MAINTAINING BIODIVERSITY BY PROTECTING THE ENVIRONMENT

A brochure published by the
Federal Environment Agency (UBA)
to mark the International Year of Biodiversity

CONTENT

BIODIVERSITY DEPENDS ON ENVIRONMENTAL PROTECTION

The introduction of wastewater treatment plants as well as the implementation of the Ordinance on large firing installations have probably been the most extensive programmes for the protection of biodiversity ever carried out in Germany. As a consequence, the water in Germany's rivers is now clean enough for numerous fish species to have returned to their natural habitats, as in the case of the river Rhine. In post-unification Germany, the Elbe region caught up rapidly with these developments. The tremendous improvement achieved there in terms of water quality can be seen in the new tradition of 'Elbebadetage' celebrating the fact that swimming in the river Elbe is now possible again. Without legal air quality standards leading to massive reductions of industrial emissions, it would not have been possible to halt the acidification of our bodies of water and to stop forest die-back. Active nature conservation efforts are of course always needed to ensure that habitats and endangered species are maintained by practical measures taken in the field. However, nature conservation alone cannot succeed. We must also continue to reduce background levels of environmental pollution so that biodiversity has a chance to prevail.

The greatest danger to biodiversity today is posed by global climate change. More than 30 % of plant and animal species are threatened by climate change. Coral reefs in the southern hemisphere are committed to an irreversible decline at atmospheric CO_2 levels exceeding 350 ppm. Considerable reef damage is already clearly visible today. The current CO_2 level of approx. 380 ppm is already well above the 350 ppm threshold, and the two-degrees target for temperature rise currently being negotiated worldwide would allow even higher CO_2 levels. If this is all we can achieve, the future of the biodiversity – and beauty – of reefs is already doomed. It is not, however, just climate change that poses a threat to nature in general, but also the high level of nutrient inputs into the landscape. In Germany, as in many parts of the world, nutrient pollution upsets the delicate ecological balance of many habitats. As a result, nutrient-poor ecosystems such as moorland and nutrient-poor grassland have no chance of survival. The reduction of ammonia and nitrous oxide emissions is therefore a truly essential part of protecting our biodiversity. For this purpose, it will be necessary - especially in the field of agriculture – to create more incentives ensuring that no more fertiliser is used than absolutely necessary. This would also relieve the pressure on freshwater lakes and coastal waters which are still suffering from high nutrient levels causing for example excessive algal growth.

In 2007 the German Federal Government adopted a National Strategy on Biological Diversity. This strategy must not be seen as referring solely to nature conservation. It is by no means restricted to setting objectives for programmes supporting threatened species or to designating various forms of nature reserves. It is, in fact, an integrated strategy which sets challenges for all sectors and embraces the entire spectrum of environmental protection measures. The Federal Environment Agency (UBA) will support the implementation of the National Strategy by contributing its own expertise so as to help ensure that the major successes achieved in respect of air pollution control and water protection are followed up by further progress in protecting biodiversity.

Jochen Flasbarth
President, Federal Environment Agency

INTRODUCTION

After decades of public discussion the importance of environmental protection and its vital role in ensuring the well-being of present and future generations has acquired considerable public awareness [1]. Ministries for the environment have been established at both Länder and federal level. As a result consideration is given today to the protection of water, soil and air across all sectors of society.

Almost 20 years ago at the Conference on Sustainable Development in Rio de Janeiro, another term emerged: namely the threat to biodiversity. For the first time the global dimension of the loss of species was recognised and a convention was adopted at international level to halt this disastrous trend. The Convention on Biological Diversity (CBD) adopted in 1992 in the course of the Conference on Sustainable Development in Rio de Janeiro, aims at the protection of biodiversity, regulates the establishment of mechanisms for its sustainable use and the equitable sharing of benefits [2]. By signing this Convention, a total of 193 states, with Germany among them, as well as all the European Union (EU), accepted their share of global responsibility for maintaining biological diversity. The EU made it one of its core objectives to halt biodiversity losses by 2010 [3].

What threatens biodiversity and how do we stop the loss?

The global decline in biological diversity is dramatic. The EU estimates [1], that for example:

- the current rate of species extinction exceeds the natural rate by a factor of 100 to 1,000.
- 80 percent of forests or woodlands which covered the earth 8,000 years ago, have been cut down, damaged or fragmented.
- up to a third of the world's coral reefs are damaged and another third is threatened.
- more than 25 percent of the land surface and more than 900 million humans worldwide are affected by progressive desertification and its consequences.

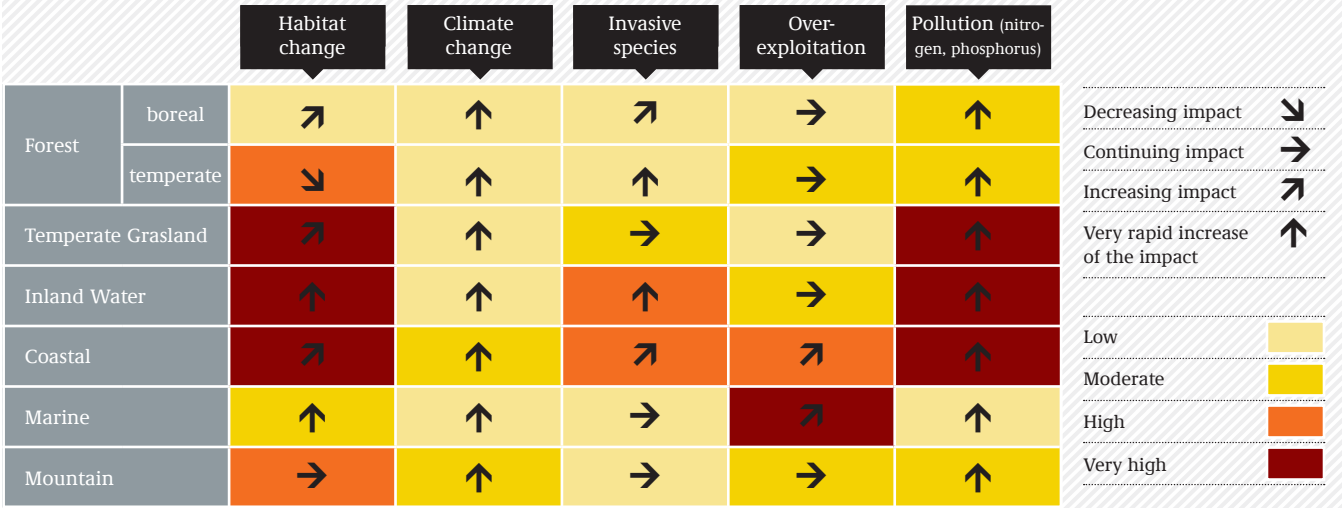
But aren't all these events something that is happening a long way off or occurred in the distant past? Isn't it sufficient when people fight for biodiversity in those countries which are still species-rich? Many people in Europe demand the preservation of primeval forest not knowing that 70 % of our own regions too were once "primeval forest". Although 30 % of our land is still covered by forests, however, natural woodland, which is particularly valuable from an ecological viewpoint, accounts only for about 1 % of the forest area. The size of these natural woodlands is often too small to provide suitable habitats for wide-roaming species such as lynx or wolf. The German Federal Government has decided to increase the percentage of natural forests to 5 % of the wooded area - an ambitious goal which will require some considerable effort to achieve [4].

