Strategic Environmental Assessment: an Instrument to Implement the Adaptation of Regional Land Use to Global Climate Change with the Aim to Mitigate Environmental and Social Impacts?

Hendrike Helbron

Scientific research assistant and lecturer at the Department of Environmental Planning, Faculty of Environmental Sciences and Process Engineering, Brandenburg University of Technology (BTU) Cottbus, Erich-Weinert-Str. 1, 03046 Cottbus, Germany, Tel 0355/69-2352, Fax 0355/69-2765, helbron@tu-cottbus.de (corresponding author)

Abstract

The paper deals with the methodological application of strategic environmental assessment (SEA) in German regional land use planning (SEA-REP) with emphasis on quantitative indicators and assessment thresholds for impact assessment and the comparison of alternatives. A future key role of regional planning in cooperation with sector planning such as agriculture and forestry under climate change is determined. It is investigated, how SEA-REP as decision-aiding instrument can contribute to an adaptation of the regions to climate change with the objective to mitigate negative impacts on the environment and societies by creating a framework for systematic implementation of quantitative indicators and assessment values. A core problem during the selection of indicators for land uses for the adaptation to climate change (*here:* called LUCCA) as part of SEA-REP and the derivation of assessment thresholds is a lack of region-wide objectives for the protection of land and resources. At the same time climate change is so far not sufficient considered in regional land use planning. It is investigated how regional planning could integrate site-specific designations and objectives for an adaptation to impacts caused by climate change. The proposed SEA-REP indicator system integrates mitigation and adaptation measures for environmental and social impacts of climate change, which are evaluated by indicators and assessment thresholds for LUCCA. These involve designations of specific land uses and priority areas for climate protection and human recreation, ecological wildlife networks, flooded sites, areas affected by sea level rise, areas for water storage and carbon storage as-well-as alternative land cultivation. The overall objective of the research focuses on a proposal of regional environmental and social orientation objectives, indicators and the derivation of assessment thresholds for an adaptation of German regional land uses to climate change.

1. Introduction

The Directive 2002/42/EC of the European Parliament and of the Council on the assessment of the effects of certain plans and programmes on the environment (SEA Directive), which was implemented into the German EIA Act, Spatial Planning Code and Federal Spatial Planning Acts, obligates competent authorities to accomplish a systematic assessment of all significant environmental impacts of a regional land use plan (Art. 3 para. 2 SEA Directive). Scientific and practical guidance is required

for the reasonable application of assessment methods and threshold values. This paper presents an example for a German application of strategic environmental assessment in regional land use planning (*here:* SEA-REP), with emphasis on the assessment method and indicator system, which integrate global climate protection targets. Based on practical experience from an INTERREG project on SEA for regional planning (TransSEA) (Stratmann et al., 2006; 2007), it was further analysed, if and how SEA-REP can contribute to the implementation of adaptation targets of climate change in regional land use, with the aim to mitigate environmental and social impacts.

A comprehensive regional spatial plan includes objectives for all land uses of a specific region. The German regional planning level offers with 1: 200 000 m an adequate scale for the designation of site-specific zones for the protection of natural resources under consideration of sustainability objectives and environmental precaution. Global climate policy has been one of the 'poor cousins' of protection of the land and natural resources against land consumption and physical degradation: 'climate' has been mainly considered as one of the natural resources in landscape planning with focus on the preservation of local bioclimatically important areas, fresh air corridors and cold air generation sites of valuable function for human health in urban settlements and recreational sites. The implementation of international Kyoto Protocol and national climate protection targets for mitigation and adaptation to a changing global climate deserve more transparent attention in regional planning (COM (2005) 35 final, p. 7; BMU 2005, 41).

2. Strategic Environmental Assessment in Regional Land use Planning

The core step of impact prediction and assessment in the SEA-REP process can be divided into a site-*specific assessment* and an *overall assessment* of the entire regional plan with all its contents and objectives (ARL, 2003, p. 141; Jacoby, 2005, p.28). The site-specific assessment method was derived from the *ecological risk analysis,* leading to a baseline-led and indicator-based approach. The application of indicator systems in SEA-REP allows the integration and implementation of global climate protection targets through the selection of state of environment indicators and assessment thresholds. As decision-aiding instrument, SEA has the objective to identify, describe and assess significant impacts – including cumulative impacts in interaction with effects of climate change. It also shall make the analysis of alternatives and the mitigation of negative impacts on the environment and societies transparent.

