



Federal Ministry for the
Environment, Nature Conservation
and Nuclear Safety



United Nations
Educational, Scientific and
Cultural Organization

German Commission
for UNESCO

Para la vida, para el futuro

For life, for the future

Biosphere reserves and climate change

A collection of good practice case studies

Pour la vie, pour l'avenir

Für das Leben, für die Zukunft



Edited by the German Commission for UNESCO

For life, for the future. Biosphere reserves and climate change

A collection of good practice case studies

Publisher:

German Commission for UNESCO (DUK), Colmantstrasse 15, 53115 Bonn, Germany

With financial support from the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and the Federal Agency for Nature Conservation (BfN).

Chief Editor: Dr. Lutz Möller (DUK)

With support from: Benjamin Hanke, Laura Lubinski and Carolin Kollig (DUK)

Special thanks go to Kremi Nikolova and Dr Peter Dogsé from UNESCO, as well to Dr Miguel Clüsener-Godt, Dr Natarajan Ishwaran and Dr Thomas Schaaf, all from UNESCO, Mr Martin Waldhausen from BMU and Mr Jörg Bruker from BfN.

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Layout: DUK based on templates by heimbüchel pr

Print: Flyerpilot, Print run: 1.000

ISBN: 978-3-940785-27-5

The German National Library registers this publication in the German National Bibliography.

Detailed bibliographic data may be found on the Internet under <http://dnb.d-nb.de>.

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Bonn 2011. This publication is printed on chlorine-free bleached paper.

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A former irrigation ditch in the Sierra Nevada biosphere reserve (© BR Sierra Nevada)

Key messages

UNESCO biosphere reserves are ideal places to test, evaluate and implement comprehensive climate change policies. This publication presents a selection of case studies about good practice to demonstrate what biosphere reserves are already doing in this policy field.

This publication does not claim that the world's most exciting pilot projects on climate change mitigation and adaptation can be found in biosphere reserves. It does not claim that all or most UNESCO biosphere reserves are at the forefront of climate change policy implementation. This publication makes an entirely different statement:

Climate change clearly is the dominant challenge to sustainable development, even shaking the conceptual foundations of sustainable development. However, climate change is not the only challenge. *Climate change may be the new lead vocalist in the choir, but it is not the solo artist.* None of the other well-known challenges to sustainability has disappeared: poverty, malnutrition, loss of biodiversity and ecosystem functions, demographic change, desertification, water scarcity, urbanization, an altered nitrogen cycle, pollution etc. Any isolated policy implementation focusing only on climate change is likely to do more harm than good.

UNESCO biosphere reserves offer two unique advantages:

First, they are based on an inter-governmental definition of an area and often protected by national law. As such, they are governance frameworks stable in the long-term, with an ambitious, cross-cutting set of objectives covering all aspects of sustainable development. This allows for the long-term processes needed to



Farmers in Kafa (S. Bender-Kaphengst)

target sustainability. Sustainable development cannot materialize through one-off projects.

Second, they offer an inclusive space for stakeholders and the population to jointly solve the difficult issues at stake when dealing with sustainable development. In most regions around the globe, different answers will be given to identical questions.

Different governance schemes will be in the background, different interests will collide. UNESCO biosphere reserves are about solving intractable conflicts. Another argument in their favour is that most regions can look back on decades of ecosystem monitoring.

UNESCO biosphere reserves all around the globe can be very suitable places where new, comprehensive policies on climate change mitigation and adaptation are tested and implemented, in order to safeguard their practical viability, *once all other variables need to be included into the equation*. They are the ideal places if an implementation project is more about long-term commitment than about one-off intentions. Biosphere reserves can make things work in a comprehensive way.

This publication provides evidence on what biosphere reserves already have done in this regard. This does not ignore that the biosphere reserves, even those 28 presented in our case studies, might still do more.

However, the responsibility to use biosphere reserves to the extent possible is a joint one. This publication invites local and national governments as well as the international community to deploy ambitious and comprehensive policies more often within biosphere reserves, in order to benefit from their unique advantages.

Message of greeting

Martin Waldhausen

The German Minister for the Environment has invited the International Coordinating Council (ICC) of the UNESCO MAB Programme to hold its 23rd session in Germany. This session coincides with the 40th anniversary of the MAB Programme. A high-level international conference on UNESCO biosphere reserves and climate change precedes this session.

Germany has been committed to the objectives of MAB even before this Programme had been created. Germany had organized two seminars preparing the UNESCO Biosphere Conference of 1968 and has submitted a resolution to the 1964 General Conference. Both German states had founded their MAB national committees in 1972, have carried out extensive international research projects over the following years, and have founded their first biosphere reserves in 1979 and 1981, respectively. After 1995, we have also transformed our pre-Seville biosphere reserves into model regions for sustainable development, and have incorporated biosphere reserves into our national law. We dispose of an enormously committed MAB national committee, have national criteria spelling out the International Framework and support many cutting-edge international and national activities.

Today, there is a new reason to get even more committed to the MAB



Programme and the biosphere reserves: Climate change as the central sustainable development challenge of our time. For this reason, the high-level international conference is organized ahead of the 23rd MAB-ICC in Dresden-Radebeul; several ministers and experts from around the globe assemble to discuss why and how we can make better use of biosphere reserves as places to implement comprehensive climate change policies.

In this publication, we would like to demonstrate to the conference participants and to all those unable to come to Dresden that biosphere reserves have already much to offer. Start here to learn about typical activities addressing climate change already taking place in biosphere reserves today. I am sure you will be positively surprised.

Martin Waldhausen is chairman of the German MAB national committee

Message of greeting

Natarajan Ishwaran

For four decades now, the UNESCO Programme “Man and the Biosphere” (MAB) has been exploring ways of sustainably using and conserving biodiversity and ecosystem functions. The MAB Programme encompasses a global network of representative model regions for sustainable development: the UNESCO biosphere reserves.

Taking into account their achievements over the last decades and their unique character as policy platforms, it is now the moment to actively promote using biosphere reserves in an even more targeted fashion as strategic instruments for implementing effective climate change policies. More than 550 sites in more than 100 countries form a unique global network contributing key practical experience for viable mitigation and adaptation strategies responding to the challenges of climate change. They have proven expertise in fields such as sustainable agriculture and forestry, regional marketing, tourism, spatial planning, participation of local communities and international partnerships.

The achievements and potential of biosphere reserves are highlighted in the Dresden conference in June 2011 with a view to agreeing on further courses of action. The “Dresden Declaration” is planned to be adopted by the conference participants. High-level



representatives from international climate and nature conservation policy, experts from scientific research, from nature conservation and practice will participate.

This publication demonstrates that we are not starting from zero. The “Madrid Action Plan” of 2008 referred to climate change as one of three central challenges for biosphere reserves during 2008-2013. Our numerous partners in the biosphere reserves, in ministries and in academia have responded to this call for action. What has started to emerge is impressive as should be evident from this publication.

Dr Natarajan Ishwaran is the secretary of the UNESCO MAB Programme and the director of UNESCO’s Division of Ecological and Earth Sciences



More than 550 biosphere reserves form a world network (CC DUK)

UNESCO biosphere reserves

UNESCO biosphere reserves are model regions where innovative economic and social strategies are demonstrated of how mankind may use natural resources in a sustainable way, and, at the same time, conserve precious habitats. Historically, i.e. in the 1970's and 1980's, biosphere reserves were places tailored to research, ecosystem monitoring, and education. They still need to be internationally representative at a continental scale for special ecosystems.

UNESCO biosphere reserves are the only category of "protected areas" at the global level following a common standard of intergovernmentally agreed principles and rules and are

designated by an intergovernmental body, the MAB International Coordinating Council. In several countries, national laws provide additional rigidity. Obviously, the area remains under national jurisdiction.

UNESCO biosphere reserves are rarely places of 'wilderness' - much more often they are cultural landscapes that have evolved over centuries through human use. An area proposed by a UNESCO member state as a new biosphere reserve, in order to be acknowledged by UNESCO, first must be characteristic for a certain type of ecosystem or landscape. In addition, it must also implement sustainable development in an exemplary fashion.

Finally, the inhabitants of the area must support the application.

All UNESCO biosphere reserves work together as a world network since 1976. Three documents are central for the daily work of biosphere reserves: the Statutory Framework and the Seville Strategy of 1995 and the Madrid Action Plan of 2008. Biosphere reserves exchange their experiences within the world network: Projects are often



Farmers' market (© G. Hein)

implemented jointly and / or comparatively. Research results are combined, practical experiences shared and tested whether they are transferable.

UNESCO biosphere reserves demonstrate at a global scale, in a variety of landscapes and under very different conditions, what obstacles must be overcome for sustainable development and what strategies can be successful. Model projects take on many tasks: conservation of biodiversity, promo-

tion of social cohesion, and resource use balancing the objectives of nature conservation and economic income generation for the local population. Biosphere reserves integrate exemplary concepts from different fields of social innovation: organic agriculture, sustainable tourism, renewable energy and regional economic cycles.

Biosphere reserves are characterized by a special zoning pattern: Only the small 'core areas' are highly protected. The biosphere reserves as a whole cover also the 'buffer zone' and the 'transition area' and thus are much larger - and the objectives are more ambitious. This zoning pattern of biosphere reserves has been taken up in nature conservation globally; the well-known notion of 'biological corridors' is closely tied to this concept.

Biosphere reserves are a unique asset of UNESCO and they play an important role in its Climate Change Strategy of 2008 and the Climate Change Initiative of 2009. According to these documents, a central objective for the next few years is to promote the recognition and use of biosphere reserves sites as priority sites for implementing UN-level climate change initiatives.



Planting trees in Niger to stop desertification (Flickr CC Max R - ooyoooy)

Climate change

Global warming is unequivocal. The global average temperature has warmed some 0.8 degrees since 1880. 2010 was one of the three warmest years on records; 2001-2010 having been the warmest decade so far. Scientists assume a further heat increase of at least 1.8 degrees during the 21st century, even if we act decisively right now. The consequences are enormous challenges for mankind. Mankind's activities and the related anthropogenic emissions of greenhouse gases, especially from fossil fuel combustion, are the main cause of climate change. The emissions of today and the recent past will lead to a significant and at the same time very predictable temperature rise during the next 30 years.

Climate change is only one of several environmental challenges, in addition to loss of biodiversity and ecosystem services, increasing water scarcity, as well as increasing floods and droughts, desertification and land degradation, intensified biogeochemical cycles as well as different forms of pollution.

At the same time, climate change intensifies all these challenges, is causally interlinked with most of them and is the one with the most rapidly growing significance. Sea-level has already risen, the ocean is already more acid, corals are bleaching, climate variability has increased, vegetation zones are shifting, tropical diseases have already spread.

If current socio-economic patterns and the related emissions do not change substantially within the next few decades, the global average temperature will rise so fast in 50 to 100 years that the consequences will be unpredictable and very likely with extremely negative impact on mankind. Examples for such 'tipping points' are a melting of the Greenland ice shelf, a desertification of the Amazon rainforest, a destabilization of the Indian monsoon, or a dysfunction of the water cycle in the Atlantic Ocean. Some claim that the Arctic Sea ice has already 'tipped'.

Climate change will have profound consequences, not only upon economic prosperity but also upon the most fundamental living conditions of all human beings. Climate change already today negatively impacts on food security, clean water, energy services, on economic and social equity, and on sustainable livelihoods in general. These impacts will be aggravated for the decades to come and will most likely hit those the hardest that are the most vulnerable and that have causally contributed the least to climate change. Particularly negative consequences are expected for indigenous people in the arctic and the tropics and of course for inhabitants of small island developing states. Relatively small investments today may help avoiding dramatic poverty scenarios in the future.