By caring for their own basic survival needs, humans change the natural conditions for the survival of plants and animals. Even long before industrialisation, but especially in the course of its progress, the intensification of production and consumption entailed major habitat losses and brought about changes in biogeochemical cycles. As long as the encroachment is minor or there is sufficient space for species to take evasive action and enough time for adaptive evolution, this is not too serious a problem for plant and animal communities. But ever since the 20th century, humans have significantly changed the global biogeochemical cycles (for example, with regard to carbon and nitrogen). This has upset the delicate natural balance on a global scale, especially in regions subjected to intensive use. Ecosystems can buffer this type of damage in the initial stages and they can even recover. However, continuous or increasing disturbances (such as eutrophication or climate change) which at first may be scarcely perceptible can distinctly affect the living conditions of plants and animals thus leading to changes in the species composition typical of a particular habitat. The Millennium Ecosystem Assessment [5] identified the most important drivers for biodiversity loss and degradation of ecosystems.

Accordingly – with the exception of invasive species – the main causes of worldwide losses of biodiversity are closely related to the classical domains of environmental protection:

- Climate change owing to the release of greenhouse gases from the burning of fossil fuels, industrial production and agriculture, as well as to large-scale changes in land use (deforestation, converting moorlands and meadows to cultivated ground).
- Changes in land use, increasing surface sealing, and landscape fragmentation as well as changes

FIG. 1 MAIN DIRECT DRIVERS OF CHANGE IN BIODIVERSITY AND ECOSYSTEMS [5]



Source: MARS 2005; Beck, S. et al (2006): The Millennium Ecosystem Assessment and its relevance for Germany, UFZ report

in the structure of natural water bodies (e.g. channelisation of rivers, construction of weirs).

↗ Nutrient and pollutant loads in terrestrial and aquatic ecosystems from agricultural, industrial and transport activities.

The importance and drama concerning these drives is illustrated in the topical research published by Rockström et al. [6] which quantifies 'planetary boundaries' (global threshold values) for a number of key processes, climate change being one of them. Transgressing these boundaries will cause global and often irreversible changes in the environment. It may be debatable to what extent it is possible to differentiate precisely between the individual processes and whether the boundaries suggested are the correct ones. It is undeniable, however, that (nearly) all of them are of crucial importance for the state of biodiversity.

In 2007 the Federal Government adopted a National Biodiversity Strategy as Germany's contribution to the CBD. It aims at significantly minimizing and eventually halting the threat to biodiversity, in Germany and worldwide. This strategy lays down objectives which must be achieved. Many of the action areas identified are closely related to the classical protection of the environment and hence to the diverse range of topics within the remit of the Federal Environment Agency (UBA).

This brochure provides an overview of the manner in which environmental protection in Germany contributes to the preservation of biodiversity. It also highlights areas where existing regulations and legal instruments remain inadequate.

TAB. 1: PROCESSES WHICH INVOLVE PLANETARY BOUNDARIES [6]

Climate change	Global freshwater use
Ocean acidification	Changes in land use
Stratospheric ozone depletion	Chemical pollution
Atmospheric aerosol loading	Biodiversity loss
Biogeochemical flows: interferences with N and P cycles	

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5 MASR 2005 adapted from Beck, S. et al.: Die Relevanz des Millennium Ecosystem Assessment für Deutschland, Leipzig, 2006 (UFZ-Bericht 02/2006), p. 13

6 Rockström, J. et al.: A safe operating space for humanity. In: Nature, 461 (2009), No. 7263, p. 472 – 475

THE HEDGEHOG

Many perish trying to overcome obstacles such as roads which cross their paths.

NO SPACE FOR BIODIVERSITY?

URBAN SPRAWL, LANDSCAPE FRAGMENTATION AND LAND USE

Burgeoning settlements and transport infrastructures mean the loss of more and more open space and uninhabited land as habitat for wildlife and plant populations.

The remaining open spaces are variously fragmented by ribbon settlements, transport routes and other linear structures such as pipelines and similar conduits. In densely populated regions only a few isolated areas of open space ultimately remain. Both problems need to be tackled using the appropriate tools.

I. Stemming the tide of urban sprawl and landscape fragmentation

For many species, ribbon developments and transport routes represent insurmountable obstacles. In particular, animal species that need large territories are directly affected by the fragmentation and loss of the associated habitat. However, there are also adverse effects on species with less extensive habitat requirements. Transport routes in particular can have fatal consequences. Many animals perish when attempting to overcome these obstacles. According to estimates produced by the Deutscher Jagdschutzverband e.V. (German association for shooting and game conservation), around 500,000 animals die on German roads every year. In the case of animal populations living in narrowly defined fragments of the landscape, with small numbers of individuals per population, the loss of just a few individuals can cause the collapse of the entire population in the area concerned. Small population sizes lead to in-breeding which, in the medium term, can deplete the gene pool. At population level, lack of genetic diversity tends to impair resistance to a wide range of pathogens and the ability to adapt to changing environmental circumstances. This mechanism too can cause the extinction of individual sub-populations.

Is there any such thing as 'Green Urban Sprawl'?

It is a fact that properly laid out and well-maintained settlements are potentially capable of providing habitats for a greater number of species than monocultural farming land devoid of biodiversity. It is humans, however, that are at the core of the problem. We treat some species like cherished guests (e.g. titmice), while waging an all-out war against others (e.g. moles), or even attempting to eradicate them. At the end of the day, it is humans who decide which species they will or will not tolerate in their vicinity. Such selective 'species conservation' is incapable of guaranteeing a sustained natural equilibrium, let alone biodiversity. However, it is also a fact that many species quite simply cannot survive in human settlements, and that other species, which used to be indigenous to the areas in question, have been driven out by changes in our construction styles and economic activities. So we are worlds away from natural biodiversity, even if we try to develop 'green' settlements. There is no substitute for near-natural open space, so that we must do everything in our power to retain or restore it in all its diversity, singularity and beauty.

Taking steps to reduce landscape fragmentation

The National Strategy on Biological Diversity [1] states that a comprehensive plan for minimising fragmentation effects must be formulated by 2010, and that above all, existing non-fragmented low-traffic areas must be safeguarded. The Federal Transport Infrastructure Plan, along with regional transport infrastructure plans, must in future be configured in such a way that any significant impact on biological diversity is avoided. The Strategic Impact Assessment, to be applied to public plans and programmes, is an appropriate tool which also provides for a comprehensive examination of the impacts of the plan as a whole. For this purpose the impacts of all projects of the plan have to be summarized. In view of the extensive landscape fragmentation that has already taken place, a programme for restoring connectivity between areas of the landscape that are of relevance to biodiversity must also be submitted by 2010.