The SEA team and competent authority specified the scope of the assessment, i.e. which REP contents are i) to be assessed on specific sites, ii) to be assessed in the overall assessment and iii) not subject to SEA. It was determined that those designations and contents of the regional land use plan require a site-specific SEA, which are directly linked to the area and set the framework for EIA projects, listed in Annexes I or II of the EIA Directive 85/337/EEC, or which require an assessment pursuant to Article 6 or 7 of the Habitats and Wild Birds Directive (SEA Directive Art. 3 para 2 a, b). Regional plan contents, not within the competency of the regional planning authority, were passed on to SEA

for other spatial or sector plans or programmes (tiering). The main REP contents and their designation criteria causing significant impacts with their implementation at lower levels are:

- urban settlements;
- industrial and commercial sites;
- routes for transport infrastructure;
- areas for the exploitation of near-surface non renewable resources;
- areas for wind energy production;
- sites for recreation on formerly used mining areas;
- sites for the extension of forests (i.e. afforestation sites);
- technical flood control measures.

Box 1 Impact factors for strategic environmental assessment in regional land use planning (from Helbron and Schmidt, 2007)

Of regional relevance on the individually affected site:

Land consumption*	**LC**	**Soil abstraction or soil sealing**
Land use change#	**LU**	**Change of function of the area without soil removal or sealing; e.g. afforestation, recreation**
Fragmentation/Barriers	FB	Separation of functions, effects on accessibility of areas

Additionally of regional and transborder relevance on impact zone:

Change of groundwater level	GW	Groundwater level increase or decrease
Directed flooding	F	Anthropogenic caused flooding of areas
Noise	N	Potential exceedance of noise standards or general increase of noise level
Pollution	P	Potential exceedance of pollution standards or increase of pollution risk
Visual Impacts	VI	Impacts on landscape character (change of pecularity, variety and natural charcteristics)
Positive Impacts	PI	Impacts that contribute to an improvement of the state of environment and achievement of environmental objectives in the region

* The impact factor land consumption includes all impacts, which lead to an irreversible destruction or removal of the soil such as soil sealing and soil degradation/excavation.
\# The impact factor land use change defines an alteration of the utilization and/or vegetation of the area without accompanying irreversible soil loss such as afforestation on formerly used arable land.

Impact factors (see Box 1) provide a systematic identification and assessment of all significant impacts of the above REP contents on the environment. The focus in this paper lies on land consumption and land use change (in bold). *Impact indicators* combine the impact factors with the assessed importance of the affected environmental components (e.g. land consumption on an agricultural area in ha with special, general or inferior importance of the productivity of the soil).

2.1 Environmental Targets for Adaptation to Global Climate Change

Environmental targets are necessary in SEA-REP in order to determine assessment thresholds to classify the conflict intensity on the affected area. They were compiled from the Saxon Federal land use development plan (SMI 2003), landscape framework plan and in form of legal or political-programmatic targets. These environmental quality objectives and environmental quality standards

were categorized according to their i) spatial relevance and applicability, ii) potential for an operationalisation at the regional scale and iii) level of legal obligation (UBA, 1995). Legally-binding standards are considered as *restrictions* of any negative harm or exceedance of limit values on the affected area or impact zone. Restrictions of land consumption are legal exclusion zones, where adverse effects are prohibited by law such as nature reserves, drinking water abstraction or recreation areas.

Adaptation is defined by IPCC (2007) as the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. The earlier in the planning hierarchy environmental conflicts with climate change are mitigated the better in the environmental, social and economic sense, as prevention saves money, effort and time and reduces the risks of hazards and technical failure. Adaptation is defined by EEA (2004, p. 79) as early and preventive preparation of the society for consequences of inevitable climate change. Adaptation and mitigation measures shall "*prevent, reduce and as fully as possible offset any significant adverse effects on [climate change] of implementing the plan*" (SEA Directive, Annex I, g). In contrast, mitigation is the attempt to avoid or lessen climatic change (e.g. reduction of greenhouse gas emissions). Mitigation measures will not stop the human induced climate change.