Climate change and the development of adaptation strategies are the key challenges of environment policy in

this age. We now need to mobilise our potential, our creativity and our learning capacity in this respect.

Climate change requires constant adaptation to changing circumstances and to a changing biosphere. Interdisciplinary research on cross-cutting themes and across academic disciplines is needed as well as very specific research on a global scale and in long-term comparison. The climate change-related knowledge collected so far must be constantly reviewed and updated. People's awareness of climate change and its consequences has to rise significantly. This includes mutual learning between all actors. Effective climate change mitigation and the development of adaptation strategies are the key challenges of environment policy these days.

Apart from targeting agreements at the multilateral level, apart from testing and deploying individual measures, we also need spaces where we ought to combine such measures to find comprehensive answers to climate change, across policy levels and across policy fields.

UNESCO biosphere reserves are ideal spaces to set up and improve such comprehensive learning processes in the context of climate change – a challenge for all of society. Biosphere reserves exist worldwide, they have appropriate management structures and they have appropriate mission statements. It is about time to make better use of this instrument.



Mitigation through agriculture and renewable energies (Flickr CC Michael Bliefert)

Overview: Climate change related activities in UNESCO biosphere reserves

In the “Madrid Action Plan” of 2008, the key result of the 3rd World Congress of Biosphere Reserves, accelerating climate change has been referred to as the first of three major challenges for the MAB Programme to effectively respond to in the period until 2013: *“MAB and the World Network of Biosphere Reserves bring added value to addressing climate change through the integrated approach which is generally absent elsewhere. The role of biosphere reserves is essential to rapidly seek and test solutions to the challenges of climate change as*

well as monitor the changes as part of a global network. For the Natural Sciences as well as other Programme Sectors of UNESCO, biosphere reserves can be areas for demonstrating adaptation measures for natural and human systems, assisting the development of resilience strategies and practices. Buffer zones and transition areas of biosphere reserves may also be used to test many mitigation tactics and strategies. In numerous biosphere reserves, carbon can be sequestered as in forest and wetland systems. In all of them capacity can be built for

low-carbon economies using a mix of technology- and labour-based social enterprises. From a social sciences point of view, the political dimensions of changing lifestyles can be explored. The range of biosphere reserves and the systems they represent will provide valuable lessons for the rest of the world.“

Thus, in 2010/2011, UNESCO works specifically on the goal *Promoting the use of participatory approaches for biodiversity conservation, climate change adaptation and mitigation through the World Network of Biosphere Reserves*. The task is to collect relevant case studies and to promote exchange of knowledge in this regard. The MAB Programme has a clear strategic underpinning as concerns climate change.

In parallel, there have been major initiatives of the German government in recent years to advance the global climate change agenda. One initiative with particular relevance to biosphere reserves has been a special federal funding programme from 2008 until 2010 entitled “UNESCO biosphere reserves as model regions for climate change mitigation and adaptation” with 9 projects in German biosphere reserves. Another example is the “International Climate Initiative” funded by Germany which also supports projects in UNESCO biosphere reserves and UNESCO world heritage sites.

These are some reasons why the German Minister for the Environment

has invited UNESCO and the MAB Programme’s International Coordinating Council to Dresden in June 2011 and why, in addition, a high-level international conference ahead of this intergovernmental meeting is organized, specifically on the topic of biosphere reserves and climate change.

In February 2011, and with a view to this conference, the German Commission for UNESCO in consultation with UNESCO and the German Federal Agency for Nature Conservation, has prepared a questionnaire and sent by UNESCO to all biosphere reserves worldwide. Through this survey, an overview has been obtained of current good practice in biosphere reserves.

This questionnaire asked three different categories of questions:

- Is there particular best practice related to climate change that the biosphere reserve prides itself of?
- Has the biosphere reserve responded strategically/politically to climate change, including building appropriate capacities?
- In which of 39 topical areas in relation to climate change is the biosphere reserve active already, how large are current investments and what is planned for the next two years?

As for the 39 topical areas, the first set of questions related to mitigation and adaptation in land-use, renewable energies and green economy. The second set of questions related to governance, research and education.

Does the biosphere reserve administration or its partners implement projects related to

- forestry that mitigates climate change (including reduced deforestation and reforestation)?
- agriculture and/or husbandry that mitigates climate change?
- rehabilitation and/or preservation of high-carbon ecosystems (swamps, bogs, mangroves, etc.)?
- improved slash-and-burn practices?
- improved stoves for simple solid biomass (firewood, flotsam,...)?
- improving energy efficiency (e.g. through insulating buildings)?
- adaptation to climate change in forestry?
- adaptation to climate change in agriculture and/or husbandry (including revitalizing traditional farming knowledge)?
- adaptation to climate change in river/flood management?
- adaptation to increasing water scarcity/droughts/desertification?
- adaptation in coastal zones (sea-level rise, storm surges, hurricanes, groundwater salinity)?
- adaptation in tourism?
- adaptation through biological corridors/zonation?
- adaptation to climate change through improved mosaics of natural and cultivated spaces?
- adaptation to shifting vegetation?
- adaptation to new (migratory and/or invasive) species?
- specifically threatened (potentially emblematic) species?
- non-conflictual biofuels (agricul-

tural residues, grass cutting, ...)?

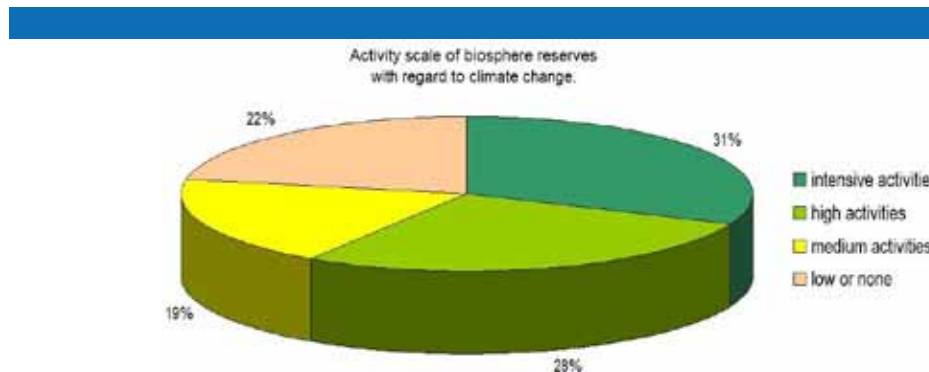
- balancing conflicting interests and newly competing forms of land use?
- low-carbon macro-economic approaches (regional marketing, circular economic flows, etc.)?
- low-emission public transport?
- low-impact tourism?
- creating income from local tourism-related carbon credit mechanisms?
- implementing emissions reduction trading mechanisms (CDM, JI, LULUCF, REDD+...)?



Gauging a solar panel (© KfW-Bildarchiv/photothek.net)

Does the administration or its partners implement projects related to

- planning priorities in a participatory process?
- adapting planning, implementing and evaluation processes of the management plan and its timing/frequency?
- involving new stakeholders, including traditional and indi-



genous communities, and from outside the biosphere reserve?

- integrating policies of several government entities/departments/agencies/ministries?
- integrating policies of several government levels (national, provincial, local)?
- local climate change scenarios/predictions (also with a view to improving spatial planning and management)?
- long-term climate change monitoring?
- new interdisciplinary research?
- synthetically generating new knowledge by combining results across projects?
- involving political/economical stakeholders into research design?
- innovative climate change education for children and students?
- creating public awareness/understanding about climate change?
- mutual learning among stakeholders about climate change?
- sensitizing decision-makers and donors about climate change?

105 biosphere reserves filled in

this questionnaire and returned it to UNESCO:

- 47 from Europe/North America,
- 34 from Latin America and the Caribbean,
- 11 from Asia and the Pacific,
- 11 from Africa, and
- 2 from the Arab World.

Taking into account the short deadline which for many biosphere reserve administrations represented serious problems, because such information had to be visa-ed by authorities, this ratio of returned questionnaires is quite satisfactory.

Grouping of biosphere reserves according to the diversity of their activity

From these 105 biosphere reserves,

- 33 can be considered as already intensively and diversely active in the field of climate change, with projects in many different areas of mitigation and adaptation (projects in at least 15 different areas).
- 28 can be considered as enter-

taining high activity in the field of climate change, with projects across several different areas of mitigation and adaptation (projects in at least 8 different areas).

- 21 can be considered as entertaining medium activities with some projects (projects in at least 3 different areas).
- 23 can be considered as entertaining little or no activities.

This grouping does not take into account overall budgets. There are some biosphere reserves which implement multi-million dollar projects but only in one specific area and are thus counted as having “low activities”. Vice versa, a biosphere reserve with 20 small scale projects of each only several thousand dollar value will count as one with intensive activities. (if budgets have been stated, they are always at least some thousand dollars).

The reason for drawing this distinction is that it is considered that the unique advantage of biosphere reserve is

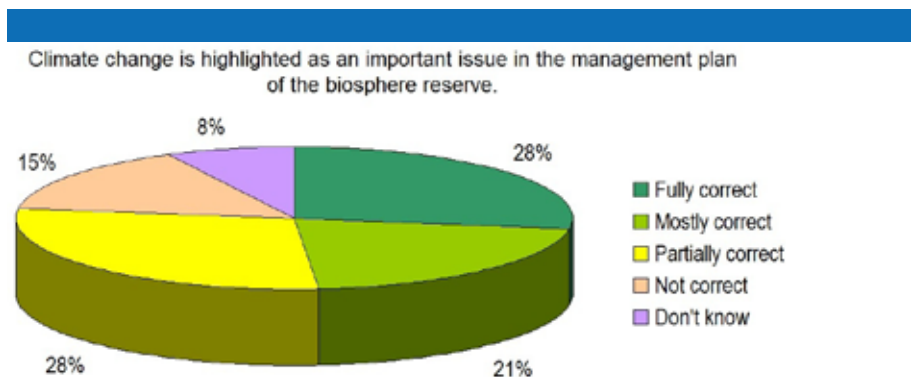
exactly this integrated approach.

Biosphere reserves from all continents can be found in all four of these “activity clusters” respectively, approximately corresponding to the relative share of answered questionnaires.

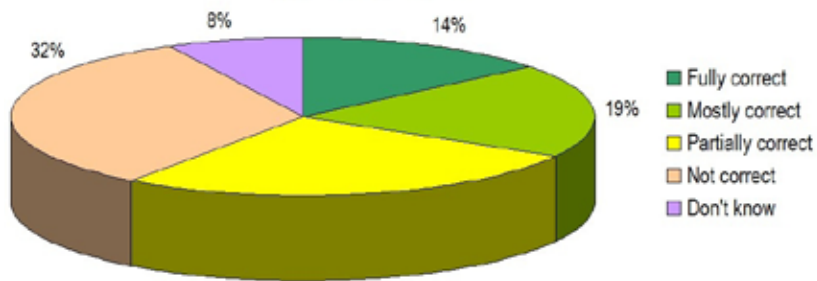
Strategic and political responses to climate change

About half of all respondents say that climate change is highlighted as an important issue in their management plan. If this is not the case, a frequently given explanation is that the existing management plan is already quite old and currently revised or that the management plan does not exist yet because the biosphere reserve itself is too young.

