in one subsystem can lead to a decline in resilience in another subsystem. Subsystems might be organisations, individuals, sectors, etc. These might be further itemised to a smaller subsystem. Thereby these systems overlap. The organisation has divisions and subdivisions, which may consist of working groups, which consist of individuals. The latter are in fact parts of other systems as well. Within SES we focus on collective actors.

How is knowledge transferred to action?

The existence of knowledge is not sufficient if it is not transferred into action. In the political area knowledge is transformed to strategies via discourses. It is therefore important who dominates this process. One strategy to prevail a discourse is to use windows of opportunity (opportunity for advocates to push their pet solutions or to push attention to their special problems[49]).[50]

Why resilience learning?

Learning is a basic ability to endure climate change challenges. Nonetheless, it is a difficult task in a complex dynamic world. Resilience can be a guiding principle reducing or at least structuring complexity. It provides an idea of a desirable and feasible future.

[47] OECD 2001.
[48] Grecksch 2007.
[49] Kingdon 1984.
[50] Lange & Garrelts 2007.

3.3. Resilience Learning and Adaptation Learning

Agyris and Schön discern two types of learning: single-loop and double-loop learning. Single-loop learning occurs when expected outcomes do not match with reality. Actions are modified through inclusion of new knowledge but values remain unaffected. By contrast, in double-loop learning processes, values and basic assumptions for behaviour and routines are being challenged and possibly changed. Besides the simple feedback loop between expectations and outcome, a second loop occurs that links outcomes, beliefs, norms and objectives. If organisations influence their learning processes themselves, this is called deutero learning.[51] The concept of single- and double-loop learning was criticised for emphasising problem detection and correction and excluding generating new ideas.[52] However, double-loop processes provide space for new concepts, since changed norms and values might bring new perspectives. Siebenhüner came to the same conclusion, when he applied this learning concept to international organisations in global environmental governance. In this study, double-loop learning is conceptualised as inducing fundamental changes in organisational structures and practices, while single-loop learning brings the organisation in line with the demands of external stakeholders and creates only minor changes inside the organisation itself.[53]

Learning is a reaction to problems, whether they are real or just perceived. If this is the same for social learning what are the dynamics within a SES? Concerning climate change we might not know exactly the type and magnitude of future disturbances, but scientists know that there will be disturbances. Nevertheless, it is important that other relevant actors are aware of this problem as well. Furthermore, for double-loop learning they have to be convinced that it cannot be solved with the help of old tools and paradigms.

Learning mechanisms to acquire and create new knowledge are needed for both, single- and double-loop learning, since they enable the actor to recognise problems and find solutions. External knowledge seems to be better suited to trigger learning on both levels. However, double-loop processes require the incorporation of external and internal knowledge. By contrast, single-loop learning can be triggered by external pressure. Learning within organisations furthermore requires engagement of individuals, so called change agents. In addition, learning processes, once started, develop their own dynamics.[54]

[51] Agyris & Schön 1996.
[52] Berthoin Antal 2001.
[53] Siebenhüner 2008.
[54] Ibid.

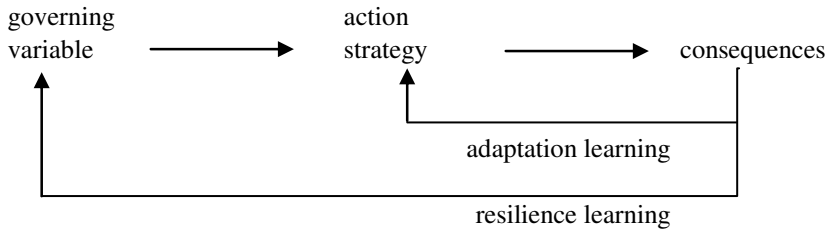
Box 2: Adaptive Learning and Resilience Learning

Adaptation Learning
The process in which actions are modified due to actual or perceived climate change related threats through inclusion of new knowledge without modification of norms and values

Resilience Learning
The processes of change on the level of individual or collective actors or even in a society that is based on newly acquired knowledge, a change in predominant value structures, or of social norms, with the objective of improvements in the field of resilience and adaptation, which results in practically sizeable outcomes

This concept can also be applied to adaptation learning and resilience learning. Building on this concept to describe resilience learning, the latter has to be reflexive, since structures able to deal with uncertainty need to be developed. Comparing outcome and expectations would not accomplish such a goal.