Progressive land consumption and physical degradation of the natural resources in Europe contradict targets for adaptation to climate change. Land consumption is a progressive environmental impact in Germany, which leads to loss and degradation of all natural resources. So far no real reversal of this trend is expected. The German objective for a reduction of soil sealing to 30 hectares per year by 2020 on the basis of the newly consumed area in 1990 (GFG 2002) so far has not been consequently implemented at regional level. The German Enquête Commission proposed in 1998 the action objective, to achieve by 2010 a reduction of the conversion rate of undeveloped areas into settlement and transport areas by 10 % of the rate of the years 1993 to 1995. BUND and MISEREOR (1996) recommended a zero growth by 2010.

A current deficiency of precise regional objectives for the protection of the land and natural resources against consumption and the adaptation of regional land use to climate change demands strategies for a focused and target-oriented process of dealing with effects of climate change and involving the society in decisions of regional area management with long-term consequences on the quality of living. The health and well-being of regional societies will depend among other factors on high quality drinking water, agricultural food supply and recreational areas.

2.2 Indicators and Assessment Thresholds

With the aim to integrate climate protection targets into SEA-REP environmental state indicators (*here called:* LUCCA = land uses for the adaptation to climate change) were identified, which can measure the environmental conflict intensity of regional plan designations with the objective of an adaptation of regional land use to climate change. They can also be applied in the *overall assessment* of the regional plan with focus on cumulative impacts and in measuring the distance-to-target to climate

protection targets. For the latter purpose the potential of the REP designations ‘afforestation sites’ was estimated.

The core module in SEA-REP can be an indicator system, which is used to predict and assess impacts of the regional plan designations on the identified environmental components and LUCCA. LUCCA state indicators have to be further defined under consideration of results of assessment of the vulnerability and adaptive capacity of land uses in a region. During the implementation of adaptation strategies to global climate change in regional planning, the SEA-REP indicator system should be permanently revised and developed. It thus should stay flexible and open to alterations, which will be induced by future experiences and increasing knowledge of sectoral experts on spatially-relevant effects of climate change.

Environmental indicators are necessary for the assessment of the environmental state and of predictable changes of the environment (Wiggering and Müller, 2004). These can be understood as „*central and representative parameters for the characterisation of complex issue*s“, which otherwise would be difficult to present (Jänicke and Zieschank, 2004, p. 48; UBA, 2006). In TransSEA twenty nine selected environmental state indicators represent the environmental state related to the individual environmental components and assess this state on the basis of legally-binding environmental objectives and standards and assessment thresholds. From these LUCCA indicators were derived, (Table 1), which focus on physical degradation and land consumption and are linked to Climate Protection Policy of mitigation of greenhouse gas release or the adaptation to effects of climate change. The quality of the natural resources and protection against pollution will stay of equal importance in the future, but was not considered in this research. LUCCA has the purpose to integrate global climate concerns into SEA-REP and make the consideration of these concerns transparent for all stakeholders, particularly the private sector and the public. The political dialogue on priority setting of measures in the region shall be strengthened and the awareness of a long-term process and urgent need for activities shall be further raised. A first guidance for the targeted adaptation of land use and the competencies of the regional planning authority is made available.