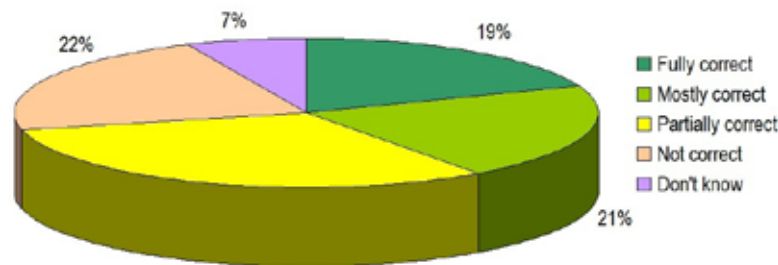
There is a specific action plan or strategy on climate change in only about a third of all biosphere reserves. Another third has not done anything in this regard.



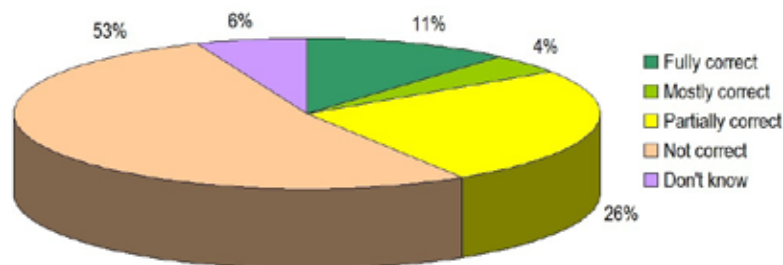
The biosphere reserve administration (and/or the government entity in charge) has formulated a specific climate change strategy/action plan for the region.



The biosphere reserve has positioned itself specifically with regard to climate change – it being a “hotspot” and/or climate change being a “flagship topic” (or similar).



The biosphere reserve has a specific budget for climate change actions.



There is a considerable number of biosphere reserves that have positioned themselves specifically with regard to climate change, by defining it as a “hotspot” or “flagship topic”.

“There are references to biosphere reserves in the national climate change strategy/action plan/other policy document.”: While a large number of biosphere reserves can’t say, there seem to be good preconditions to engage biosphere reserves into climate change policy implementation more frequently. In fact there seem to be surprisingly many policy references to biosphere reserves (18 % say that this statement is fully correct, 17% say it is mostly correct, 20% „partially correct“). While there seem to be quite some contradicting statements from biosphere reserves from the same country; the reason often is that reference is made to provincial policies.

There is quite limited knowledge among biosphere reserves managers about the existence of official linkages between national MAB activities and national climate change policy (25% say „don’t know“, only 18% say „fully correct“ or „mostly correct“). Since this question clearly refers to the national level, divergent answers from biosphere reserve managers from the same country only demonstrate that so far most managers have not looked carefully enough into this important policy dimension.

Some 40% report that their government expressly supports the biosphere

reserve’s activities on climate change (24% say „partially correct“).

Most biosphere reserves (53%) do not have a specific budget related to climate change activities. On the other hand, taking into account that new budget lines usually take many years to be created, it must also be noted that every eighth biosphere reserve already has such a budget item (15% say „fully correct“ or „mostly correct“).

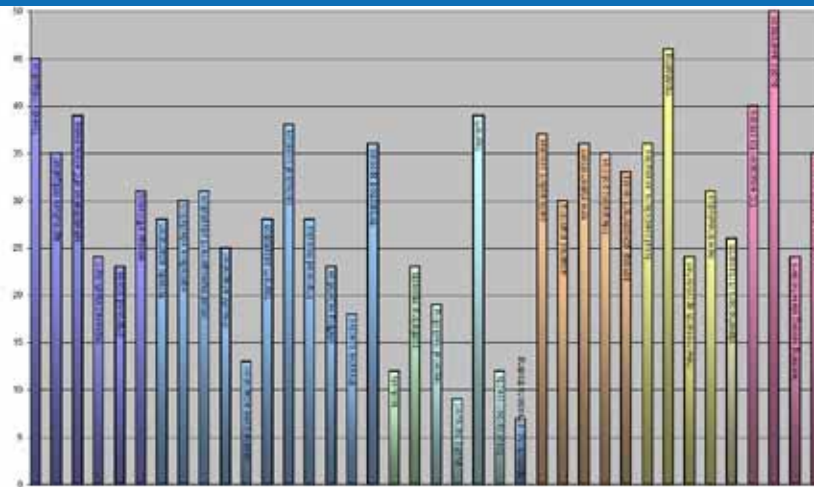
Half of all respondents claim that their



Protecting the coast (© NPA Stock)

capacities related to climate change are not very specific (47% say that the statement „staff members have specific knowledge and capacities“ is „partially correct“). Only a third of all respondents claims to have such specific capacities (34% say „fully correct“ or „mostly correct“).

The extent to which the biosphere reserves participate in knowledge



exchange about climate change is still not satisfactory, both at the national (which should be easier to implement) and at the international level. 44% say that the statement „The biosphere reserve takes part in international knowledge exchange and/or capacity development related to climate change“ is „fully correct“ or „mostly correct“, while for international knowledge exchange the respective share is only 29%.

In which areas related to climate change are biosphere reserves active?

- In absolute terms, the areas where most biosphere reserves report specific projects are raising public awareness (50 out of 105 biosphere reserves are active in this field), long-term climate change monitoring (46), and mitigating climate change through forest management or reforestation (45).
- Other fields with strong activities

are climate change education for children (40 biosphere reserves are active in this field), rehabilitation of high-C ecosystems (39), low-impact tourism (39), and maintaining/re-establishing biological corridors needed to facilitate climate change adaptation (38).

- Among mitigation projects, forestry is clearly the most frequently used approach (45) followed by rehabilitation of high-C ecosystems (39) and improved agriculture techniques (35). Mitigation approaches addressing the population at large is less wide-spread, also because the approaches widely differ between the developed and the developing world: energy efficiency is the key topic in the former, improved cooking stoves in the latter.
- With the exception of improved biological corridors and endangered species, there is less clear

focus in the field of adaptation to climate change – but there is a reason: the measures depend on the geographic region. The reason that only 13 out of 105 report measures in coastal zone adaptation is that most are not located on the coast. Some have to deal with increasing floods, others with increasing droughts.

- Surprisingly few biosphere reserves so far tackle conflictual issues, i.e. cases where nature conservation and climate change mitigation/adaptation seem to give contradictory advice.
- With the exception of low-impact tourism, the economic dimension of climate change mitigation (regional marketing, low-impact public transport) also is not a clear focus area so far.
- Very few biosphere reserves so far are implementing international emissions reduction trading schemes (CDM, JI, LULUCF, REDD+, etc.) – even fewer than those that are experimenting with local transfer schemes. Only 7 biosphere reserves report specific pilot projects.
- A clear focus area in many biosphere reserves is to adapt their governance system, bringing in new stakeholders, bridging several governmental levels, varying the time-frame of the management plan etc.
- It does not surprise that research on climate change is a clear strength as well, with long-term monitoring and local climate change predictions being the focal areas.
- Even more important is the field of education and raising public awareness, including sensitizing decision makers – combining all factors, this field of activity is even more widely used than that of climate change mitigation through land use.



Tree plantation in Costa Rica (© Agua y Paz BR)

Collection of good practice

28 case studies



Photos, from upper left clockwise (all rights reserved): Flusslandschaft Elbe Brandenburg, Katunskiy BR, Grosses Walsertal BR, Radom BR, Biosphärenreservat Mittelgebirge/Mirko Pannach, Sierra Nevada BR



Meadows around the Sonntag village (Flickr CC Wolfgang Pichler)

Renewable energies and energy efficiency

Grosses Walsertal (Austria)

This UNESCO biosphere reserve demonstrates an integrated concept of how to sustain livelihoods in a mountain environment. A particular focus is on using 100 percent renewable energies, energy efficiency and low-emission transportation concepts.



The Grosses Walsertal valley is situated in the western part of the Austrian Alps and comprises six villages. The valley is a prime example of a living cultural landscape where since the 13th century a system of highly adapted mountain farming, pasture and extensive forestry has been developed.

Today, the mosaic of open land, forests and traditional settlements is the reason for very high biodiversity. Some 3,500 residents live here permanently and some 180,000 overnight stays of tourists are registered annually.



Photovoltaics at Blonz (© Gr. Walsertal BR)

One of the main objectives of this biosphere reserve is to supply 100 percent of its energy from regional renewable sources (currently 84 percent – mainly hydro power and photovoltaics). The biosphere reserve has a targeted portfolio of climate change activities. It addresses energy

efficiency in terms of improved heating systems, tourism and public transport - and at the same time, raises public awareness. Additional measures are governance reforms and working dynamically with stakeholders.

In the frame of the “e-regio”-project (funded by Austrian funds of the programme “energy and climate model regions”), a professional and integrated concept and clearly defined measures were elaborated to reach the goal of energy self-supply. In addition, the Grosses Walsertal valley will take part in the transnational LEADER-project “cc.alps” of the European Union that aims to implement climate response measures (especially in the field of mobility) in line with the principles of sustainable development in several alpine regions.

Since 2001 the biosphere reserve has taken part in the Austrian certification programme “e5 for energy-efficient communities”. In 2008 it received the fourth of five possible “e”s. Projects which contributed to this success: membership in the “climate alliance”, model low-energy or passive municipal buildings, certification of all schools according to the Austrian “Ecolabel for Schools”, buses for hiking tourists, biomass exploitation at an impressively large and quickly extended rate (construction of a biomass converter in Raggal), energy-saving championships, public education work, action days, etc.



Aerial view of Agua y Paz (© Agua y Paz BR)

Piloting carbon neutrality

Agua y Paz (Costa Rica)

The UNESCO Biosphere Reserve in the North-East of Costa Rica covers a territory of approximately 916,000 hectares. Much of the biosphere reserve was declared a prototype territory for the national carbon neutrality objective for 2021.



The landscapes and ecosystems in the biosphere reserve range from tropical cloud forests around volcanoes such as Arenal down to the plains with alluvial forests and swamps. There are eight core areas composed e.g. of national parks. The connectivity areas are part of the national biological corridor system. Some 300,000 people live in the rural territory covered by the biosphere reserve designated in 2007.

The biosphere reserve prides itself of three best practices in relation to climate change: Large parts of the territory of the biosphere reserve have been declared in a prototype fashion



Farmer in Agua y Paz (© Agua y Paz BR)

as carbon neutral. The administration identifies and co-operates with companies pioneering carbon-neutral approaches. It raises awareness among local and central government, academic institutions, farmer and community associations, the private sector and the general public.

The backdrop of the activities is the decision of the Costa Rican government to be a carbon neutral country by 2021. Thus a process was initiated to formulate and update an inventory of emissions in the biosphere reserve in carbon equivalents, i.e. a carbon footprint, at the level of each municipality within Agua y Paz. The biosphere reserve signed a protocol with pioneer companies, so that their experiences can be transmitted to other sectors. There have been several seminars and workshops led by the biosphere reserve administration aimed at climate change issues and carbon neutrality. In financial terms, the main contribution comes from private companies interested in changing their behaviour. In order to generate operational funds, the Agua y Paz Foundation has been established.

Many other stakeholders implement projects on a vast number of climate change related topics within the biosphere reserve, such as mitigation through forestry or agriculture, e.g. through the Fondo Nacional de Financiamiento Forestal together with the NGO CODEFORSA. The environmental ministry rehabilitates high-carbon ecosystems; the cooperative for rural electrification and the state bank promote energy efficiency and the soil department of the agricultural ministry promotes a cultural landscape with rich mosaics of natural vegetation. An education programme has been set up together with the UNESCO Chair in Biosphere Reserves and Natural/Mixed World Heritage from San José.



Montane coffee forests (© Bruno D'Amicis)

Avoiding deforestation through Participatory Forest Management

Kafa (Ethiopia)

Kafa contains a large portion of the remaining montane forests in Ethiopia. It is the centre of origin and genetic diversity of wild *Coffea arabica*. A comprehensive strategy reduces deforestation, CO² emissions and poverty.