Figure 2: Relation of Adaptive Learning and Resilience Learning



Derived from Agyris & Schön 1999.

The pivotal question in this context is, whether organisational learning theories are applicable to social learning, which, among others, includes public institutions. The authors of a study conducted by IISD and TERI, who also investigated the connection of social learning and adaptation, veto, since public institutions are structured less flexibly. There often are organisational and geographical distances between decision makers and executive units.[55] Beyond that, several authors argue that the analysis of networks and governmental organisations questions some of the basic principles of organisational learning. LaPalombara points out the difficulty of changing means to achieve a goal. Change the goal itself, he adds, is almost impossible.[56] Furthermore, private organisations focus on efficiency and utility in the first place. Governmental organisations on the contrary have to consider normative factors, which are results of negotiation processes as well. Thus, efficient and rational policies are not necessarily politically feasible. LaPalombara finally detects differences between public and private organisations in four categories: a) purposes and goals, b) accountability,

[55] Swanson et al. 2006.
[56] LaPalombara 2001b.

c) autonomy) d) orientation to action, and e) environment.[57] Besides all these differences several studies argue that the basic activity of learning remains the same.[58] [59] [60] We therefore argue that the concept of adaptation and resilience learning is applicable.

3.4. Determinants of Resilience Learning

Resilience learning a form of aimed learning that could enable actors to make decisions in complex and dynamic systems in a way basic functions can be maintained. In this section, we will try to address the question what makes actors learn. First, we state that resilience learning aims at:

- Better understanding of interactions between socio-economic and ecological systems, as well as the development of integrated view
- Better understanding of the possible climate change long term consequences and better handling of those
- Linking different areas of knowledge from different branches of science but also from different actors
- Enhancement of capacity to solve or to reduce environmental problems

We argue that these goals can be achieved through the following determinants. They will be based on a literature review[61] and internal discussions. Therefore, empirical data cannot be provided yet. Hence, we understand this as setting up hypothesis. Furthermore, many of the following determinants overlap and cannot be separated as easily as a list indicates.

<u>Providing Variety</u>

Variety includes two dimensions, *diversity* and *redundancy.* Whereas diversity aims at having different things[62], redundancy means keeping more than one of the same thing. Electricity grids for example, need to be designed in a way that breakdowns of some electrical towers can be offset (redundancy) However, electricity might not only be provided through electricity grids but also through local electrical generators or photovoltaic modules combined with batteries that are able to – at least for a short time – counterbalance the grid failure (diversity)

[57] LaPalombara 2001a.
[58] Huber 1991.
[59] Siebenhüner 2008
[60] Bauer, Busch & Siebenhüner 2007.
[61] Thereby the work of Gupta et al. 2008 has been particularly useful.
[62] Gupta et al 2008.

Embracing Complexity

Knowledge does not automatically lead to better results, in this case a more resilient system. Even when resilience learning takes place it is not ensured that the result will be increased resilience. Failed learning processes in the area of resilience have not been in focus yet; nevertheless, negative effects of learning in general have been discussed before. Declining resilience might be a result of resilience learning if information is false, missed or misinterpreted. If farmers cultivate new crops that need higher temperatures due to the expected increase in average temperature, but fade out weather extremes, resilience might even decrease if the new crops are even more susceptible to the latter. Therefore, a holistic understanding of resilience processes as well as performance review is needed. Learners need to be aware of the problems learning faces in complex and dynamic systems. [63]

- Learning is based on feedback. Complex systems complicate learning because of lacking, delayed and blurry feedback. Hence, it is difficult to detect behaviour, which is worth to be repeated[64]
- Incoming Information depends on the perception of the system. Systems interrelations have to be identified and interpreted[65]
- A vast amount of Information need to be filtered, relevant information has to be selected
- Even relevant and useful information cannot ensure correct interpretation
- Defensive routines hinder learning
- Implementation might fail