FIG. 2
THE RAPID INCREASE IN ROAD TRAFFIC AND THE DENSITY OF REGIONAL TRANSPORT NETWORKS GO HAND IN HAND

FIG. 3
A GROWING NUMBER OF GREEN BRIDGES PROVIDE WILDLIFE CROSSINGS

UBA action targets in relation to Federal transport routes

Two indicators are used to measure landscape fragmentation: 'non-fragmented low-traffic areas' and 'effective mesh size. As early as 2003, the Umweltbundesamt (UBA/Federal Environment Agency) proposed the first action targets for the restriction of further landscape fragmentation by means of using the 'effective mesh size' (Meff) indicator [2]. In order to prevent any further fragmentation of the landscape by new transport infrastructures, the UBA also put forward proposals for curbing the growth in traffic volume (especially long-distance haulage) and reducing the associated land take [3]. Under the next Federal Transport Infrastructure Plan, the Strategic Impact Assessment should provide a useful tool for analysing the overall effect of new fragmentation impacts.

NABU's Federal plan for wildlife crossings and the Federal habitat networking programme for restoring connectivity

To offset the impacts of existing landscape fragmentation, the NABU (German association for nature conservation) has formulated a plan to interlink, over the next few years, the most important natural habitats into one coherent network (the 'Bundeswildwegeplan'/Federal plan for wildlife crossings) [4]. The Bundesamt für Naturschutz (BfN/Federal Agency for Nature Conservation) commissioned Kassel and Kiel Universities to develop a calculation tool of prioritising measures designed to restore connectivity, for use in a Federal habitat networking programme. Initial measures designed to restore connectivity (by means of green bridges, for example) have now been introduced under the German Federal Government's economic stimulus package. Furthermore, the UBA is now proposing, in advance of the next Federal Transport Infrastructure Plan, to also incorporate a 'defragmentation programme' for upgrading and adapting existing federal transport routes in order to meet biodiversity requirements. The UBA recommends that similar programmes be considered at the level of Länder governments and regional administrations.

II. Limiting the land take

The German Federal Government aims to reduce the land take for settlements and transport routes from 130 ha per day in 2000 to 30 ha per day in 2020 ('30 hectare target'). In 2002, this action target was incorporated into Germany's 2002 Sustainability Strategy at National Government level, having been formulated for the first time in 1998 by the then Federal Environment Minister, Angela Merkel. The National Biodiversity Strategy (NBS) addresses this target by specifying that by 2015, individual targets for reducing spatial and local development at the level of the Federal Länder, districts and municipalities, must be formulated. The reduction in land take should lead to environmentally and socially compatible land use, and thereby to sustainable development. This involves not only drastically reducing the

development of new settlements and the construction of buildings in open space and undeveloped land, but also restricting the growth of additional long-distance traffic. The ability of habitats to function as ecosystems when they are fragmented by ribbon settlements and transport routes is seriously compromised, and they become worthless for wide-roaming species sensitive to disturbance. The UBA has proposed interim targets in order to monitor the actual development and effectiveness of the measures implemented. With a view to achieving the target at National Government level, the 80 ha per day target for 2010 marks the halfway point between the initial situation in 2000 when land take reached 130 per day and the 30 hectare target for 2020. However, the long-term target must be the achievement of a net land take per day of 0 ha. If we fail to achieve this, then every natural space in Germany will sooner or later disappear [2]. Over the four years from 2005 to 2008, the average growth in land take for settlements and traffic stood at 104 ha per day. The current economic situation has brought a downward trend, so that in both 2007 and 2008, the total was below the 100 ha per day threshold (see figure 4) [5].

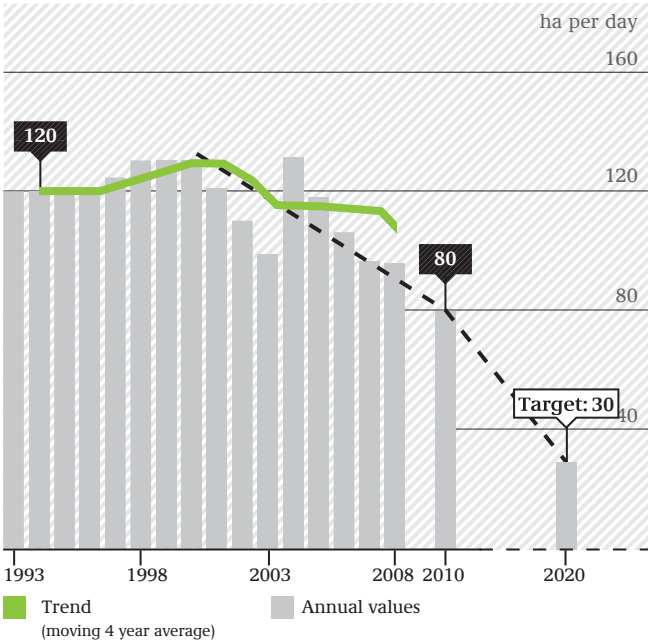
Despite this reduction, there is no certainty that the 80 hectare interim target for 2010 will be attained. Although growth in land use for residential and commercial purposes has slowed, there has been sustained high growth in land use for transport routes over the past 20 years. An economic revival in housing and commercial construction could put a definitive end to the encouraging downward trend we have seen over recent years.

Vast potential for development in brownfield sites and other derelict or vacant areas within settlements

The German Federal Government's 30 hectare target can only be attained provided that future land take for new developments shifts from greenfield to brownfield sites, by building on existing vacant sites or abandoned industrial sites, or by moderate infilling. If demand remains constant, it should be possible for the 30 hectare target to be attained by locating three quarters of new land use on brownfield sites and only one quarter on greenfield sites.

Given the fact that, by statistical projection, there were at least 168,000 ha of sites with unproductive buildings or undeveloped building ground in Germany as a whole in 2004, unproductive land within settlements offers vast potential, the greater proportion of which remains unexploited. However, the situation differs significantly from region to region – a fact that must be taken into account when defining local targets. Unproductive land in

FIG. 4 DAILY INCREASE IN AREAS TAKEN UP BY SETTLEMENT AND TRANSPORT ROUTES BETWEEN 1993 AND 2007



Source: Umweltbundesamt: Zunahme der Siedlungs- und Verkehrsfläche vom Jahr 1993 bis zum Jahr 2008

the eastern German Länder increased between 2000 and 2004 by 2.5 ha per day, whereas the economically advancing regions of the western Länder were increasingly able to put unproductive land to new use. Nevertheless, sizeable injections of public funds were required in order to subsidise the upgrading of formerly developed areas.