Kafa, 460 km southwest of Addis Ababa, is part of the East Afromontane Biodiversity Hotspot and hosts a cultural identity quite distinct from the rest of Africa. In particular, there is a unique coffee culture that is deeply engrained in the Ethiopian economy and history. The area is home to some 800,000 people. Agriculture is by far the most important economic sector, followed by tourism, manufacturing and trade. Key goals are protecting the globally important genetic resources of *Coffea arabica* and its associated ecosystems and promoting sustainable development to alleviate poverty.



Wild coffee (© Bruno D'Amicis)

The Kafa coffee biosphere reserve has only been designated by UNESCO in June 2010. Years earlier, a number of NGOs such as NABU joined with private and public partners in an integrative project addressing sustainable development. Apart from setting the grounds for the establishment as

biosphere reserve, wild coffee marketing and Participatory Forest Management (PFM) have been supported. PFM proved to be a key to preserve the remaining pristine forests as well as to improve local livelihoods. It prevents greenhouse gas emissions, maintains ecosystem services and reduces vulnerability to climate change.

Only 40 years ago, some 40 percent of the Ethiopian land surface was occupied by forests; today, less than 3 percent remains, a large part in the Kafa coffee biosphere reserve. These forests contain some 25 million tons carbon in above-ground biomass. Some 600,000 tons carbon could be removed from the atmosphere annually through natural forest growth – if the forest remains intact. But the forests are endangered due to clear-cutting for smallholder agriculture and industrial coffee and tea plantations.

A 3 million Euro project funded by the German Ministry for the Environment as part of its “International Climate Initiative” is being implemented by NABU from 2009 until 2013. Its major goal is to increase carbon sequestration in the biosphere reserve through reforestation and rehabilitation of fragmented forests and degraded areas. At the same time, community plantations with fast-growing tree species as fuelwood as well as 10,000 efficient wood-burning stoves are introduced. Tourism opportunities and jobs are created e.g. by constructing a model lodge, and a microcredit system is set up.



Agricultural landscape behind the dyke (© Nationalpark- und BR-Verwaltung Niedersächsisches Wattenmeer)

Coastal water management

Wadden Sea of Lower Saxony (Germany)

The Lower Saxon Wadden Sea covers tidal flats, salt marshes, dunes and beaches between the border to the Netherlands and the estuary of the Elbe River. The biosphere reserve investigates how the land behind the dyke can be drained in times of sea-level rise.



There are three German biosphere reserves in the Wadden Sea that have been designated by UNESCO. The site is a very important nursing ground for fish and every year provides resting and feeding for many millions of birds. The Lower Saxon part includes most parts of the East Friesian Islands. Two other large rivers, the Ems and the Weser, form large estuaries. The area is also a Ramsar site, a World Heritage site and a National Park, and it is protected by a trilateral agreement between the Netherlands, Germany and Denmark. The biosphere reserve has safeguarded a scientific monitoring over many decades.



Pumping station at Weser dyke (© Nationalpark- und BR-Verwaltung Niedersächsisches Wattenmeer)

In the current extension, hardly any people live in the biosphere reserve, although several villages are contiguous to it. A process for extending the biosphere reserve is underway, following the periodic review of 2005. The most important human activity is tourism. There are many visitor

centres informing tourists about the sensitive ecosystem.

Climate change is highlighted as an important issue in the management plan of the biosphere reserve. In fact, climate change is a “flagship topic” with a specific budget. Two activities stand out: “Storing instead of pumping” investigated alternative water management options in low lying coastal areas, responding to climate change and its effects such as accelerated sea level rise, changing sediment structure and seasonal distribution of precipitation. The drainage and irrigation patterns of areas along the coast will therefore need to change substantially. Current drainage systems using pumps are not sustainable once the sea level will rise significantly.

The project identified means of storing drainage water in the landscape. To this end, an extensive data base on water management infrastructure, land use rights, tourism and nature conservation was scientifically established. Based on this data and local climate scenarios, several options are developed and discussed with stakeholders. The focus is not on stand-alone measures, but on options fostering multifunctional use in favour of sustainable land management.

The project “flotsam: from trash to biofuels” investigates whether vegetation material washed up along the dykes can sensibly be recycled in biogas plants. Since first results have been inconclusive, research will continue.



Waterfall at DingHuShan (Flickr CC alanalew)

Carbon in old forests

DingHuShan (China)

DingHuShan has had a high importance for the conservation of Chinese ecosystems over the last 40 years; also because the area is well-known as a major Asian Buddhist centre. Climate change research focusses on carbon cycling and accumulation in old forests.



The biosphere reserve DingHuShan was China's first nature reserve. It is situated in Guangdong Province in southern China and has been designated by UNESCO in 1979. This very small biosphere reserve of only 1,100 hectares consists of hilly lands and is mostly covered by subtropical forest. While forests in the surrounding region have been considerably altered by human intervention, the biosphere reserve comprises rare primary forests of at least 400 years age. The DingHu shrines attract up to 1 million visitors per year. Managing the increasing tourism is both a challenge and chance for the biosphere reserve.



DingHu shrine (Flickr CC wodnerduck)

Apart from several hundred seasonal residences, there are no permanent inhabitants. Research has been carried out since the 1950's and education programmes are on offer.

Today DingHuShan focuses on climate change as a central management

challenge. Activities implemented address a vast array of interventions such as improved corridors, improved mosaics of natural and cultivated spaces or adaptation to shifting vegetation patterns. Also invasive species are a matter of great concern. Considerable funds are invested on these projects.

Scientific research on climate change is a specific priority: The scientists working in and with DingHuShan consecutively did research on the carbon cycle, the nitrogen cycle and the water balance of forest ecosystems. Significant progress has been made on the understanding of the interaction of carbon and nitrogen, and of their link to species diversity and ecosystem services.

Together with the New Phytologist Trust, an international workshop entitled "Carbon cycling in tropical ecosystems" has been organized in 2011. One of the key projects of the Chinese Natural Science Foundation (NSFC), dealing with forest carbon accumulation in old forests, is carried out here. More hands-on efforts are done as well: In March 2011, 300 employees of the bank HSBC attended tree-planting with the Earthwatch Institute in DingHuShan. Adapting the management plan to the current needs, alone is a comprehensive project that will cost 300,000 dollars. There are also extensive climate change education efforts, initiatives at regional marketing and low-impact tourism.



Experimental site: measurement of precipitation (© ForeStClim)

Sharing a vision across borders

Vosges du Nord - Pfälzerwald (France - Germany)

This French-German area was the first transboundary biosphere reserve in the EU and the first to be jointly evaluated by two MAB national committees. Successful projects on one side, e.g. on climate change, are actively transferred to the other side of the border.



This area was the first transboundary biosphere reserve of the European Union. Both the German part Pfälzerwald and the French part Vosges du Nord had been designated by UNESCO before. As a connected region they have been designated since 1998, spanning a total area of 301,800 hectares, of which nearly three quarters are covered with forests.

Characteristic are hundreds of castles, impressive red sandstone cliffs and numerous caves. The first legally protected transboundary nature forest reserve in Europe has been set up, forming a joint core area. Regularly,



Biosphere house (© Biosphärenhaus)

transboundary rural markets are organized. The winegrowing district on the German side is nationally known as the 'German wine route'; organic viticulture is part of a regional quality certificate network, comprising e.g. local food producers, gastronomy or local forest producers.

The project KlimLandRP has been an interdisciplinary research project from 2008 until end of 2011, covering wide fields such as fresh water, soils, forestry, agriculture and biodiversity with the main target to determine the local and regional impact of climate change on different sectors. This project has been an umbrella for many parallel and successive measures, each worth several hundred thousand Euros, being implemented in co-operation with different partners.

Some examples: The project ForeSt-Clim investigates the suitability of different tree species under changing site conditions, as well as opportunities and challenges of short rotation forestry. The effects of invasive tree species and of a changing water cycle are investigated as well. Renewable energies including fuelwood and waste wood utilization are implemented and energy efficiency is promoted. Mediation focuses on conflicts relating to the construction of wind power plants in densely forested areas or to large-scale biofuel-plants close to protected areas. Additional buffer zones are going to be created in order to counterbalance the accelerating habitat-loss and shift of wildlife-communities.

Finally, a European Union co-funded project deals with the implementation of such strategies and results in the transboundary, French-German context. The well-established transboundary management of the biosphere reserve is fostered by a joint steering committee and joint working groups.



Aerial Noosa River mouth and Noosa Heads region (© Noosa Tourism)

Community adaptation

Noosa (Australia)

Noosa north of Brisbane focuses all its attention with regard to climate change on establishing a climate change adaptation programme that fully engages into action the broader community living in the biosphere reserve.



Noosa is a UNESCO biosphere reserve only since 2007. It is situated north of Brisbane, on the Eastern Australian Coast, on some 150,000 hectares of marine and terrestrial areas. Some 50,000 people live in the biosphere reserve, seasonally up to 65,000. For more than 40 years, a very active network of community conservation groups has shaped local policy. At the same time, numerous outstanding scientific studies have been undertaken in this region.

Key drivers of the Noosa biosphere reserve are to sustainably manage urban growth and responsibly involve



Climate action workshop (© Noosa BR)

all community members into the area's stewardship. The management organisation, Noosa Biosphere Ltd, addresses many questions in parallel, culture, environment, social issues, education, R&D, economy and tourism, all together with the community.

Most core areas are publicly owned lands and waters managed by government authorities for conservation under state legislation. In the transition area, there are productive agricultural lands, light industry and managed forests.

The key objective with regard to climate change is to establish an adaptation programme to engage in action the broader community living in the biosphere reserve. A partnership has been formed to develop knowledge and understanding of the critical issue for climate change response and adaptation. The contributors to the partnership include the "biosphere governance group", Sunshine Coast university, South East Queensland Catchments Group, Noosa residents and ratepayers and the Sunshine Coast Regional Council. The partners are working towards the development of a robust climate change adaptation plan and a programme of activities.

Beyond building robust mechanisms for involving the community, many different measures have been implemented, e.g. mitigation through improved forestry, through restoration of high-carbon ecosystems, or through improving energy efficiency. Adaptation measures focus on the increasing water scarcity and on the coastal zone (sea-level rise, storm surges, hurricanes, groundwater salinity). The biosphere reserve is also involved in the regional climate change strategy for the Sunshine Coast.



Brauntun burrows dunes (Flickr CC That bloke)

North-South cooperation on sea-level rise

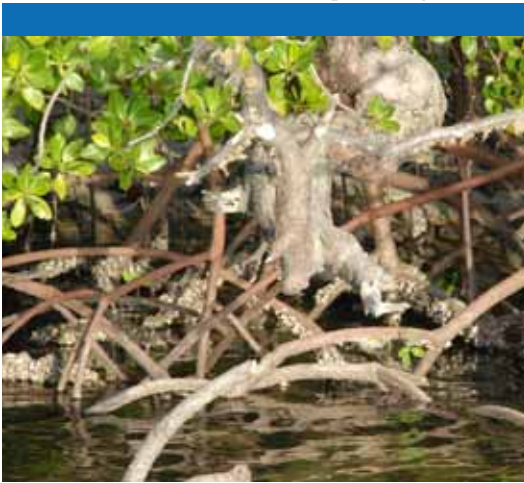
Malindi Watamu (Kenya) - North Devon (UK)

While the two biosphere reserves are 7,500 kilometres apart and have very different climates and ecosystems, they share some very similar problems: Sea-level rise and erosion are eating into their beautiful coastlines, threatening wildlife habitats and the local economy.