Table 1 Environmental indicators of land uses to be adapated to climate change (LUCCA)

Indicators for Land Uses of Importance for the Protection of Human Health and Air
LUCCA 1 – Densely populated urban areas
LUCCA 2 – Bioclimatic Areas with Relevance for Urban Settlements
LUCCA 3 – Land Uses with Potential for Tranquil Recreation in Fresh Air
LUCCA 4 – Coastal Areas Below Sea Water Level
Indicators for Land Uses of Importance for the Protection of the Structure and Function of Ecosystems
LUCCA 5 – Land Uses with Potential as Refugia or Corridor of the Ecological Wildlife Network
LUCCA 6 – Woodlands and Forests
LUCCA 7 – Not Forested Land Uses with Potential for Water and Carbon Storage
Indicators for Land Uses of Importance for the Protection of the Natural Resources Soil and Water
LUCCA 8 – Unsealed Soils
LUCCA 9 – Soils for High Quality Agricultural Food Production
LUCCA 10 – Soils to be Protected against Erosion
LUCCA 11 – Freshwater Resources with Long-Term Potential for Water Storage and Supply
LUCCA 12 – Land Uses with Potential for Retention and Absorbtion of Precipitation and Inundation Water

With the help of the environmental indicator system the potential environmental impacts of individual site developments are estimated and assessed in relation to the environmental importance of the respective affected area and conflict with environmental targets including global climate protection targets. The conflict with a legal restriction or exceedance of a set assessment threshold is classified in three ordinal classes of conflict intensity, which are quantified in hectares or squaremetres for the affected area: *1a. High conflict with restriction, 1b. High conflict without restriction, 2. Medium conflict 3. Low conflict,* determined by the importance of the environmental component on the affected site and impact zone and cross-linked with relevant impact factors. The classification of the conflict intensity on alternative sites assists in their comparison under additional consideration of positive impacts and verbal-argumentative reasons for final decisions. The medium rank is necessary in order to steer developments of a high conflict towards environmentally more resistant locations and/or away from sensitive areas. The final result should be designated sites with the least possible negative effect on the environment and the best compromise between conflicting objectives of land use (Helbron and Schmidt, 2008). The conflict intensity can be compared for individual environmental components, and can be summarized for each natural resource for a specific designated site.

Beside the site-specific analysis "*a key challenge is to ensure, that SEA remains strategic"(*Thérivel and Wood 2005, p.362). In the overall assessment of the regional plan *strategic options*, *designation criteria* and *structural alternatives* (Schmidt et al. 2004; Jacoby 2000) should be assessed on the basis of criteria such as minimum area sizes, minimum distances, existent infrastructure, concentration or restriction of certain types of regional plan designations in different natural areas. The aim is an evaluation of designation criteria, a comparison of the REP objectives with the status-quo prognosis and a balance of negative and positive impacts with the implementation of the plan in the entire region (Stratmann et al. 2006). Special attention requires the assessment of (transboundary) cumulative and synergistic effects, including future effects of global climate change. They indicate a negative tendency of degradation or positive tendency of remediation in a region and show the level of optimization of the regional plan and if mitigation and adaptation measures are put in place.

2.3 Adaptation Measures of Regional Land Use Planning

Predicted social-ecological effects of global climate change on the regional land use and natural resources such as periods of high temperature and temporary drinking water scarcity or heavy precipitation events demand strictly set priorities for mitigation measures already at the higher planning level with early warning function for the implementation of site-specific projects. Adaptation measures of regional land use planning mainly concentrate on designations of zones, with specific objectives for sustainable area management, creating a spatially-relevant decision-support framework for lower planning tiers. The implementation of the adaptation of spatial planning systems and land use to effects of climate change is a long-term process, which generally cannot be achieved in one decade. Adaptation of regional land use potentially contributes to the prevention or reduction of severe damage to the environment, society and economies, and ensures sustainable regional development under changing climate conditions. A regional spatial plan should regulate and implement *adaptation*

measures such as flexible options, which can integrate further measures and strategies in the future and 'no-regret' or 'low-regret' adaptation options, which deliver net benefits, "*whatever the extent of climate change"* (CCW et al. 2004, 6). Adaptive capacity is defined by the Intergovernmental Panel on Climate Change (IPPC, 2007) as the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences. Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity. Adaptation involves a reduction of the vulnerability of land uses and an increase of their resilience to the effects of climate change (COM (2005) 35 final, p. 7).