Despite the availability of a significant amount of unproductive land in many regions, the trend is still towards the development of greenfield sites rather than formerly developed sites which are now abandoned. One reason for this is the fact that some players incur costs while others accrue benefits in connection with the development of settlements: the owners of greenfield sites and project developers in particular accrue benefits, while taxpayers, feepayers and central administrations incur costs. However, in the case of a local authority that allocates land for construction, it is frequently not clear whether it actually derives any long-term profit from doing so, even if most of the councillors believe that this is so. In addition, subsidies (the use of subsidised Riester pension savings for housing purposes, and the use of structural funding) as well as the prevailing tax system (commuting allowances) also serve to promote urban sprawl. The network of costs and benefits associated with urban sprawl was studied in detail in the project entitled 'Von der Außen- zur Innenentwicklung in Städten und Gemeinden' (from greenfield to brownfield development in towns and municipalities) which

was commissioned by the UBA [6]. The Länder have developed many activities designed to promote a reduction in land take, while the Federal Ministry of Education and Research also promotes the development of progressive approaches [7]. However, these activities alone are not capable of bringing about a sustained reversal of the trend in relation to land take. The recent decline in land take per day should not be mistaken for evidence of a lasting change in human behavioural patterns, because it is due primarily to the slowdown in new construction activity as a result of the economic downturn. Most local authorities, planners and even private individuals are still entirely or relatively unaware of the need to develop land sparingly.

III. What still needs to be done

If we are to halt the repression of nature, then the adverse consequences of land take and fragmentation must be highlighted through intensified and effective public relation activities. This includes raising awareness of the benefits of brownfield development. This approach can also foster the acceptance of a supraregional change of policies throughout Germany, giving incentives which seek to curb urban sprawl, thus strengthening spatial planning and cooperation between local authorities.

Spelling out the ecological impacts of land take, but above all highlighting its negative economic and social repercussions

The continued expansion of settlements and infrastructures generates ongoing costs producing high fixed costs for the economy as a whole, i.e. for both businesses and their employees. Given the relentless nature of economic globalisation, we need to prevent the generation of additional fixed costs in order to increase competitiveness. Demographic change has not only brought the threat of growing numbers of empty properties but also of reductions in the value of a large proportion of the existing commercial and residential properties. This also impacts on pension provision for a progressively ageing population. In many regions, urban sprawl exacerbates the further segregation of social groups and can consequently further undermine social cohesion.

Optimising the situation at the margins of economic centres

In a number of research projects, the UBA has examined subsidies that harm the environment, in particular those that promote urban sprawl. In addition to commuting allowances which encourage urban sprawl in the environs of conurbations, these subsidies may include a number of programmes which are designed to promote structurally weak areas and rural regions, unless they are targeted precisely at making the existing settlements and infrastructures more viable. The publicly-subsidised scheme for the use of Riester pension savings for housing purposes is equally critical, because it could, in the medium term, also boost new housing development in static or shrinking regions.In order to regenerate unused brownfield sites, we would also wish to see local authorities being given the opportunity, under a zone-related statute enactment regime, to impose higher land tax on sites that are developed but remain unused, in zones which suffer from shortages of development land. This should encourage property owners to put the relevant sites to use. For the purposes of municipal development planning and the expansion of infrastructures of all kinds, it would make sense to subject such measures in the first instance to a regionally-coordinated demographic survey, together with a cost-benefit analysis and an Environmental Impact Assessment, and to make the granting of subsidies dependent on the findings resulting from this survey.

Setting rigorous planning targets at the level of Länder Governments and regional administrations

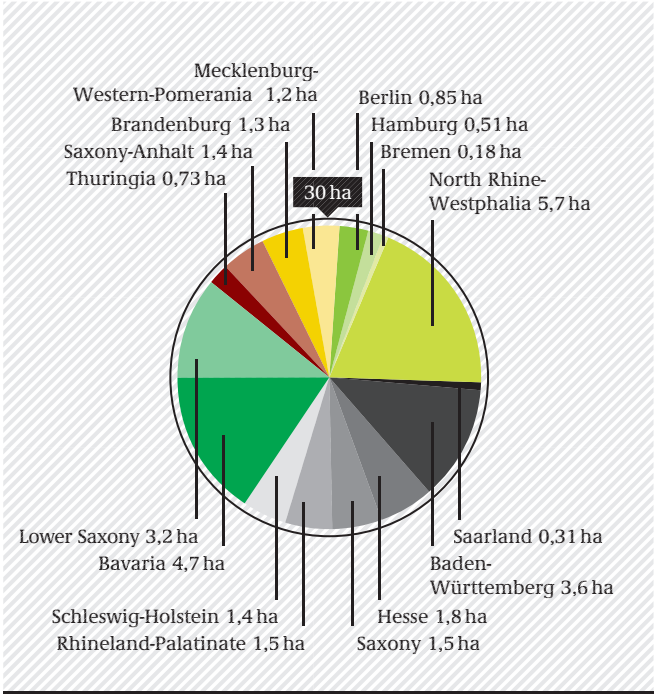
In order to further promote cooperation between local authorities and to restrict the growth in land use for settlements and transport to what is absolutely essential in the region concerned, the Länder should set quantitative regional targets for the amount of additional land that is released for use by 2020, in order to meet the 30 hectare target. The regional planning departments should then apportion these quantity targets (contingents) among the individual local authorities. However, more stringent spatial planning is only possible provided the Länder set themselves targets for reducing land take, which ultimately combine to meet the 30 hectare target. The KBU (Kommission Bodenschutz/Commission for Soil Protection of the UBA [8]) has proposed a formula for the fair apportionment of the 30 hectare target among the autonomous Länder which make up the German Federal Republic (see figure 5).

Innovative Tools? The proposed land development certificate trading

Binding quantitative targets in relation to spatial planning are often criticised for being too inflexible to respond to unpredictable economic or social requirements and local developments. In order to permit greater flexibility without jeopardising the 30 hectare target, the introduction of a trading scheme for land development contingents was proposed, similar to the scheme used for climate certificate trading. However, the controlling effect of traditional planning would remain in force, thus retaining the function of protected areas and

of areas designated for special use [9]. In its coalition agreement, the German Federal Government resolved, based on the available research data and results from pilot schemes, to institute a national pilot scheme for land contingent trading. The scheme is currently under preparation, with the UBA's active involvement.

FIG. 5 THE 30 HECTARE TARGET CONTAINED IN THE SUSTAINABILITY STRATETY 2007 - 2020: APPORTIONMENT AMONG THE FEDERAL LÄNDER



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LAND TAKE IN GENERAL:

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THE EARTHWORM

There is no ecological substitute
for its function.