Malindi-Watamu on the Kenyan coast some 100 kilometres north of Mombasa has been designated in 1979. Its core area is one of the best-investigated Kenyan reefs, the reserve includes cliffs and sandy beaches, tidal mud flats, mangrove swamps, and sea-grass beds. The important tourist destination hosts 120,000 inhabitants.

The Branton Burrows–North Devon biosphere reserve was extended to 350,000 hectares following a periodic review in 2002 and community consultations. It covers the two large river basins on the north shore of Cornwall. The core area comprises large dunes



Mangroves at Malindi (Flickr CC sallylondon)

and estuary systems; beyond that, farmland, heath, wetlands and woodlands. About 150,000 people live here. In the UK biosphere reserve, some 20 percent of intertidal habitats will be lost to sea-level rise over the next 20 years. For example, a golf course needs to be re-located and the manage-

ment of a pebble ridge needs to be re-considered. Salt marshes as flood defences will need to be re-created through re-flooding farmland.

The main challenge of Malindi Watamu is the preservation of mangroves and beaches. Half of the original mangrove forest along the Kenyan coast, serving as fish nurseries and dissipating wave energy, has already been lost. Corals are stressed by rising sea temperatures and ocean acidification. A 30-m strip of the beach above the mean high-water mark is legally protected since sea turtles nest here; this strip is eroding as well, partly due to illegal development. Climate change adds to the effects of poverty.

In 2008, the two communities decided to cooperate in order to learn from one another how best to adapt to their changing world. The Malindi Watamu community offers a very thorough commitment to the value of the ecosystems and their services – demonstrating how the community can drive conservation. Some community groups have even started to plant mangroves. The North Devon partners in turn have experiences in getting people to understand long term effects of tiny annual sea level rise. Once the time horizon for the impact is placed just beyond the life expectancy of the current community, the issue is depersonalised; an adaptation policy that the grandchildren might appreciate, becomes much more acceptable. The UK also provides Kenya means to obtain better information and data.



Aerial view of the Schaalsee region (© Schaalsee BR)

Adapted agriculture and bog restoration

Schaalsee (Germany)

The biosphere reserve has published an exhaustive study in 2008 assessing climate change impacts and developing strategies for mitigation and adaptation in the region. The priorities are implemented today, especially climate-adapted agriculture and restoring bogs.



The Schaalsee biosphere reserve, designated in the year 2000, is located right at the former border between West and East Germany. It is rather small but covers a diverse landscape with a variety of habitats, especially woods, bogs and lakes. The Schaalsee itself is a lake originating from one of the most recent glacial periods. Some 8,000 people in the biosphere reserve make their living mainly from agriculture, fishery, forestry and tourism. Sensitive cultivation methods are promoted to maintain the cultural landscape and to reduce the eutrophication of rivers, lakes and bogs. The production of high value foodstuffs



Restoring a bog (©BR Vessertal-Thüringer Wald)

creates substantially improved income for farmers. Additional tourist attractions increasingly replace day-trip tourists by long-term tourists and therefore add economic value.

The comprehensive 2008 study has built on a regional climate change

forecast for all of North-East Germany. Localizing and concretizing this forecast to the Schaalsee region has been financed by the ministry for economic affairs and private partners. The study resulted in a 180-page expert report covering all areas of economic, social and ecological interventions and priorities; an English-language short version is available.

Five projects have been identified as future priorities: “Establish a regional greenhouse gas balance sheet”, “Increase research on the Schaalsee water supply”, “Promote research on forestry”, “Promote climate protection in schools”, as well as “Implement local climate round tables”.

An implementation focus is on promoting “climate adapted agriculture and fruit-growing cropping methods”. Together with the Gülzow Research Institute, climate friendly and energy efficient agricultural and fruit production practices are established, as well as the sustainable cultivation of renewable energies. This is implemented through training for farmers and for fruit growers during winter-time, through demonstration plots and through field guides for farmers. The “Bioenergy Village Neuhoﬀ” produces electricity and heat from biomass and informs the public such that they might copy these efforts. Several projects worth close to a million Euro from public and private donors such as Honda have led to the restoration of large areas including several fens and bogs with a high carbon storage effect.



The Sierra Nevada de Santa Marta (Flickr CC kontour travel)

Including indigenous people in adaptation

Sierra Nevada de Santa Marta (Colombia)

In this highly diverse biosphere reserve, comprehensive projects, including on climate change, are implemented through participatory restoration projects and sustainable agriculture of crops and husbandry in cooperation with the Kogui, the Arhuaco, and the Wiwa.



The Sierra Nevada de Santa Marta biosphere reserve has been designated by UNESCO already in 1979. Situated at the northern coast of Colombia, this large area of 675,000 hectares stretches from the Caribbean coast with a finely preserved coral reef and extensive beaches up to steep peaks of 5,775 meters, at a distance of only 42 km. The snowy peaks are independent of the Andean cordillera and are considered sacred. Corresponding to the large variation of height, all types of forest can be found.

Large forest areas have been modified by peasants for agriculture, cattle



Arhuaco mother and child (Flickr CC ca.millionaire)

grazing, and extraction of high-value timber. Still, there is no management policy of the biosphere reserve as a whole; yet, based on scientific research, a sustainable development plan targets agro-ecology, fish-farming and environmental health. The area is of great archaeological value, including

sites such as the Ciudad Perdida and artefacts of the Tayrona culture.

Some 10 percent of the population of some 220,000 are indigenous; the Arhuaco, the Kogui and the Wiwa have own indigenous reserves, but a considerable number live outside. Ethnic groups are involved in developing policies. Since 2002 and based on a national agreement, the management authorities cooperate with the Kogui, the Arhuaco, and the Wiwa mainly in three areas: Strengthening governance of public environmental authorities, restoration of the ecosystems and support to the ancient people in defining their autonomy.

The national protected area framework awards them an important role in the response to climate change. In Sierra Nevada de Santa Marta, comprehensive projects for more than 1 million dollars are implemented including participatory restoration projects and sustainable agriculture of crops and husbandry, including as well improved vigilance for slash-and-burn. The rapidly disappearing glaciers are to be monitored.



Rakov Škocjan (Flickr CC Viajero Italico)

Learning across borders

Karst (Slovenia)

Several protected areas along the Italian and Slovenian border cooperate in a project providing a sound knowledge base on the impact of climate change on the tourism industry and on biodiversity in the region. This biosphere reserve and world heritage site is on board.



The Karst biosphere reserve has been designated in 2004. It encompasses the area characteristic for the geological phenomenon which has globally become known under the name of “karst” and which is the reference for all karst studies worldwide. The Kocjan caves in the area are designated both as World Heritage and as Ramsar Wetland. The constant lack of running surface water also influences the way animals and plants have adapted and the occurrence of endemic species.

The biosphere reserve is important to demonstrate the rational use of water; the land is vulnerable due to large un-



Crocus (Flickr CC Amadej Trnkoczy)

derground pools of potable water. The biosphere reserve seeks to integrate and co-ordinate sustainable agricultural practices with the preservation of caves and hydrological processes, controlling surface and subsurface pollution from fertilizers and wastewater. Three villages are part of the biosphe-

re reserve, with a population of some 12,000 people.

The Karst biosphere reserve is partner of the EU-funded Interreg project CLIMAPARKS. This programme of cross border cooperation between Italy and Slovenia 2007 – 2013 involves several protected areas on both sides of the border. The project will provide a sound knowledge base for comparative analysis about the impact of climate change on the tourism industry and on biodiversity in the region.

Several measurement networks and monitoring instruments are developed, e.g. making data available online. For the first time, capacity for climate change-related analysis and decision-making is created within these protected areas, which shall be established as models of good practices. In addition, joint and individual public awareness measures for visitors and education programmes for schools and local people are introduced. The project targets the communication and exchange of good practices about climate change among these protected areas in Italy and Slovenia. Outreach beyond the nine protected areas foremost among the project’s partners is done through a series of conferences, websites and publications.

Other significant activities of the biosphere reserve are adaptation to climate change through improved biological corridors and new, interdisciplinary research.



The traditional healers meet (© Kruger to Canyons – Biosphere Region)

Setting up a local carbon credit scheme

Kruger to Canyons (South Africa)

Tree nurseries set up to stabilize the vegetation of the region Bushbuckridge through planting medicinal trees shall safeguard the future of a group of traditional healers. This scheme is to be financed through voluntary payments by tourists compensating carbon emissions.



The biosphere reserve „Kruger to Canyons“ consists of 4.8 million hectares of lowveld savannah, grassland and forest in North-East South Africa. It encompasses the Kruger National Park as well as the Blyde River Canyon. There is a high level of biodiversity, especially plant endemism on mountain tops. It has some 1.5 million inhabitants in large, rural communities, where many natural resources have been over-utilized. Land use includes mining, the plantation of exotic species and the extensive cultivation of subtropical fruits. The foremost objective of the Biosphere Reserve, designated in 2001, is to improve the



Blyde River Canyon (© Kruger to Canyons BR)

inhabitants' quality of life. For several years already, it cooperates with the German biosphere reserve Rhön.

“Kruger to Canyons” has long been working together with a group of some 80 traditional healers; in 2009 they jointly defined their community

role and the intellectual property rights on their traditional knowledge in a “bio-cultural protocol” in the context of CBD “Access and Benefit Sharing”.

With financial support from the German pharmaceutical company Merck KGaA, through the German Commission for UNESCO, the biosphere reserve has commissioned two feasibility studies in 2010 on sustainably financing and practically building tree nurseries in order to stabilize the vegetation of the region Bushbuckridge through planting medicinal trees and other plants to be harvested by these healers. The plantations will be financed through voluntary payments by tourists who stay in and around the Kruger National Park to compensate for their carbon emissions.

Such a „Voluntary Carbon Off-Set“ programme was found to be very promising - so its creation is currently funded by Merck KGaA until the end of 2011. The biosphere reserve will set up a mechanism that addresses all the tourists who stay in the many lodges in the region. By paying a contribution to a fund they can offset their carbon emissions from travel, accommodation and local transport. Money from the fund will be used exclusively for planting trees, which will capture and store a corresponding amount of carbon from the atmosphere (summary at <http://bit.ly/iZIRJw>)

Another pilot project trains teachers from impoverished rural schools on implementing renewable energies.



A student group from Spohn's Haus visit the new photovoltaics installation (© Dr Gerhard Mörsch)

Becoming a zero-emissions region

Bliesgau (Germany)

The biosphere reserve will be turned into a zero-emission region until 2050. That means avoiding 95 percent of the CO₂ that has been emitted in 1990. Therefore climate change is a very high priority, leading to innovative renewable energy solutions - and using horses!



The biosphere reserve Bliesgau is located in the far west of Germany on the border to France. Over thousands of years, the population has created a well preserved cultural landscape with many different habitats on a small area in the hilly Bliesgau, characterized by valuable extensive grassland-orchard systems, species-rich meadows, beech and alluvial forests and water meadows, which are crossed by the river Blies. The north of the Bliesgau is quite urban, with a population density above the national average. An important threat is that many submarginal agricultural areas are just left to themselves; therefore 50 percent of



Logging horse of the city of Blieskastel
(© Fredi Brabänder)

the orchards are gone. The biosphere reserve therefore tries to create new marketing schemes of organically produced goods that also have a nature conservation value, following the example of many other German biosphere reserves. Demographic change in suburban areas is another challenge

that the biosphere reserve addresses, supporting rural infrastructure and local social networks. Another strategic direction is that the biosphere reserve will be designated as free from genetic engineering. Ecologically compatible tourism is a major area of action in the regional tourism concept. Great potential exists for renewable energy in terms of biomass from agriculture and forestry.