Memory

To learn from experiences access to past processes and insights has to be provided. Additionally, these documents have to be studied.[66]

Dealing with Uncertainty

The way complex systems will develop is uncertain. Not only the ecological development, but also technological developments are unforeseeable.[67] This can lead to downplay or ignorance of the problem itself. It is not that there has not been uncertainty before. Business companies' environment has always changed. However, climate change adds a new

[63] Sterman 1994.
[64] Schwab and Miner 2008
[65] Norberg and Anderies 2008
[66] Gupta et al 2008.
[67] Walker et al 2002.

dimension and therefore demands for an even greater effort. Therefore, it is important to know about and deal with uncertainty. Even if actors are aware of uncertainty, they might not address to it, because of missing resources/overstraining, unwillingness/lethargy ore fatalism. Indicators for facing and dealing with uncertainty are scenario building and the development of diverse strategies. Therefore, diversity and uncertainty are closely linked.

Access to Information

To create projections and scenarios, it is important to have access to information of climate change and adaptation necessities must be available (if known at all).[68]

Acknowledgement of Climate Change/ Will

While big companies claim to believe in climate change and therefore in the necessity to adapt to it, it should not be taken for granted that small business all share this view. Even if so, they might feel too small and weak to adapt and hence not act at all.

Change Agents

While the determinants addressed collective actors so far, individuals are still of importance for learning processes. They can spread new views and ideas within companies and therefore increase the pace.[69] They are change agents either because of their professional expertise (e.g. developers) or because of their hierarchical position (management).

Networks

Social learning also has been addressed to within network literature. Prell et al. (2008) define social learning as process of social change resulting from interaction within social networks.[70] Network theorists have emphasized the role of different relations between actors. If actors are connected via strong ties, there is an intensive communication and trust. However, there is a lack of diversity of thinking. Weak ties on the contrary are bridging many diverse actors; there is flow of new information. Nevertheless, there is a lack of trust and connections are easy to destroy.[71] [72] Learning requires flow of information; therefore, weak ties seem to be better suited. Contrarily lack of trust itself may undermine flow of important information. Probably a mixture of both could be the best solution. Since SESs include many stakeholders that need to be included, strong ties appear to be unlikely. Newig, Günther and Pahl-Wostl

[68] Gupta et al 2008.
[69] Arnold & Siebenhüner 2006.
[70] Prell et al. 2009.
[71] Ibid.
[72] Granovetter, 1973.

argue for modular networks consisting of "several cohesive subgroups with strong ties and several weak tie relations within the broader network."[73] [74]

Trust

Trust is an important feature of networks. It enhances the amount of information transferred between the networkers. Nevertheless, trust is mostly to be found between actors already sharing the same visions. To enhance communication between actors with different views and therefore enhance diversity trust within society is a precondition. [75]

Long Term Orientation/ Incentives

Conflicting rationalities are often by different temporal perspectives. Short-term considerations may lead to decisions that would not have been taken under long term planning.[76] Besides politicians, particularly private companies face this problem. Benchmarks need to be fulfilled to satisfy shareholders.

Furthermore, there can be conflicts of scale. Variety and redundancy can increase resilience. However, they can conflict with economic constraints. Redundancy can clash with the economic imperative of efficiency. Decision makers might focus on short-term aims even if they understand the need of long-term strategies. However, this might not be rewarded. Performance-related wages for managers and discounting rates as basis for investors' decision-making can shift foci on short-term goals.

Interdisciplinarity

Since SES are by definition subject to social and natural scientists of different branches, the need for interdisciplinarity is self-evident. Therefore interdisciplinary attempts to face climate change related threats promise higher success since they consider more aspects than sticking to one discipline. This does not indicate futility of disciplinary research. However, interdisciplinary approaches can enrich the debate, since disciplinary research tends to take conditions out of its research foci as given[77]

[73] Newig, Günther & Pahl-Wostl 2009, 12.
[74] Other important characteristics are size, homophily, multiplexity, centralisation density and cohesion. We will not discuss them although they are important as well. However, this is a diverse and would require a disquisition on its own, Newig, Günther & Pahl-Wostl 2009.
[75] Gupta et al 2008.
[76] Lange & Garrelts 2007
[77] Norberg and Anderies 2008.