Land consumption is one of the problems to be tackled as soon as possible, in order to preserve a certain level of adaptative capacity of the natural resources in a region. It irreversibly damages productive soils and poses threats to the water resources in a region. Moreover are long-term and cumulative impacts of the degradation of the landscape still insufficiently addressed in regional planning, due to difficulties in the choice of methods and lack of data and knowledge. Regional planning should provide the adaptation measure of 'planning for land use change' (CCW et al., 2004) for the environmental prevention of foreseen risks of the environment and human health. Planning for land use change in the context of global climate change requires a more target oriented regional framework with priority areas for adaptation to climate change with high potentials for mitigation of adverse effects of climate change. Current relevant German REP contents are for instance afforestation sites, flood generation areas or remediation areas for surface water, groundwater, soil or nature and landscape. A strategic assessment of the potential of such REP contents to enhance the adaptive capacity in a region was carried out for each LUCCA 1-12, the example of afforestation sites is presented below.

2.4 Strategic Assessment of the Mitigation Potential of Afforestation Sites

The REP designation of afforestation sites is part of the entire forested area in the region, which is measured with the state indicator of 'LUCCA 6 woodlands and forests'. General regional environmental orientation objectives for forested land use to be operationalised are:

- Strict prohibition of deforestation of native woodlands: achievement of a positive ratio (≥ 1) of afforested area divided through deforested area taking the level of naturalness and compensation of the lost area at another place into consideration;
- Preservation of the permanent vegetation cover and long rotation periods in forests and woodlands for prevention of soil erosion, flooding and negative balance of the carbon and water storage capacity;
- Increase of the area share to be wooded, in conformity with the natural and geographic context of the region (e.g. by > 10 % by the year 2020);
- Incrase of the area share of native (broad-leaf) woodland at the forested area, in conformity with the natural and geographic context of the region (e.g. by > 20 % by the year 2050);

Woodlands and forests are of importance for water storage and mitigation of carbon release. Effects of climate change will likely make periods of high temperature and temporary drinking water scarcity or heavy precipitation events more frequent and signficant. Table 2 shows the estimated moderate potential of afforestation sites for mitigation of carbon release and enhancement of the adaptive capacity, which will have to be specified by regional forestry experts. Afforestation is a long-term development that requires decades to be beneficial, trees alter over at least 60 years until they can function as carbon and water storage pools, a positive balance of carbon relsease and carbon sink may require ages of over 500 years. The potential of afforestation as carbon sink also depends on the geographic context abiotic conditions on the site (WBGU 2003). The classification will have to be amended according to regional assessments on the importance and future potentialof different types of woodland and forests for carbon and water capture and storage by foresters.

Table 2 Estimated potential of the regional plan content of afforestation sites for mitigation of carbon release and enhancement of the adaptive capacity of a region

Mitigation Potential	**Type of Woodland or Forest**
(5) High	<u>International and national importance for carbon and water capture and storage:</u> • Native woodlands over 80 years old ≥ 5 ha • Semi-natural woodlands with a rotation period of over 60 years • Tree specie composition of the native woodland plant society or close to this (≤ 20 % of the composition are tree species, which are not adapted to the natural habitat) • Tree specie composition of 50-80 % of tree species of the native woodland plant society. • Natural woodland society, extensively or low intensively used; rare to common biotope type; hardly or no possibility of remediation • Tree specie composition of 50-80% of pioneering and/or secondary tree species of the native woodland society;
(3) Moderate	<u>Regional importance and future potential for carbon and water capture and storage:</u> • **Afforestation sites, which need over 60 years to establish long rotation periods** • Tree specie composition of 10-50 % of tree species of the native woodland society (primary and secondary tree species); • Mixed forests with 30-70 % share of broad-leaf respectively coniferous tree species; • Transitional woodland shrubs • Species including neophytes, which are adapted to climate change • Forests far from nature, more or less intensively used; common to very common biotope types; limited to good possibility of remediation, dependent on age of the trees; • Management intensity of forests overlaps natural site conditions; forest at the borderline of best practice forestry. • Tree specie composition consists of < 10 % of primary and secondary tree species of the native woodland society
(1) Low	<u>No regional importance or future potential for carbon and water capture and storage:</u> • Highly damaged coniferous monocultures • Forests characterised by vegetation-free areas and occurrence of plant species of eutrophic sites. • Forests far from nature; intensively used; very common biotope types; limited possibility of remediation, dependent on age of trees; • Forested land uses, which are not part of the scope of investigation, are not accessible or their development is unclear.