UNDERSTANDING SOILS

IT CANNOT BE DONE WITH LEGAL FRAMEWORKS ALONE: WE MUST IMPROVE PUBLIC AWARENESS OF SOIL ORGANISMS

One gram of soil contains billions of microorganisms; extrapolated to one hectare, this equals 15 tonnes live weight.

‘Plants, animals, fungi and microorganisms purify the water and air, and ensure fertile soils. The intact ability of the soils and waters to perform self-purification is therefore crucial for the abstraction of drinking water. The natural fertility of the soil ensures a supply of wholesome food. These are not mechanical processes, but instead form part of a complex structure of ecological interactions. Ecosystems have a high absorption capacity and ability to regenerate, but they too have their limitations.’ [1]

This quotation from Germany’s National Biodiversity Strategy (Nationale Strategie zur biologischen Vielfalt) encapsulates rather neatly what biodiversity means to us as users of natural resources. One gram of soil contains billions of microorganisms, such as bacteria, fungi, algae and unicellular organisms. Several hundred thousand, if not millions, of soil animals, such as nematodes, earthworms, acarians, woodlice, springtails and insect larvae live under one square metre of soil. Extrapolated to one hectare, this equals approximately 15 tonnes live weight in rooted soil. Putting it another way, this equates roughly to the weight of 20 cattle. This means that there are significantly more organisms living in the soil than on it. The role played by these organisms in converting nutrients, decomposing contaminants and in the development of soils, is extremely complex. The examples listed below demonstrate that soil organisms play a crucial role in the formation of humus and soil:

- Litter is decomposed by soil animals, which greatly increases the surface area (pelleting effect) available for microbial conversion.
- Microscopic soil animals (e.g. springtails, (Collembola)) feed selectively on specific microorganisms thus maintaining the optimal growth phase of these creatures.
- The substrate relevant to microbes is continually changed by soil animals; earthworms, for example, and other microfauna transport nutrient-rich organic substances into deeper soil layers.
- The activity of soil organisms can offset inhibitory effects on microbes (bacteriostasis).

Microorganisms, in particular, fulfil essential functions in soil ecosystems, especially in making accessible those nutrients which are required for plant growth. Soil life plays a key part in maintaining natural soil functions. Organic plant waste, for example, is integrated into the soil, broken down and ultimately decomposed thanks to decomposition and conversion activities. In this way, the nutrients present will finally be released in mineral form thus making them available to plants. In this process, soil organisms also provide favourable physical conditions in the soil. Owing to the fact that they displace and mix soil material (bioturbation) and owing to the bonding of soil particles by means of mucilage secretion (organic stabilisation), soil organisms are instrumental in building the soil pore system. They form stable clay-humus complexes with high storage

capacity for water and nutrients and provide a fine crumb structure with very low susceptibility to erosion. Furthermore, they are able, up to a point, to buffer adverse effects of organic contaminants on the soil, on groundwater and on the food chain. It is of vital importance to understand the biocenosis (organisms interacting in an ecological community) of individual soil organisms (microorganisms, plants, animals, fungi), because the overall soil cenosis contributes towards maintaining the habitat function and other soil functions (biogeochemical cycling, soil fertility). Soil organisms are present in soil in varying densities, with the number of organisms and the number of species giving only vague clues as to their importance to biogeochemical and energy cycles (Fig. 7). Soil biology with its soil-typical cenoses is characterised by means of determining population density, biomass and species diversity. Research into soil biology is a major component of a research programme in Germany conducted on permanent soil monitoring sites (Bodendauerbeobachtungsflächen, BDF) at regular intervals, because biological characteristics of soil can be used as an early-warning system for recognising adverse changes in soil [2]. Furthermore, results from monitoring sites can be used to indicate whether good agricultural practice has been observed in order to maintain or facilitate a given biological activity. Finally, they can be used as a basis for monitoring compliance with threshold values for contaminants, such as heavy metals and organic compounds harmful to the soil and to soil organism pathways.

FIG. 6
SPRINGTAIL (COLLEMBOLA) AND NEMATODES.

So far Germany's National Biodiversity Strategy, adopted by the Federal Government in 2007 has not adequately addressed the subject of soil biology. The Action Fields merely set objectives – e.g. reduction in substance inputs (such as nutrients, contaminants and pesticides) – which indirectly also fulfils the purpose of protecting soil organisms. The achievement of goals in respect of nature conservation and species conservation, in combination with the envisaged extensification in agriculture and forestry, and cutting down on land take, will also contribute to the conservation of soil organisms. Living soils are essential for maintaining soil quality and soil fertility. It will, however, be necessary to carry out further research on (epigeal) organisms living on the soil in order to obtain better descriptions for interactions between these groups of organisms and those (endogeic) living in the soil.

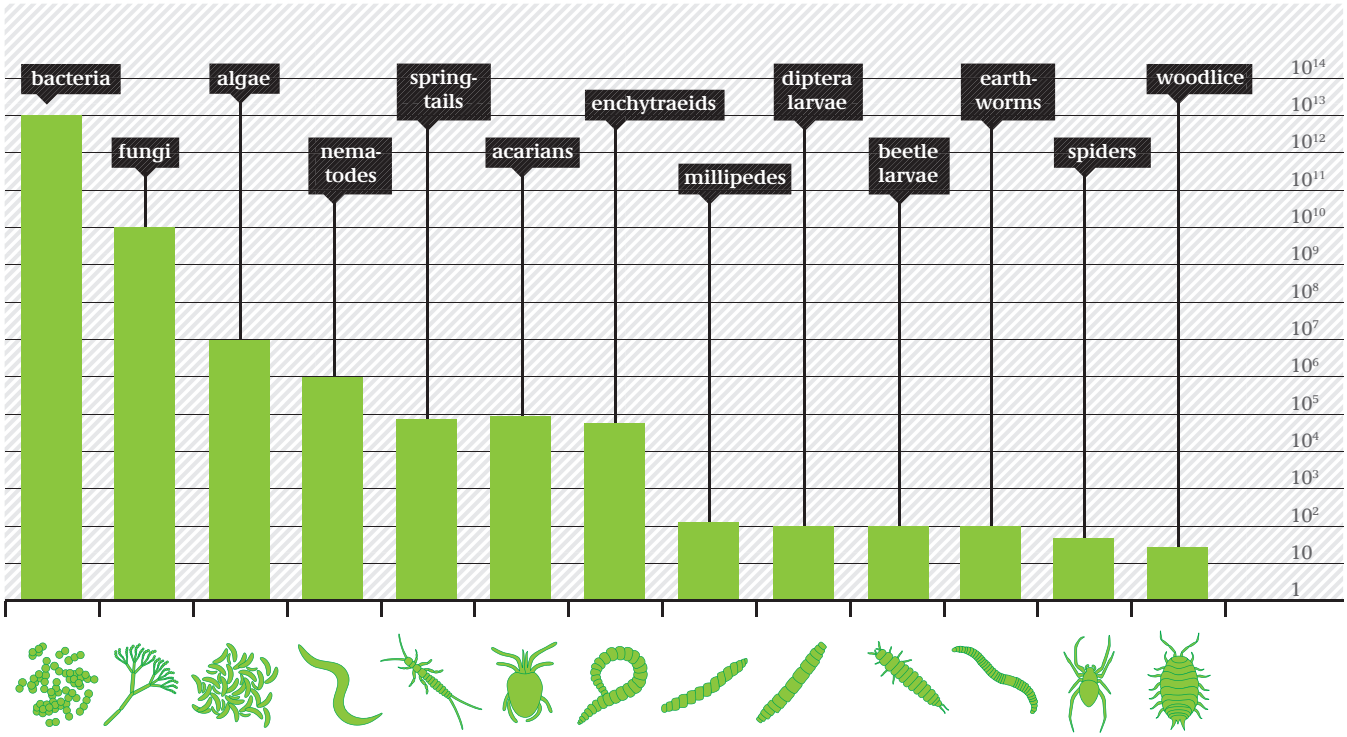
In agricultural landscapes, for example, spiders are the most important invertebrate predators. There is a distinct lack of knowledge as to what impact these animals have on other compartments of the cenosis. In addition to researching bulk soil, there are indeed other areas of interest in which more significant ecological effects come into play: the rhizosphere, i.e. the zone surrounding the roots of plants, can be called the 'coral reef' of the soil. A plethora of symbioses, competitions, food chains and metabolic processes are encountered here. This is where crucial biogeochemical reactions take place which will ultimately benefit humans too, not least thanks to the decomposition of contaminants and biomass growth.