The responsible state government has decided in 2010 to transform the biosphere reserve into a zero-emission region until 2050. That means avoiding 95 percent of the CO₂ that has been emitted in 1990. Therefore climate change clearly is a flagship topic and a specific climate change strategy exists.

The preparations for the project outline are in full swing. The project will be submitted in summer 2011. Current interventions encompass several projects each in the fields of low-emission public transport systems, low-impact approaches to tourism, low-carbon regional marketing, forestry as well as agriculture that mitigates climate change. As a first step, in June 2011, a 2.5 hectare photovoltaic installation has been set up in a former lime quarry with an output of up to 1.85 MWp. The installation is run by a public association and all income generated is ploughed back into measures of nature conservation. Since very recently as well, in order to reduce emissions, the city of Blieskastel operates its forest management with a horse.



Pastoruri landscape (Flickr CC Andras Janscik)

Climate change as a tourism opportunity

Huascán (Peru)

The biosphere reserve Huascarán, designated in 1977, is situated in the highest tropical mountain range in the world, the Cordillera Blanca with 27 snow-capped peaks. Afforestation by tourists and the “Route of climate change” on the Pastoruri Glacier are noteworthy.



On its more than 1,100,000 hectares, the biosphere reserve supports a wide diversity of vegetation, but conservation efforts are under many pressures. The international designation was helpful in solving a conflict in how to deal with the Antamina mine project and the location of a pipeline for mineral transport. Too many fires are started either by careless tourists or in order to clear land for pasture. The core area is uninhabited, only some llama and alpaca are grazing in the lowlands. Over 260,000 inhabitants live here, making a living mostly from agriculture, forestry, and mining. More than 100,000 visitors per year



Tourist path at Pastoruri (Flickr CC zazk)

marvel at cultural and archaeological remains and at the astonishing nature.

Impacts of climate change are quite well assessed, for example there are exact figures for glacier retreat since 1970. A dedicated research plan and the global GLOCHAMOST research

partnership underpin further scientific understanding. The biosphere reserve has established a risk management as well as a management plan targeting climate change. In the area of mitigation, priorities are to contain forest fires, to restore the landscape through afforestation, and to recover pasture.

Reforestation efforts amount to 4 million dollars, carried out by public and private organizations. Adaptation efforts amount to 2.5 million dollars, partially financed by local municipal governments. Along the most popular trek in the Cordillera Blanca, a US Peace Corps volunteer has created the reforestation project and eco-business Montikuna, meaning “forest” in Quechua. Visitors can donate and in turn plant native tree species in designated areas along the trek. Future plans are to expand the project to devastated areas, thus creating local income, preventing soil erosion, and sequestering carbon.

What is especially noteworthy is the project “Route of climate change” on the Pastoruri Glacier. This area is visited by 15,000 tourists. With some 1.5 million dollars this figure and the associated income shall be stabilized, although the glacier recedes by as much as 18 metres per year. Several paths and an interpretive centre are to be implemented – with a view to educate tourists on climate change based on a real life example. The administration also informs tour operators about opportunities to reduce or offset carbon emissions.



For life, for the future

Biosphere reserves and climate change





Volcanic rock on Jeju Island (Flickr CC Leo Laporte)

Islands in climate change

Jeju (Republic of Korea)

The international “Jeju Initiative” supports insular and coastal biosphere reserves in Asia and the Pacific with a view to inspire partner biosphere reserves to take up important challenges, such as loss of biodiversity, climate change, tourism and natural disaster prevention.



Jeju is the largest Korean island situated quite far out from the southern end of the Korean Peninsula. The biosphere reserve of 83,000 hectares which has been designated in 2002 by UNESCO is near to the centre of this volcanic island, covering almost half of its lava plateau and rising up to almost 2,000 meters above sea level. Several forest ecosystems and temperate grasslands form the landscape. Three small islands with coral reefs are also part of the biosphere reserve. The buffer zone and transition area include afforestation areas, agricultural and pasture land as well as residential areas. Jeju Island has 560,000



Spring blossoms (Flickr CC future15pic)

inhabitants, 7,500 within the biosphere reserve. Jeju Island is a major Korean tourist attraction. Developing tourism sustainably is a major challenge.

At the strategic level, climate change has been fully incorporated into the work, including a specific budget and

means of exchange of knowledge. More than 100 million dollars are invested into measures contributing to climate change mitigation through land use (forestry, agriculture and preserving high-carbon ecosystems) and an even greater amount is invested into adaptation to climate change in the area of agriculture, including revitalizing traditional farming knowledge. Flood management and adaptation in the coastal zone are other areas of massive investment. Long-term monitoring of climate change is another major investment, as are low-impact approaches to tourism.

In spite of this impressive work at home, the most exciting aspect might be the international “Jeju Initiative”. The Jeju Provincial Government cooperates with the UNESCO Jakarta Office for the benefit of three regional networks of biosphere reserves: in East Asia (EABRN), Southeast Asia (SeaBRnet) and the Pacific (PacMAB). The initiative launched in September 2006 aims to inspire partner biosphere reserves to take up sustainable development challenges, including climate change.

Activities include practical site training and exchange on integrated management in early 2008, exchange between Korea, Vietnam and the Philippines, the international conference on coastal and island biosphere reserves focusing on climate change in December 2008 and another international workshop on climate change in May 2009.



Charming Spreewald channels (Flickr CC Eric Drommer)

Adapting to increasing drought

Spreewald (Germany)

The Spreewald biosphere reserve is an inland river delta with a finely structured network of small water channels, riparian forests on wetlands and extensive wet meadows; as such, it is unique in Germany. The „Water Edge Project“ prepares for increasing drought.



The Spreewald biosphere reserve, one hundred kilometres southeast of Berlin, was designated by UNESCO in 1991. It features a network of some 1,500 kilometres of water bodies on 47,500 hectares. Humans have always lived and worked here on small farmsteads. Still, the biosphere reserve is hardly dissected by roads and offers a home for numerous rare species. An important objective of the biosphere reserve is to preserve traditional forms of land use, e.g. through offering reliable funding to the farmers.

The river Spree has been changed by human intervention over the centuries,



Cows in the Spreewald (Flickr CC Gertrud K.)

e.g. through melioration and large-scale lignite mining. Climate change in this quite arid region will lead to drier and warmer summers and thus reduce flow velocity and water quality in the streams. Climate change has been defined, although only recently, as a flagship topic of the biosphere

reserve. Since 2000 and until 2013, the biosphere reserve implements a large-scale project in order to preserve and restore natural and semi-natural components of the cultural landscape by stabilizing the water balance – also in the context of climate change.

This “Spreewald Water Edge Project” is supported by the German Ministry for the Environment with more than 12 million Euro, covering e.g. the following interventions: 7 large and many smaller oxbow lakes have been reconnected, sludge has been removed from water bodies and natural bank structures have been rebuilt. Obsolete water management constructions have been removed or replaced by ecologically more permeable units. Water bodies are enabled to flow again. Bogs and fens are restored. The project is accompanied by intensive measures to inform local inhabitants about the impact of climate change and to moderate conflicts.

In addition, a national pilot research project on bog restoration for carbon sequestration is implemented in the biosphere reserve. The biosphere reserve also implements projects on mitigation and adaptation in the agricultural sector and in tourism.

Local organic products are very successfully marketed in the region, the Spreewald prides itself of the highest share in organic products in all of Germany. Education and sensitizing decision-makers are other focus areas of intervention.



Sugarcane cultivation (Flickr CC Sweeter alternative)

Reorganizing agriculture to improve carbon sequestration

Buena Vista (Cuba)

The biosphere reserve rearranges its territorial production scheme according to the suitability of the soil for carbon sequestration, especially targeting areas previously used for sugarcane monoculture.



The biosphere reserve Buena Vista is a 300,000 hectares area situated on the northern coast of Cuba, in parts of the provinces Villa Clara, Sancti Spiritus and Diego de Avila. It has been designated by UNESCO in the year 2000.

The marine part includes coral reefs and beaches, the terrestrial evergreen coastal forest, mangrove forest, and matorral. The biosphere reserve has a high biodiversity, including some 20 endemic, threatened species. The eleven core areas are part of two national parks and two fauna refuges, including 35 archaeological sites and caves with wall paintings.



Cayo Santa Maria (Flickr CC tesKing)

Some 25,000 inhabitants live in four towns and six villages, mainly from tourism, handicrafts, traditional medicine, apiculture, traditional sugar cane agriculture and fishery. Around 7,000 tourists visit the area annually. Conservation of traditional practices for the use of natural resources by local

communities strengthens their cultural identity. Activities supported by the biosphere reserve include environmental education, scientific research through international cooperation, e.g. hydrology and meteorology, conservation of beaches, as well as promotion of using mud for therapeutic use on small islands. Research on mangroves is carried out together with UNESCO.

In the area of climate change, a considerable array of activities is implemented. Climate change has been fully incorporated into the management of the biosphere reserve, both at the strategy level and at the level of project implementation. Indeed, the biosphere reserve defines climate change as a flagship topic.

About a million dollars are currently implemented in different fields of mitigation and adaptation, with particular emphasis on improved agriculture mitigating climate change (300,000 dollars are invested alone in this field). Territorial production schemes are rearranged according to the suitability of the soil for carbon sequestration. Areas previously used for sugarcane monoculture are transformed to maintain livestock farming and for several crops. These transformative measures are carried out as well with a view to optimize the use of water supply available in the territory, in order to avoid overexploitation.



Vattenrike vegetation (Flickr CC Bengavoice)

Fossil fuel free municipalities

Kristianstads Vattenrike (Sweden)

The municipality of Kristianstad in the far South of Sweden declared in 1999 its intention to become free of fossil fuels. This is achieved e.g. through district heating with cogeneration of electricity; a biogas distribution system; and extensive investments in wind power.



Kristianstads Vattenrike is located in Skåne, in the far south of Sweden. The biosphere reserve has been designated by UNESCO in 2005. The area is at the coast of the Baltic Sea, including a Ramsar wetland, and a rich diversity of land cover such as broadleaf forests, sandy grasslands or dunes.

The main part of this 100,000 hectares of cultural landscape is the result of long-term cultivation of the land. The municipality of Kristianstad has almost 75,000 residents, half of them in the central town, being a commercial and trading centre, mainly for foodstuffs and agriculture.



Kristianstad inner city (Flickr CC kavin)

Climate change is a flagship topic for Kristianstads Vattenrike biosphere reserve. It has been strategically incorporated into the management plan, there is a strategy in place, there is a specific budget and staff takes part in knowledge exchange nationally and internationally.

The municipality of Kristianstad has for a long time strived to reduce the use of fossil fuels and declared in 1999 its intention to become a fossil fuel-free municipality.

The most relevant activities to this end are: district heating with cogeneration of electricity; a biogas system serving renewable fuel to public buses and other vehicles, at the same time recirculating fertilizer to agriculture; and extensive investments in wind power by private investors. Other measures address energy efficiency, restoration of high-carbon ecosystems or carbon sequestration through agriculture. Investments of some 20 million Euros have been made in additional levees for flood protection. The action plan 2010-2013 specifies the focus of the biosphere reserve on conflict solution: "When switching to energy from renewable sources, it is important to manage the expansion of windpower and other alternative energy sources in a sustainable way without jeopardizing the high recreational and natural values."

Therefore, measures are implemented through a participatory process, involving all stakeholders. Also because of this, climate change education is another focus area. The city of Kristianstad has received several awards for its work on climate change mitigation: the Climate Star 2002, the 3rd prize at the Energy Globe Award 2003, the "Best work for environmental friendly cars" and the "Best climate work in Swedish municipalities 2005".