In SEA-REP regional-specific designation criteria for afforestation sites are assessed, which often include the avoidance of highly productive agricultural soils and a priority on extensions of existent forested areas and slopes of arable land, which are threatened by water or wind erosion. Additionally

abiotic conditions and *qualitative requirements* from forestry for the development of the afforestation sites should be integrated into the regional plan designation. In order to achieve the regional environmental orientation objectives, afforestation sites should develop into native broad-leaf woodlands with permanent vegetation cover and long rotation periods in conformity with the natural and geographic context of the region. Priority forested areas with the objective to develop their potential for mitigation of effects of climate change and adaptation should be evaluated on the basis of their soon achieved *future potential* to function as recreational areas, fresh air generation areas, value for biodiversity and contribution to biomass production. The regional plan should integrate priority areas linked to requirements from the forestry sector guidance framework for lower tiers on the use of tree species of the potential natural habitats, which can best adapt to climate change, on future rotation periods longer than 60 years and on best practice criteria of sustainable forest management. The evaluation of the potential of new afforestation sites is based on the assumption that forests can act as carbon sinks and on time point of planning and a future potential for carbon an dwater storage, which has to be assessed and monitored by regional forestry experts. However, if global temperatures further rise and wooded ecosystems cannot adapt anymore but break down, they could within decades release the CO_2 into the atmosphere they stored before (EEA 2005).

3. Conclusion and Recommendations

With the German Federalism Reform (2006), national framework legislation is abandoned in favour of a strengthening of the legislation of the Federal states through a clearer determination of their legislative powers. Spatial planning now belongs to the concurrent legislation of the state and the federal states according to Arts. 47 and 72 para. 3 No. 4 of the Constitution. The Federal states can release Land Use Planning Acts, which diverge from the national Spatial Planning Act. However, regional planning in closely linked to sector planning and accompanied by informal communication and cooperation instruments has the advantage of setting a framework for sustainable area management at a high planning level. The prevention of harm of the environment and human population funded through target-oriented strategies for adaptation measures becomes more efficient with planning. SEA-REP is a well integrated formal instrument and process, which involves actors from the private sector and civil society into decision-making and the meeting of long-term social-ecological challenges. The major strength of the LUCCA indicator-based approach is its systematic consideration of the environmental climate targets against which potential impacts of REP designations can be questioned.

The idea of setting priorities of land uses at the higher planning level with the aim to prevent from harm of the environment at an early stage in the tiering system is not new, but requires more attention in order to mitigate the conflict intensity and significance of the regional area management in combination with negative effects of climate change. For this purpose SEA-REP can function as a trigger for the regional implementation of national climate protection targets and act as a decision-support instrument, which highlights the current and future potential of land uses and REP

designations. The LUCCA indicators highlight priority actions for adaptation. A consequence should be an amendmend of traditional regional plan contents in form of designations of 'priority areas with high potential for the adaptation to global climate change', which are linked to certain restricted land uses, objectives for remediation of degraded land and further future requirements of reducing the vulnerability and enhancing the adaptive capacity of the land use. A need in regional planning for an area management, which is linked to future land use potentials and the securing of the allocation of natural resources is recognized. Regional land use planning should aim at avoiding decisions that conflict with the management of climate risks in the future, so called '*adaptation constraining decisions',* such as deforestation, loss of high quality agricultural soils or inappropriate development in flood risk areas (CCW et al. 2004, p. 7).

It is concluded that SEA is an adequate instrument to implement the adaptation of regional land use to global climate change with the aim to mitigate environmental and social impacts, if:

- it is effectively implemented and a best practice SEA-REP process is in place;
- site alternatives and strategic options are handled well and with innovation;
- the adequate integration and regionalization of climate policy is made transparent to stakeholders and the public;
- LUCCA environmental indicators can be operationalised;
- Environmental data collection is iterative and tied in with the identification of regional environmental orientation objectives;
- flexible follow-up strategies and monitoring and evaluation concepts (particularly for tiering and the implementation at project level) are installed and
- the political willingness and acceptance for the soon implementation of adaptation strategies continuously improves.