Ability to Unlearn

Since learning can prove "old" knowledge to be wrong, the latter needs to be unlearned, i.e. organisations need to forget old beliefs and techniques to avoid perfecting obsolete skills.[78] [79]. The dictum of efficiency for instance might prevent measures increasing redundancy and partly needs to be unlearned or at least reinterpreted.[80] Old knowledge restrains the scope of new insights. Thus, it creates path dependency and system idleness. Unlearning can confine these effects.

4. Conclusion

In this paper, we gave a short overview about the role of learning within resilience and adaptation concepts. Besides some remarkable leadoff contributions and an increasing interest in learning within resilience debates in general, we noticed that some question have not been fully addressed yet. How can collective actors learn to be more resilient, i.e. what needs to be provided to do so? Hence, we shaped a sketch of a resilience learning concept and named its determinants, based on the idea to develop a useful approach to conceptualise problems of climate change effects on SES. Resilience learning requires a change of the actor's guiding norms and values with the objective of improvements in the field of resilience and adaptation that is discernable in its behaviour.

Still there are unsolved problems. Learning processes have their own dynamics and are therefore hardly controllable.[81] Furthermore, it suffers from the weaknesses the resilience term itself has to face. Similarly, to sustainability there is no overall understanding and usage of it. In contrast to sustainability, it is not common beyond academic debates. Furthermore, even a unitary definition of resilience might be difficult to grasp for non-academics. Hence a lively debate might be difficult. As shown in this paper, communication between different societal groups is crucial for successful climate adaptation. However, the yet limited prominence might even be advantageous, since sustainability discussion would have a greater path dependency. For more than 20 years it is part of public discussions and was also used as marketing tool and therefore might have lost some of its credibility.

Therefore, we believe resilience learning to be a promising concept for guided learning. Since the concept is in its early stages, it is a desktop study yet. In a next step, it will be tested empirically.

[78] Berthoin Antal 2001.
[79] OECD 2001.
[80] Butzin 2000.
[81] OECD 2001.

Literature

Adger, W.N., 2006. Vulnerability. Journal of Global Environmental Change 16 (3), 268–281.

Adger, W.N., Hughes, T.P., Folke, C., Carpenter, S.R., Rockström, J., 2005. Socio-ecological resilience to coastal disasters. Science 209 (5737), 1036-1039.

Agrawal, A, 1995. Indigenous and scientific knowledge: some critical comments. IK Monitor 3(3) http://www-personal.umich.edu/~arunagra/papers/IK%20Monitor%203(3)%20Agrawal.pdf

Argyris, C., Schön, D., 1996. Organizational learning II: Theory, method and practice, Addison Wesley, Reading (MA).

Arnold, M., Siebenhüner, B., 2006. Organisationales Lernen für Klimaschutz und Nachhaltigkeit. In: Ibid et al., Gesellschaftliches Lernen und Nachhaltigkeit. Metropolis-Verlag, Marburg, S. 149-180.

Banathy, B.H., 2006. Designing social systems in a changing world. Plenum Press, New York.

Bauer, S., Busch, O., Siebenhüner, B., 2007. Administering international governance: what role for treaty secretariats? Global Governance Working Paper No 29.

Berkhout, F., Hertin, J., Gann, D.M., 2006. Learning to adapt: Organisational adaptation to climate change impacts. Climatic Change, 78, 135-156.

Berthoin Antal, A., 1998. Die Dynamik der Theoriebildungsprozesse zum Organisationslernen. In: Albach, H. Dierkes, M., Berthoin Antal, A.,Vaillant, K. (eds.), Organisationslernen: Institutionelle und kulturelle Dimensionen. edition sigma, Berlin, 31-54.

Berthoin Antal, A., Dierkes, M, Child, J, Nonaka, I., 2001. Organizational learning and knowledge: reflections on the dynamics of the field and challenges for the future. In: Ibid, Handbook of organizational learning and knowledge, Oxford University Press, Oxford 2001, S. 921-939.