Fishermen in the Saloum delta (Flickr CC Ghijsseppu)

Protecting mangroves through buffer zones

Delta du Saloum (Senegal)

The biosphere reserve Delta du Saloum is situated in the delta of the two rivers Sine and Saloum. As regards climate change, mangrove restoration is of central importance, both for conserving high-carbon ecosystems and for coastal protection.



The biosphere reserve Delta du Saloum is about 150 kilometres south-east of Dakar. The biosphere reserve has a size of some 200,000 hectares, half of which are islands, many of them inhabited, and the other half marine or flooded areas. Mangroves of four species are dominant, but sand dunes, open forest and islands are also characteristic. The delta is a very important bird area, including for migratory birds; for species such as the royal tern it is the number one nesting site in the world. The mangroves are permanently threatened by pressure from rice cultivation and deforestation in the Fathala area. Other pressures



Heron in the mangroves (Flickr CC J.M. Liotier)

include fires, excessive fishing, and destruction of bird colonies.

As regards climate change, several issues are at stake, with mangrove restoration being of central importance, both for conserving high-carbon ecosystems and for coastal protection;

in this regard, climate change has become a central issue of the biosphere reserve. Six community nature reserves have been created around the core areas and the marine protected area Bamboung in the transition area. Conserving the natural resources, these community nature reserves will meet future population demand in fuelwood and non-wooden forest products. This will reduce pressure on the core areas and will stabilize their role as carbon sinks. Other measures include the construction of a dam sealing off agricultural land from seawater inflow.

Village associations play a critical role in mangrove restoration, including the establishment of tree nurseries and of reforestation plots. Village community organizations also have a key function in combining traditional and modern practices in fisheries or to set up 'eco-guards'. In cooperation with local communities and national agencies and research institutions, several international donors such as the Netherlands, and international NGOs, they are working on implementing an integrated management plan for the biosphere reserve.

In order to electrify the villages of the delta, close to 1,000 solar panels have been installed on five islands with support from the Spanish government. The beneficiaries pay an initial and a monthly fee. Through a local management committee the operation of the panels is safeguarded for 15 years. Climate change education is important as well, done through several projects.



The Channel Islands information centre (Flickr CC wanderingnome)

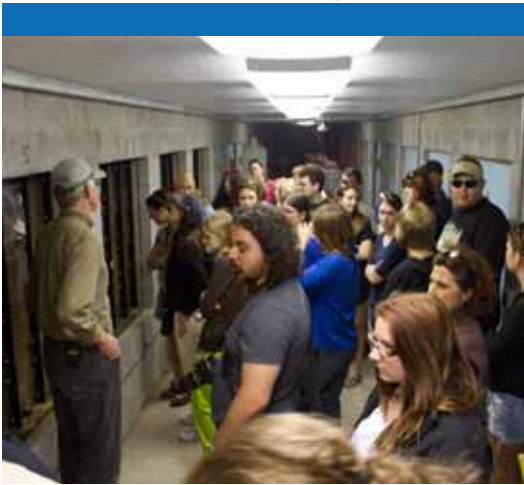
Education and research on climate change

Channel Islands and UM Biological Station (USA)

The Channel Islands with a marine area of 400,000 hectares were designated in the 1970's, just as the area around the University of Michigan Biological Station with a size of 4,000 hectares. As "first generation biosphere reserves" they focus on research and education.



Situated west of Los Angeles, the Channel Islands represent one of the last examples of natural Mediterranean ecosystems in North America. They have been altered by human activities, including fires, fishing, shipping, and livestock grazing. Many now dominant plant and animal species have been introduced. Unregulated tourism on the islands is another problem. Within the biosphere reserve, there also is national park with a visitor centre offering numerous educational programmes. The local communities participate in management decisions through public workshops, an advisory council and hearings.



The UM soil biotron (Flickr CC washtenawcc)

The biosphere reserve around University of Michigan Biological Station is the research and monitoring site for a special instructional, research and training centre established in 1909, serving students and scientists from all around the world and utilizing long-term environmental monitoring to

enhance understanding of the Earth's largest freshwater system. The local ecosystems, especially hardwood forests, wetlands, and swamps, are of particular interest and long-term monitoring and experimental plots are utilized. Population density is low and tourism is the major industry.

Through research and through education for students, decision-makers and the public at large, the UM Biological Station focuses on climate change as its most visible and successful programme, especially on biological and physical controls on forest carbon uptake and storage, biodiversity, and invasive species. In addition, energy efficiency of installed buildings is a high priority. The UM Biological Station aspires to produce as much energy as its operations require, e.g. through geothermal, solar and wind energy installations. All stakeholders are involved to prioritize mitigation and adaptation measures.

Similarly, the Channel Islands focus on research and education with regard to climate change. Recently an overview report on ocean acidification was produced, compiling information on impacts of lowered pH on marine organisms and ecosystems. The administration prepared an action plan that identifies specific budgets and the capacities needed, focusing on improved energy efficiency, identifying and tracking specific habitats and species to gauge climate effects and resilience. Educational programmes target decision makers and the public at large.



Rapeseed is a typical sight in the Rhön (CC Lutz Möller)

Maintaining quality of life in rural areas

Rhön (Germany)

The biosphere reserve manages to keep social structures intact in this rural part of Germany. It organizes local supply chains, offers advice on local biomass or on non-conflictual biogas production. Recently, it has established an online carpool for the region.



The biosphere reserve Rhön, designated by UNESCO in 1991, is located very centrally in Germany, covering 185,000 hectares. The rather isolated location on the former East-West border and the firmly rooted agricultural traditions have led to an intact cultural landscape. The Rhön is special in that traditional human use has kept the hilly ranges open, leading to the tourist slogan 'land of open distances'. The predominant occupation of the 160,000 inhabitants is farming and handicraft. A representative enquiry published in 2011 demonstrated that 91 percent of the population are proud of the biosphere reserve. 89 percent



Commuter waiting for his driver (© BR Rhön)

directly associate the Rhön with it. Most inhabitants perceive the biosphere reserve as a benefit and as an example for other regions. An important reason for this is the establishment of local supply chains and the successful marketing of regional products, crea-

ting real income.

Today there are also many flagship projects related to climate change in the Rhön. At the district level, renewable energy concepts target energy supply and demand. Local biomass networks for both electricity and heat have been created, just as local co-operatives on photovoltaic energy and biogas. The biosphere reserve offers advisory service for these networks, and to businesses, municipalities and private households on energy efficiency, especially on insulating buildings. A focus is on non-conflictual renewables such as rape-oil and biogas production from agricultural residues. The use of renewable energies has risen significantly over the past 5-10 years, mostly due to attractive feed-in tariffs in the national electric grid. Yet, the advice from the biosphere reserve accelerates this trend. In education, school curricula now include the issue of climate change. In the field of adaptation, non-natural conifer forests have been converted to broad-leaf woodlands, farms pass on to organic farming and bogs are restored.

A particularly interesting project is an internet-based carpool. While agencies for arranging lifts are well established for trips between German cities, there have been no offers for rural areas. Most people tend to commute from village to village every day with their individual cars. Through the new simple and cost free agency, commuters and travellers now have the opportunity of halving their traffic greenhouse gas emissions with a mouse click.



Monarch butterflies (Flickr CC Glenn Franco Simmons)

Global species migration and global change

Mariposa Monarca (Mexico)

The biosphere reserve preserves the pine-fir forest ecosystem critical for the survival of the Monarch Butterfly, since only this forest type provides the microclimatic conditions that give shelter from frost and winter rains. Climate change is beginning to change all that.



The Mariposa Monarca biosphere reserve, designated in 2006, is located in the extreme South of the Mexican plateau. Mountain ranges and hills cover three quarters of the surface of 56,000 hectares; the vegetation consists of several forest types, dominated by firs, pines, oaks and cedars.

Every autumn the migratory Monarch butterfly travels about 4,500 kilometres from Canada and the United States to arrive at its winter habitat in Mexico in November, one of the most amazing natural phenomena on earth. Here, millions of butterflies stay



They fill the sky (Flickr CC Pablo Leautaud)

for 5 months. The conservation of the pine-fir forest ecosystem is critical for the survival of the Monarch Butterfly, since only this forest type provides the microclimatic conditions that give shelter from frost and winter rains.

Climate change is most likely felt substantially already today in the area. Atypical rainfall and droughts have led to forest pests, floods and landslides in 2009 and 2010. At present, several projects address conserving the migratory species in times of climate change, foremost through improving scientific understanding and monitoring: At the hibernation sites, the microclimate, the soils, the butterflies' magnetoreception and their genetic variety are analysed; the firs, the pines and the birds are monitored.

At the level of adaptation, the most expensive measures in the biosphere reserve address adaptation in forestry, where almost 5 million dollars are invested. Major areas of investment in mitigation address improved slash-and-burn techniques and new forms of agriculture. The biosphere reserve brings together all stakeholders and other relevant partners as much as possible, e.g. in monitoring landslides or forest pests. Many different projects are carried out in improving participatory management.

Starting in 2010, the effectiveness of the existing management plan of the biosphere reserve is being evaluated, leading to recommendations for changes and adjustments of strategies. Some of the changes are already implemented, such as including climate change as a central component in everyday operating procedures of area management.



Fishermen in Velky Tisy 2009 (Flickr CC Lhotacus)

Adapting to increasing floods

Trebon basin (Czech Republic)

For the biosphere reserve in the shallow Trebon basin in South Bohemia, “low-impact” flood control along the Lužnice river is of particular importance for adapting to climate change. The key is to integrate effective nature conservation of alluvial ecosystems with flood control.



The biosphere reserve of some 70,000 hectares is located in the shallow Třeboň Basin in South Bohemia, not far from the Austrian border. This semi-natural landscape, designated by UNESCO in 1977, has been modified by human activities for more than eight centuries. It comprises 460 artificial fishponds and lakes that constitute the centre of the Czech fish-farming industry. There are floodplain swamps, marshes, primeval forests and sand dunes, as well as peat lands in the core area, which are also a Ramsar site. The biosphere reserve provides suitable habitats for many birds such as



Aerial view of the pond system

ducks, geese, or the white-tailed eagle. Nowhere else in the Czech Republic are there so many otters. The main economic activities of the 26,000 inhabitants are fish-farming, agriculture, forestry, timber and furniture manufacturing as well as tourism. The biosphere reserve administration pro-

motes management approaches linking local and central government, local communities and resource users.

So far, climate change is not clearly articulated as a priority in the strategy of the biosphere reserve. However, many activities de-facto directly address climate change. Of particular importance for adapting to climate change is “low-impact” flood control along the Lužnice river. The key is to integrate effective nature conservation of alluvial ecosystems with flood control. Several non-urbanized floodplain areas along the Lužnice river have been declared as nature reserves and thereby represent a space for retention of flood water, help to decelerate floods and to decrease their intensity and negative impacts.

In addition, peatbogs, fens and alluvial wetlands are protected and/or restored to increase their carbon storage capacity. Several communities in the biosphere reserve participate in nationwide programs for energy saving and insulation of buildings; the administration only provides additional support to this programme. This also applies to the several biogas plants using local agricultural residues, biomass and organic waste. The zonation of the biosphere reserve, including its designated biocorridors, is firmly embedded in all land use plans with a view to support adaptation to climate change. A long-term ecological research (LTER) network of the Czech Academy of Sciences monitors climate change at the Mokre louky site.



Hiking in the Vessertal biospher reserve (Flickr CC Matthias Durstewitz)

Proactively adapting management strategies

Danube Delta (Romania - Ukraine) and Vessertal-Thüringer Wald (Germany)

The EU “Habit Change” project assembles 16 “protected areas” and 17 scientific institutes from Central and Eastern Europe, establishing an adaptive management of climate-induced changes of habitat diversity.