Further the following major tasks have to be addressed in policy and plan making, in order to tackle current implementation deficiencies:

- set strict legally-binding limit values for land consumption for the regional territory;
- avoid or mitigate high conflicts with LUCCA;
- fund and implement strategies to achieve regional environmental orientation objectives within a set time horizon;
- regionalise and apply LUCCA indicators and integrate them into a monitoring plan;
- improve the dialogue of regional planners between landscape and other sector planners, regional stakeholders and the public in the context of an efficient implementation of adaptation measures at regional level;
- actively contribute to the transparency of regional decision-making, particularly in the fields of land consumption and its conflicts with adaptation strategies.

3.2 Future Outlook

The adaptation process requires a frame for the integration of future climate risks into political decision-making processes at regional level, which again calls for a challenging of traditional regional planning systems in Germany. The overall objective is the preservation of the current standard and quality of living of the regional societies. Therefore priorities will have to be newly fixed in the future concerning the protection of our natural resources. Regional planners will have to be responsible for a

stricer sustainable area management, where social-ecological concerns are to a less extent overweighted by economic development. A future key role will lie in the setting of stricter regional environmental orientation objectives in cooperation with sector planning and in line with environmental objectives for adaptation of regional land use and activities to climate change. An effective network with additional informal instruments of regional development will have to be established for this specific field of concern. The LUCCA indicators will have to be amended on the basis of increasing future knowledge on regional specific effects of climate change on natural resources, land use and society. Due to the high level of uncertainty of future changes and lack of data environmental monitoring and evaluation will gain importance. Finally, humankind might inevitably have to accept a higher area share dominated by 'natural' development and the abandonment of certain land uses of the past.

Acknowledgement

I am very grateful to Ms Bernadett Hoppe for her help and guidance in writing this article.

References

Ad-hoc-Arbeitskreis „Plan-UVP" der ARL. Zweites und abschließendes Positionspapier zur Umweltprüfung von Raumordnungsplänen. In: Eberle, D., Jacoby, C. (eds.) Umweltprüfung für Regionalpläne. Hannover, p. 138-144; 2003.

BMU – Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit. German National Climate Protection Programme from 13th July 2005. Internet: http://www.bmu.de/files/klimaschutz/downloads/application/pdf/klimaschutzprogramm_2005_lang.pdf, last access 02.11.2007; 2005.

BUND and MISEREOR (eds.) Zukunftsfähiges Deutschland - Ein Beitrag zu einer global nachhaltigen Entwicklung - Wuppertal Institut für Klima, Umwelt, Energie, Basel; 1996.

CCW – Countryside Council for Wales, Environment Agency, English Nature, Levett-Therivel Consultants et al. (eds.) Strategic Environmental Assessment and Climate Change: Guidance for Practitioners; May 2004.

Commission of the European Communities. COM (2005) 35 final from 9.2.2005. Winning the Battle Against Global Climate Change. Communication from the Commission to the Council, the European Parliament, the European Economic and Social Commitee and the Committee of the Regions. {SEC(2005) 180}, Brussels.

EEA – European Environment Agency. The European Environment – State and Outlook 2005. Copenhagen; 2005.

EIA Directive – Environmental Impact Assessment Act from 10 August 2000, amending the EIA Act, Federal Law Gazette 2000 No. I 89; 2000.

Enquête Commission. Final report 'Protection of human being and the environment'. Abschlußbericht der Enquete-Kommission "Schutz des Menschen und der Umwelt - Ziele und Rahmenbedingungen einer nachhaltig zukunftsverträglichen Entwicklung" des 13. Deutschen Bundestages: Konzept Nachhaltigkeit. Vom Leitbild zur Umsetzung (ed) Deutscher Bundestag, Referat Öffentlichkeitsarbeit; 1998.

German Federal Government. National Sustainability Strategy of the German Government 'Perspectives for Germany'; 2002.