Bierly III, P.E., Kessler, E.H., Christensen, E.W., 2000. Organizational learning, knowledge and wisdom. Journal of Organizational Change Management 13 (6), 595-618.

Butzin, B., 2000. Kreative Milieus und Lernende Region: Perspektiven für die regionale Entwicklungsplanung? Zeitschrift für Wirtschaftsgeographie 44 (3/4), 149-166.

Castellano, M.B., 2000. Updating aboriginal traditions of knowledge. Hall, B.L., Sefa Dei, G.J, Rosenberg, D.G., Indigenous knowledges in global contexts. University of Toronto Press, Toronto, 21-36.

Checkland P.B., 1999. Systems thinking. In Currie, W. and Galliens, R. (eds.), Rethinking management information systems, Oxford University Press, Oxford, 45-56.

Folke, C., 2006. Resilience: the emergence of a perspective for socialecological systems analyses. Journal of Global Environmental Change 16 (3), 253-267.

Folke, C., Hahn, T., Olsson, P., Norberg, J., 2005. Adaptive governance of social–ecological systems. Annual Review of Environment and Resources 30, 441-473.

Gallopín, G.C., 2006. Linkages between vulnerability, resilience, and adaptive capacity. Journal of Global Environmental Change 16 (3), 293–303.

Granovetter, M., 1973. The Strength of Weak Ties. American Journal of Sociology, 78 (6), 1360-1380.

Grecksch, K., 2007. Die Implementierung der EU-Wasserrahmenrichtlinie in Deutschland und Großbritannien. Eine Multi-level Governance Analyse (unpublished).

Grothmann, T, 2005. Klimawandel ,Wetterextreme und private Schadensprävention. Entwicklung, Überprüfung und praktische Anwendbarkeit (Dissertation). Universitätsbibliothek Magdeburg, Magdeburg.

Gunderson, L.H., 2000. Resilience in theory and application. Annual Review of Ecology and Systematics 31, 425-439.

Gupta, J., Termeer, K., Klostermann, J., Meijerink, S., van den Brink, M., Jong, P., Nooteboom, S., 2008. Institutions for climate change: a method to assess the inherent characteristics of institutions to enable the adaptive capacity of society. Institute for Environmental Studies, Vrije Universiteit, Amsterdam.

Howells, J, 1996.Tacit knowledge.Technology analysis & strategic management 8(2), 91-106.

Huber, G., 1991. Organizational learning: the contributing processes and the literatures. Organization Science, 2: 88-115.

Jansen, D., Wald, A., 2007. Netzwerktheorien. In: Benz, et al (eds.), Handbuch Governance. Theoretische Grundlagen und empirische Anwendungsfelder. Wiesbaden, Springer, 190-199.

Jackson, M.C., 2003. Systems thinking: Creative holism for managers. Sussex, John Wiley&Sons.

Kenis, P., Schneider, V., 1991. Policy networks and policy analysis: scrutinizing a new analytical toolbox. In: Marin, B. Mayntz, R. (eds.), Policy networks. Empirical evidence and theoretical considerations. Campus, Frankfurt a.M., 25-59.

Kingdon, J. W., 1984. Agendas, alternatives, and public policies. Boston, Little, Brown and Co.

Lange, H, Garrelts, H., 2007. Risk management at the science-policy interface: two contrasting cases in the field of flood protection in Germany. Journal of Environmental Policy & Planning, 9 (3) 263-279.

LaPalombara, J., 2001a. Power and politics in organizations: public and private sector comparisons. In: Dierkes, M., Berthoin Antal, A., Child, J., Nonaka, I. (eds.), Handbook of organizational learning and knowledge. Oxford, UK: Oxford University Press, 557-581.

LaPalombara, J., 2001b. The underestimated contributions of political science to organizational learning. In: Dierkes, M., Berthoin Antal, A., Child, J., Nonaka, I. (eds.), Handbook of organizational learning and knowledge. Oxford, UK: Oxford University Press, 137-161.

Morgan, K. 1997 The learning region: Institutions, innovation and regional renewal. Regional studies 31, 491-503.