The Danube Delta is a water labyrinth and the largest European wetland, made up of countless lakes and channels where the river Danube enters the Black Sea. The biosphere reserve designated in 1998 is shared by Romania and Ukraine and is particularly well known for its abundant birdlife; it is also a World Heritage and a Ramsar site. Many different ethnic groups live in small villages in the 630,000 hectares of the biosphere reserve, mostly from fishing, hunting, subsistence agriculture, reed harvesting and tourism.

Vessertal is the valley formed by the Vesser creek in the Thuringian forest



Pelicans in the Delta (Flickr CC Mugur Paun)

in the centre of Germany. With the surrounding area, and intersected by the famous long-distance hiking trail 'Rennsteig', this 17,000 hectare biosphere reserve dates from 1979. It mainly comprises spruce and beech forests and raised bogs, and is an important water source. The 4,200 in-

habitants live from agriculture, retail, forestry, glass manufacture and crafts. Tourism is a major source of income.

The "Habit Change" project is financed by the EU regional development fund. The 16 areas covered include Vessertal and the Danube Delta. The objective of the project is to establish an adaptive management, allowing the detection of changes based on a model and a map of habitat locations especially vulnerable to climate change. Current management practice is evaluated through stakeholder dialogues. It has been found that practitioners cannot easily differentiate pressures from climate change from other pressures; therefore supportive modelling is necessary. Guidelines for climate change adapted management are developed and their feedback into the system is investigated.

A comprehensive mapping exercise leading to a Web-GIS platform classifies all currently existing habitats, also including satellite imagery. This allows distinguishing disturbed from undisturbed habitats and the generation of regional risk maps. The final product will be an innovative web-based Spatial Decision Support System. Possible measures for an adapted management might be: (1) selecting some protected areas as redundant, (2) flexible buffer-zone management, or (3) management for landscape connectivity. In the long run, the objective is a joint European strategy for nature conservation under conditions of altered natural conditions.



Beach on San Andrés island 2009 (Flickr CC Colombia Travel)

Integrated coastal zone management

Seaflower (Colombia)

The management of the coastal zone on the overpopulated island San Andrés in the middle of the Caribbean involves policies on climate change, population, development, agriculture, oil exploitation and many other policy fields.



The Seaflower biosphere reserve is an archipelago of three islands in the middle of the Caribbean, not far from the Nicaraguan coast. It has been designated in the year 2000. The islands San Andrés, Providencia and Santa Catalina of altogether 30,000 hectares are at its centre, but the marine surface of the biosphere reserve extends enormously in all directions, with an altogether size of 46 million hectares. The three main islands are surrounded by coastal mangroves and intact coral reefs. The Providence barrier reef, one of the largest in the Americas, is 32 kilometres long and a biodiversity hotspot.



Tropica coral reef (Flickr CC USFWS)

The population is some 80,000 and concentrated in a coastal city at the north end of the San Andrés island. The other two islands are covered by an unusually well preserved tropical forest. The ecosystems on San Andrés suffer from the effects of over-population and mass tourism, inadequate in-

frastructure and poorly planned urban development. A special programme of education, public awareness and community involvement was therefore organized; it included environmental education entitled “Islands Natural Alphabet”, covering coral reefs and mangroves, tree planting and seed collection. The biosphere reserve supports eco-tourism, traditional subsistence agriculture, small animal husbandry, and artisan, self-sufficient fishing.

Climate change has entered the range of challenges only recently, yet today it is defined as an important issue in the management plan, with appropriate support from the government. The biosphere participates in national and international knowledge exchange.

Climate change is seen always in conjunction with other current pressures such as large development projects, mining as well as oil exploration and exploitation. Adaptation to climate change focuses on: integrated surface and groundwater management; strengthening the implementation of the Seaflower marine protected area through demarcation, enforcement and a specific management plan; as well as integrated coastal zone management.

The management of the coastal zone is a specifically important measure since it involves addressing population policy, guidelines on climate change-proof construction, recommendations to improve cattle raising, and many others.



Automatic Weather Station in Katunskiy BR (© Tatjana Yashina)

Monitoring the mountains

Sierra Nevada (Spain) and Katunskiy (Russian Federation)

Two out of 25 mountain biosphere reserves taking part in the GLOCHAMOST initiative of UNESCO, implementing a research strategy to cope with the impact of climate change on the environment and on livelihoods.



The Sierra Nevada is the highest mountain chain in the Iberian Peninsula reaching up to 3,479 meters above sea level. At its periphery, the Sierra drops quickly, forming steep slopes and deep valleys. Special flora can be found in the high cold pastures, in the midlands dolomite scrub communities and in the lowland semiarid scrub. There is a diverse entomofauna and avifauna and a rich cultural heritage. Some 1,500,000 tourists visit the biosphere reserve, which was designated in 1986, every year and some 10,000 inhabitants live inside, engaged in agriculture, animal husbandry, forestry and tourism.



Calahorra castle and the Sierra Nevada (© BR)

The Katunskiy biosphere reserve is located in the higher part of the Altai Mountains and neighbouring ridges. Designated in 2000, it is also a World Heritage site; an important objective is to conserve archaeological objects, as well as the cultural landscape and the culture of the indigenous popula-

tion. These make a living from deer farming, sheep grazing, forestry, apiculture, hunting, fishing and tourism.

Both biosphere reserves take part in the GLOCHAMOST initiative investigating the impact of climate change on biodiversity, water, land use change and mountain economies. The research reports of Sierra Nevada and Katunskiy have already been published in 2009 and 2010.

A “Global Change Observatory” monitoring programme is one of the key activities of Sierra Nevada, assembling managers and scientists. The Spanish biosphere reserve invests more than 30 million dollars on forest adaptation and 9 million dollars on reforestation. Many other projects of more than a million dollars are underway such as adjusting to increasing drought, adaptation in agriculture or protecting rare high-altitude flower species. Climate change is fully integrated into the work of the biosphere reserve as a very high priority.

Katunskiy focuses on climate change mitigation in forestry, especially increasing capacities to prevent and fight forest fires, on transboundary cooperation with the Kazakh Katon-Karagaiskiy National Park to sustain biological corridors and on provision of alternative sources of income for local communities, e.g. through ecotourism. The strategic significance of climate change is also fully identified, including piloting the use of solar heaters instead of fuel wood.



The area won by relocating the Lenzen dyke (© Flusslandschaft Elbe Brandenburg)

Restoring wetlands and solving biomass production conflicts

Elbe river landscape (Germany)

The biosphere reserve along the Elbe river contains the largest contiguous floodplain forests in Central Europe. Floodplains are restored, comprehensive research is done and low-impact biomass energy is produced.



The biosphere reserve spans 340,000 hectares along 400 river kilometres and has 270,000 inhabitants. Habitats of European significance are flooded grasslands, sand dunes, mixed forests and marshlands. Having been threatened with extinction in the 1950s, again more than 1,200 Elbe beavers live in the biosphere reserve. The floodplain is an important resting and wintering area for Nordic swan and goose species. Potential conflicts between migratory birds and farmers' land requirements are kept to a minimum by special interventions. Some villages host considerably large stork communities.



Biogas plant & sunflowers (© Susanne Laschütz)

Another key area of intervention, especially in the context of climate change, is the restoration of wetlands. The oxbow lake 'Kühnauer See' was restored for more than 5 million Euros. The largest dyke relocation projects in Europe can be found in the biosphere reserve as well. Relocation

of the Lenzen dyke, for example, was finalized in 2010, replacing 430 hectares of farm land by floodplains interspersed with alluvial forests. As a consequence, floods have more space to spread out into oxbow lakes and flooded meadows, thereby reducing flood risks for residents. At the same time, new natural habitats with little human interference are created.

From 2009 to 2014, a research project defines climate change adaptation strategies for the Elbe river floodplains. This project is part of the federally funded "KLIMZUG-NORD" project. Priority research issues are: extreme flood and extreme low water events, conservation of floodplain grasslands, sustainable agriculture on floodplain grasslands contaminated by dioxins and heavy metals, restoration of alluvial forests, as well as participation of residents in climate change issues.

In 2010, the biosphere reserve has finished a large-scale pilot project resulting in recommendations for solving potential conflicts between nature conservation and production of biomass as a source of renewable energies. These recommendations have been worked out in close cooperation with relevant stakeholders in a series of round table discussions. A pilot project to produce biogas from floodplain grassland silage has been carried out. The approach of the biosphere reserve is to focus on the opportunities to reconcile conservation and economic use rather than on the potential conflicts.



Strong winds have brought down this tree (Flickr CC Pachango)

100 percent renewable energies

El Hierro (Spain)

The biosphere reserve on the smallest of the Canary Islands currently builds a wind-hydro power station that could make it the first island in the world to become entirely self-sufficient in electricity. In addition, all of the island's cars shall be powered by electricity.



El Hierro has been a biosphere reserve since 2000. This Spanish volcanic island is the most western, youngest and smallest of the Canary Islands off the coast of Morocco. El Hierro has a great biological diversity at the ecosystem and at the species level.

One of the three core areas is situated in the marine part to the south of the island. Local fishermen have cooperated in the establishment of the marine reserve and are supportive of marine biodiversity protection and sustainable fishing. The programme for the sustainable development of El Hierro involves all economic sectors and has



El Hierro coast (Flickr CC May Escobar)

been in place since 1995. The main economic activities of the population are agriculture, cattle raising, fishery and ecotourism.

El Hierro has decided to invest about 54 million Euro in the construction of a wind-hydro power station that could

make it the first island in the world to become entirely self-sufficient in electricity. The power station is due for completion in 2011.

The project entails building an integrated hydro-station and wind farm which will complement one another. When the wind blows strongly, as it often does, the five windmills perched on a crest of this steep volcanic island will produce enough energy to pipe salt water from the sea up a steep slope to a reservoir 700 m above sea level nestled in the volcanic crater. When the wind falters, the water in the reservoir will be released down the hillside into a lower reservoir, generating power as it passes through the turbines.

The wind-hydro station is expected to produce 10 megawatts, enough to fulfil all the electricity needs of the island's 11 000 inhabitants and of the 60 000 tourists who visit in summer. The energy generated is expected to save the islanders 2 million Euro per year, enabling them to write off the project cost by 2040. Some 60 percent of funding is being provided by the El Hierro municipality, 30 percent by a Spanish company and 10 percent by the Technology Institute of the Canary Islands. Part of the investment will finance the construction of a desalination plant to provide water for irrigation.

In addition, there are plans to make the island's cars 100 percent electric and to install solar panels on the island to produce hot water.

The selection of good practice case studies in this publication is based on information provided by respondents to the questionnaire distributed in February 2011 to all UNESCO biosphere reserves; in addition, information from the UNESCO MAB online database has been used. If you miss a case study on a particular good practice, the reason might be that a biosphere reserve has not responded in time. This might also be the reason why there might not be a case study from a particular country. The editors thank all those managers and scientists having contributed to this publication.



Photos, from upper left clockwise (all rights reserved): Flusslandschaft Elbe Brandenburg, KfW--Bildarchiv/photothek.net, Gertrud Hein, Flickr CC james00marsh, KfW-Bildarchiv/photothek.net, BR Noosa



UNESCO biosphere reserves are ideal places to test, evaluate and implement comprehensive climate change policies. This publication presents case studies about good practice to demonstrate what biosphere reserves are already doing in this policy field.

The case studies are drawn from an international survey. 28 case studies cover good practice e.g. from UNESCO biosphere reserves in Costa Rica, Mexico, Ethiopia, Senegal, China, Republic of Korea, USA, Germany, Spain, Sweden or many others.

ISBN: 978-3-940785-27-5