German Federal and European Regulations

The natural soil function of providing the 'Basic requirements for the life of humans, animals, plants and soil organisms', which must be protected according to Article 1 of the Federal Soil Protection Act (§ 2 BBodSchG), is often characterised in terms of abiotic or pedological (soil science) parameters.

However, reliable statements regarding a soil's suitability as habitat for soil organisms can be made only on the basis of parameters relating to soil biology. Even if it is possible to identify all determining factors for the distribution (the potential) of a cenosis, this will not reveal whether the cenosis is actually present at a given site [3]. The objective of protecting natural soil functions also extends to

FIG 7: AVERAGE NUMBER OF INDIVIDUALS PER M² IN SOILS OF TEMPERATE CLIMATE ZONES (LOGARITHMIC SCALE) BASED ON A PUBLICATION BY LANDESUMWELTAMT NORDRHEIN-WESTPHALEN/NORTH RHINE WESTPHALIA STATE ENVIRONMENT AGENCY (2003)



Source: North Rhine Westphalia State Envirinment Agency (2003): Bodenbiologie: Leben im Dunkeln, LANUV-Info Nr. 13 http://www.lanuv.nrw.de/veroeffentlichungen/infoblaetter/infoblatt13.pdf

organisms typical of a specific soil. Protection of soil organisms was taken into account when deriving precautionary values for protection against harmful soil changes. The fact that soil organisms were taken into account is due to the special protection afforded to natural soil functions.

However, more research is needed in respect of the derivation of soil-biological indicators for characterising good ecological soil status. The present proposal for a Framework Directive by the European Commission does not address the loss of biodiversity in soils. The EU Commission assumes that the measures proposed (protection from compaction, erosion, salinisation, acidification and reduction in contaminant inputs) will have some beneficial effects on soil biodiversity, thus making an adequate contribution towards achieving the objective set by the Convention on Biodiversity, i.e. to halt species decline. It is not clear yet whether the Framework Directive on Soil will be adopted in the near future, but it does not exist in isolation. It is embedded in the European soil protection strategy *(http://ec.europa.eu/environment/soil/three_en.htm)*, along with an assessment of the economic, social and environmental implications of various soil-protection options. Although the Thematic Strategy for Soil Protection (EU Commission, 2006) recognises the loss of biodiversity in soils as a threat to soils, it calls for further research which is to be addressed by projects in the Seventh Framework Programme.

Raising Soil Awareness

As shown by experience, improvements to environmental conditions cannot be brought about by laws and administrative actions alone. It is also important to involve the public. Here is a good example from Britain: This year, the Museum of Natural History has organised the first ever nationwide count of earthworms in Great Britain. The plan is for volunteers equipped with a standardised questionnaire and a robust method for collecting earthworms from the soil, to identify and count these earthworms, and to forward the results to the museum *(http://www.opalexplorenature.org/)*. Other examples demonstrating how to familiarise the public with soil organisms, is the touring exhibition 'Beneath our feet: the soil habitat' (Unter unseren Füßen - Lebensraum Boden) organised by the Staatliche Museum für Naturkunde Görlitz *(http://www.umweltbundesamt.de/boden-und-altlasten/boden/bildung/reisef/wa.htm#Leben%20im%20Boden)* or the soil exhibition ‚unter.welten' at the Museum am Schölerberg in Osnabrück *(http://www.museum-am-schoelerberg.de/)*. The European Network on Soil Awareness (ENSA) was founded in September 2009 in order to improve soil awareness.