Helbron H, Schmidt M. Indicator system as instrument for the prediction and assessment of the environmental state and environmental impacts of regional plans (in German). In: Stratmann et al. (eds.) Final report of INTERREG project on „Strategic environmental assessment for regional planning – development of a transnational assessment and practice concept for Saxony, Poland and Czech Republic"; 2007.

Helbron H, Schmidt M. Quantitative Threshold Values for Strategic Environmental Assessment. In: Schmidt M et al. (eds.) Standards and Thresholds for Impact Assessment, Berlin: Springer; 2008, p. 405-418.

IPCC (Intergovernmental Panel on Climate Change) (2007) Climate Change 2007 – Impacts, Adaptation and Vulnerability Cambridge University Press.

Jacoby C. Die Strategische Umweltprüfung (SUP) in der Raumplanung – Instrumente, Methoden und Rechtsgrundlagen für die Bewertung von Standortalternativen in der Stadt- und Regionalplanung. Berlin; 2000.

Jacoby C. SUP in der Raumordnung: Positionen und Praxishinweise von ARL und MKRO. In: UVP-Report 19 (1), 2005; p. 26-30

Jänicke M, Zieschank R. Zielbildung und Indikatoren der Umweltpolitik. In: Wiggering H, Müller F (eds.) Umweltziele und Indikatoren. Wissenschaftliche Anforderungen an ihre Festlegung und Fallbeispiele. Berlin; 2004, p. 39-62.

Schmidt, C., Gather, M., Knoll, C., Müntz, S., Wurzler, S., Blank, J. (2004): Die Strategische Umweltprüfung in der Regionalplanung am Beispiel Nordthüringens. Forschungsprojekt im Auftrag des Bundesministeriums für Bildung und Forschung. Fachhochschule Erfurt, Fachbereiche Landschaftsarchitektur und Verkehrs- und Transportwesen. Erfurt.

SEA Directive – Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programs on the environment, OJ L 197 of 21.07.2001, p. 30.

SMI – State Ministry of Interior of the Free State of Saxony. Saxon land use development plan (Landesentwicklungsplan Sachsen, LEP 2003), from Government resolved on 16.12.2003 and published on 31.12.2003 (GVBl. Nr.19/2003)

Stratmann L., Helbron H., Heiland S., Schmidt M. Prüfmethodik und Bewertungsmaßstäbe für die SUP in der Regionalplanung. UVP-report 20 (5): 229-235; 2006.

Stratmann, L., Bölitz, D., Helbron, H., Heiland, S., Reinke, M., Schmidt, M. (eds.) Strategic environmental assessment for regional planning – development of a transnational assessment and practice concept for Saxony, Poland and Czech Republic (in German). Final report of INTERREG project. Dresden. Internet: http://www.ioer.de/ioer_projekte/p_165.htm; 2007.

Thérivel R, Wood G. Tools for SEA. In: Schmidt, M, Joao, E and Albrecht, E (eds.) Implementing Strategic Environmental Assessment. Berlin: Springer; 2005. p. 349-362.

UBA – Umweltbundesamt. Definitionen wichtiger Begriffe und ihre Interpretation. Internet: http://www.umweltbundesamt.de/uba-info-daten/daten/umweltqualitaetsziele/definitionen.html, last access: 01.11.2006; 2006.

UBA (ed). Internationaler Vergleich von Verfahren zur Festlegung von Umweltstandards (International comparison of procedure for the setting of environmental standards, Erich Schmidt publisher, 259 p., UBA-reports 3/93, Berlin; 1993.

UBA. Glossary of space-oriented environmental planning. Internet address: http://www.umweltdaten.de/rup/glossar/deutsch.pdf, last access: 08.01.2008; 1995.

WBGU – Wissenschaftlicher beirat Bundesregierung Globale Umweltveränderung (eds.) Über Kioto hinaus denken – Klimaschutzstrategien für das 21. Jahrhundert; 2003.

Wiggering H, Müller F (eds) Umweltziele und Indikatoren: Wissenschaftliche Anforderungen an ihre Festlegung und Fallbeispiele. Berlin; 2004.