Nelson, D., Adger, W. N. Brown, K., 2007. Adaptation to environmental change: contributions of a resilience framework. Annual Review of Environment and Resources 32, 395-419.

Neuweg, G.H., 2004. Tacit knowing and implicit learning. In: Fischer, M., Boreham, N., Nyhan, B. (eds.), European perspectives on learning at work: The acquisition of work process knowledge. Luxembourg, Office for Official Publication for the European Communities, 130-147.

Newig, J., Günther, D., Pahl-Wostl, C., 2009. Neurons in the network: learning in governance networks in the context of environmental management, Paper prepared for presentation at the 7th International Conference on the Human Dimensions of Global Environmental Change, Bonn, 26-30 April 2009.

Norberg, J., Anderies, J. M., 2008. Theoretical challenges. Informational processing and navigation in social-ecological systems. In: Norberg, J., Grumming, C.S. (eds.): Complexity theory for a sustainable future. Columbia University Press, New York, 155-79.

O'Brian Melone, A., 2000. Implicit learning. In: Coffield, F., The necessity of informal learning. Policy Press, Bristol, 37-55.

O'Brien, K.L., Eriksen, S., Schjolden, A., Lygaard, L., 2004. What's in a word? Interpretations of vulnerability in climate change research. CICERO Working Paper 2004:04, Oslo.

Organisation for Economic Co-operation and Development 2001, Cities and regions in the new learning economy: education and skills. OECD, Paris.

Pelling, M,. High, C. 2005. Social learning and adaptation to climate change. Disaster studies working paper No. 11, Benfield Hazard Research Centre, UCL, London.

Prell, C., Hubacek, K., Reed, M., 2009. Stakeholder analysis and social network analysis in natural resource management. Society and natural resources 22, 501-518.

Resilience Alliance, 2007. Assessing and managing resilience in social-ecological systems: a scientists workbook. Volume 1, version 1.0., http://www.resalliance.org/3871.php

Schwab, A. and Miner, A. S., 2008. Learning in Hybrid-Project Systems. The Effects of Project Performance on Repeated Collaboration. Academy of Management Journal, 51 (6), 1117-49.

Siebenhüner, B., Müller, M., 2003. Mit Umweltpolitik zu nachhaltigen Lernprozessen. In: Zeitschrift für Umweltpolitik und Umweltrecht 26 (3), S. 309-332.

Siebenhüner, B., 2005. The role of social learning on the road to sustainability. In: Rosenau, J. R., Weizsäcker, E.U. v., Petschow, U. (eds.): Governance and sustainability. Greenleaf, Sheffield, 86-99.

Siebenhüner, B., 2008. Learning in international organisations in global environmental governance. In: Global Environmental Politics, 8(4) 92-116.

Smit, Barry, Buton, Ian, Klein, Richard J. T., 2000. An anatomy of adaptation to climate change and variability. Climate Change 45, 223-251.

Sterman, J. D., 1994. Learning In and About Complex Systems. System Dynamics Review, 10 (2-3), 291-330.

Swanson, D., Venema, H.D., Barg, S., Tyler, S., Drexhage, J., Bhandari, P., Kelkar, U., 2006, Initial conceptual framework and literature review for understanding adaptive policies. In: ISDD/ TERI (eds.), Designing policies in a world of uncertainty, change, and surprise adaptive policy-making for agriculture and water resources in the face of climate change. ISDD/ TERI, Winnipeg/ Manitoba.

Walker, B., Carpenter, S., Anderies, J., Abel, N., Cumming, G., Janssen, M., Lebel, L., Norberg, J., Peterson, G.D., Pritchard, R., 2002. Resilience management in social-ecological systems: a working hypothesis for a participatory approach. Conservation Ecology 6(1), 14, http://www.consecol.org/vol6/iss1/art14

Walker, B. H., L. H. Gunderson, A. P. Kinzig, C. Folke, S. R. Carpenter, and L. Schultz. 2006. A handful of heuristics and some propositions for understanding resilience in social-ecological systems. Ecology and Society 11(1), 13, http://www.ecologyandsociety.org/vol11/iss1/art13/