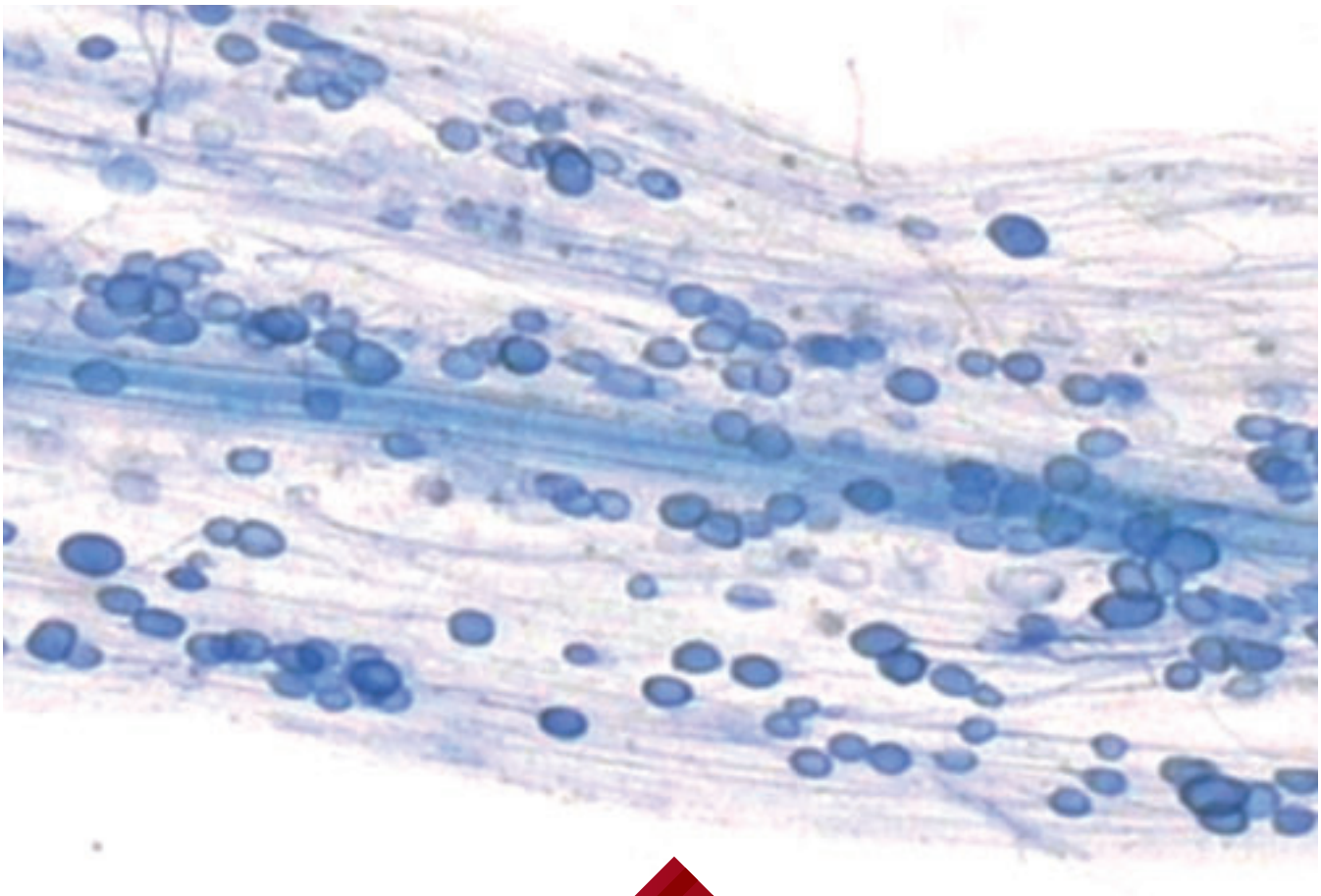


FIG. 8
MYCORRHIZA-FUNGUS SYMBIOSIS IN THE ROOT OF A WHEAT PLANT

A contribution to the raising of soil awareness was made by the Federal Environment Agency by publishing a brochure for children entitled 'Die abenteuerliche Reise von Fridolin dem Regenwurm' which features the adventurous journey of an earthworm. The UBA's Commission for Soil Protection (Kommission Bodenschutz) acknowledged the importance of soil biology by making it the focus of an event held on 5th December 2008 celebrating World Soil Day. The talks presented at this event were posted on the UBA Internet *(http://www.umweltbundesamt.de/boden-und altlasten/veranstaltungen/ergebnisse-fachveranstaltung-081205.htm)*.

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THE STURGEON

Will water protection maintain its habitat?

THE RETURN OF SALMON AND STURGEON

IS THIS ACHIEVEMENT DUE TO THE ECOLOGICAL FOCUS ON WATER PROTECTION?

Water protection is seen as a successful example of Germany's environmental policy: no more foul-smelling rivers with foam floating by.

The biological water quality map shows continuous improvements in oxygen conditions between 1975 and 2000, and from 1990 onwards, this also applies to the new Länder in post-unification Germany. However, is this enough to protect biodiversity in water bodies? The Water Framework Directive (WFD) adopted in 2000 and the Marine Strategy Framework Directive (MSFD) adopted in 2008 introduced a new standard of assessment focused on biodiversity and naturalness – the ecological status. Judging by this standard, there is still a lot to be done:

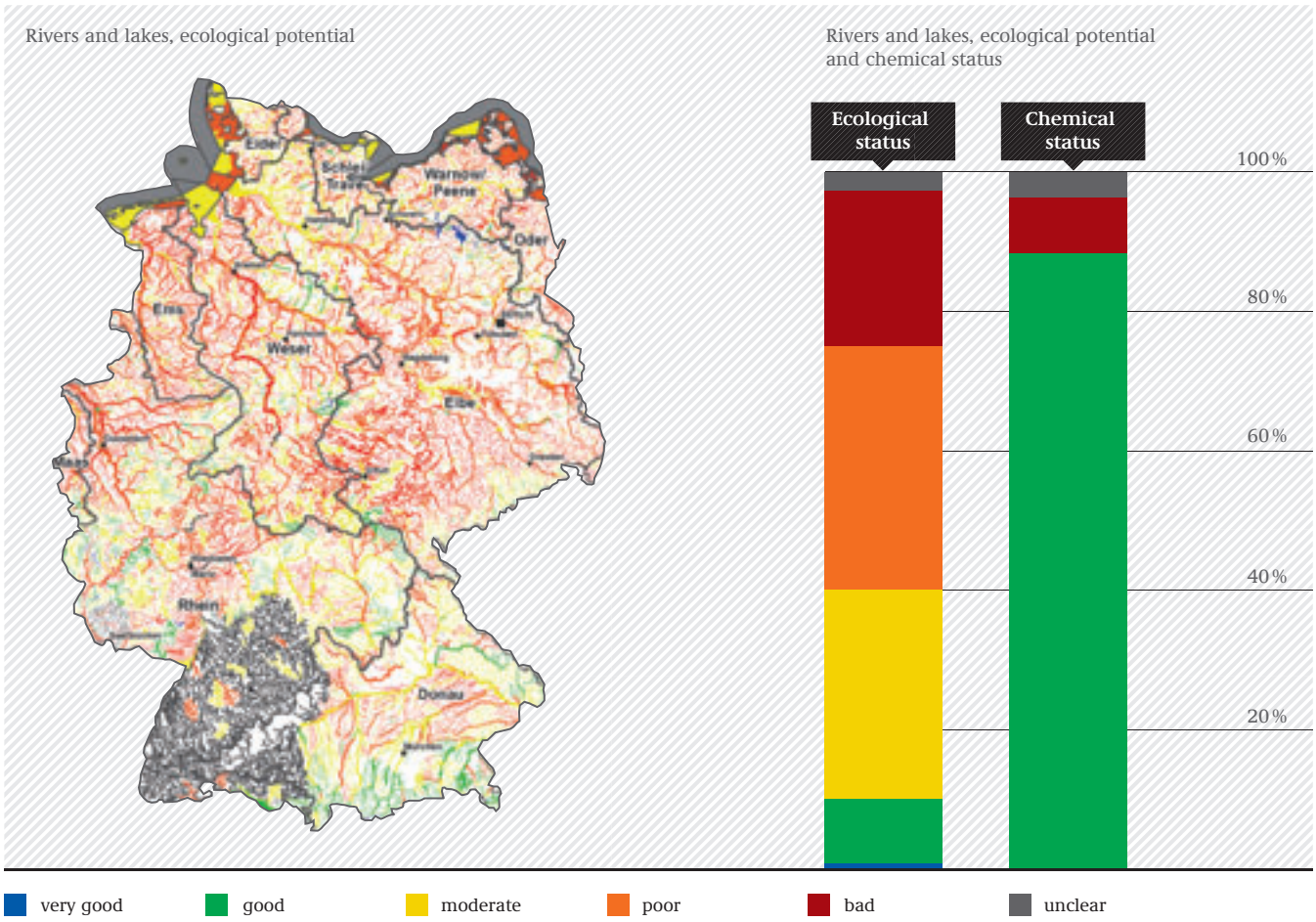
- Approx. 200,000 weirs cut across Germany's streams and rivers roughly every two kilometres. As a result, numerous fish are unable to maintain their migration and spawning cycles.
- Water bodies are constricted and channelised in order to allow residential and industrial development right up to a river's bank; others are deepened to allow enough depth for shipping. As a result, fish do not find the natural variety required for their habitat, namely gravel, sand and mud, let alone the diversity of aquatic plants, invertebrates and bivalves.
- Excessive nutrient levels which are mostly due to agricultural practices, give rise to excessive algal growth, lakes silting up and coastal waters turning barren. The pollutant load in rivers and oceans tends to weaken the immune system of marine mammals thus making them vulnerable to infectious diseases. It is one of the major factors which caused seal deaths in the North Sea in the years of 1988 and 2002.

The National Biodiversity Strategy incorporates the objectives laid down in the WFD and the MSFD thus demonstrating the urgent need for action in respect of water protection.

Assessing water bodies on the basis of their ecological status

The EU Water Framework Directive (WFD) requires that all the issues mentioned above are addressed in order to ensure that by 2015 water bodies have good status. The first evaluation in 2004 and the assessment within the management plans contained in the 2009 WFD produced evidence for considerable progress in terms of chemical water pollution control. However, they also indicated deficits and underlying causes in respect of ecological status (see Fig. 9 a and b), i.e. less than 8 % of rivers in Germany can be said to have good status. It should, however, be possible to achieve this status by 2015 for another 10 % of rivers. These disconcerting statistics are to be attributed mainly to hydromorphological pressures such as structural changes in streams and rivers owing to flood control, shipping, or water management in an agricultural context. The picture is more favourable with regard to lakes. It can be said that approximately 40 % of lakes have already achieved good status. The status of estuaries and coastal waters is much worse. So far, only 1 % have achieved good status. This is primarily due to nutrients [1, 2]. The WFD pioneered the introduction of biological assessment standards for aquatic ecosystems in combination with the evaluation of the ecological status

FIG. 9A/B ECOLOGICAL POTENTIAL AND ECOLOGICAL/CHEMICAL STATUS OF RIVERS AND LAKES IN GERMANY IN 2009



Source: Umweltbundesamt (UBA) on the basis of data from the Reporting Portal WasserBLIcK/BfG; last accessed 22.01.2010

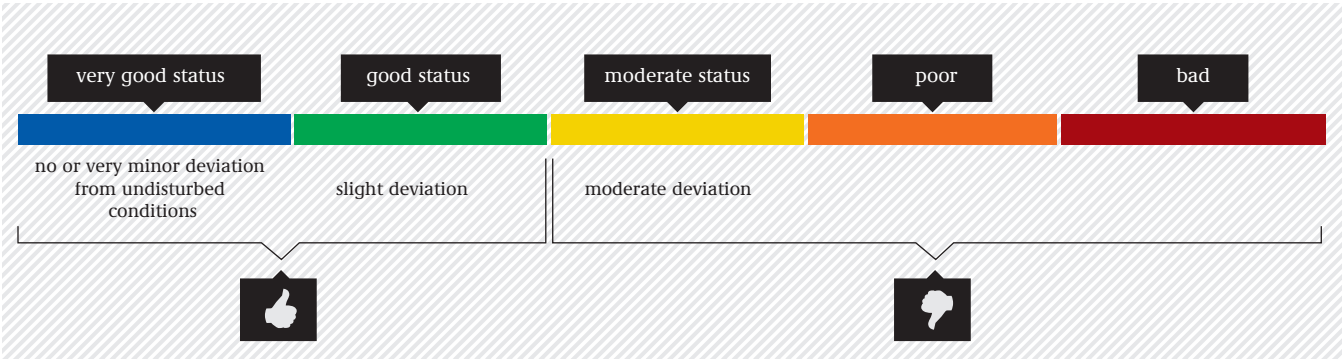
of surface waters. The classification system used in the WFD is explained in an EU guideline of the Common Implementation Strategy (CIS) drawn up by a working party headed jointly by Germany (UBA) and the UK [3]. The reference for comparison applied in Germany is therefore based on what is considered the potentially natural condition. This reference is thus to be understood as the natural condition of the type of water body, at the same time as covering any irreversible changes which occurred in the past, such as the development of clay alluvial soils.

Water bodies are deemed to have good status when there are only minor deviations from the relevant near-natural and disturbance-free reference conditions (see Fig. 10). To achieve this 'good status' is the WFD's goal for the rehabilitation of water bodies. In the first instance, a water body's biological quality is determined by assessing the composition of its aquatic biocenosis and the frequency of animal and plant species occurring in it. Thus the WFD introduced a new assessment procedure for water bodies focused on biodiversity and naturalness, which makes it possible to identify any potential burden by means of evaluating the existing biological quality components. The assessment system is based on establishing discrete water-body categories (rivers, lakes, transitional and coastal waters) and types which can be differentiated on account of their near-natural reference conditions. There is a total of 51 water body types defined for Germany. In 2006, the Umweltbüro Essen was commissioned by the Länder and the UBA to issue a description of the 25 types of water courses describing their abiotic (e.g. substrate) and biotic (e.g. invertebrate fauna) characteristics [4]. By now nearly all assessment methods required by the WFD in respect of the biological components mentioned in Fig. 11 have been developed. On behalf of the UBA, the necessary procedures were developed by Essen University and other institutes of ecology [5], and they are currently being adapted in the light of experience gained from surveys carried out in the course of the first management cycle [5a]. As far as the protection of groundwater is concerned, the biological criteria have yet to be laid down. So far the focus has been on chemical parameters (such as concentrations of nitrate and pesticides) as well as quantitative parameters (water balance). Groundwater assessment also includes protection of terrestrial ecosystems

which are water-dependent, such as species-rich and endangered wetlands and alluvial areas [5b]. Further research should be conducted for developing criteria for the assessment and protection of groundwater ecosystems. This prerequisite is also expressed in the Groundwater Daughter Directive issued by the EU in late 2006 (2006/118/EC). The UBA sponsored research projects for the biological assessment of groundwater ecosystems and for the derivation of reference conditions [6]. The Groundwater Daughter Directive is being incorporated into a German framework. The technical principles for this framework have been established by the UBA.

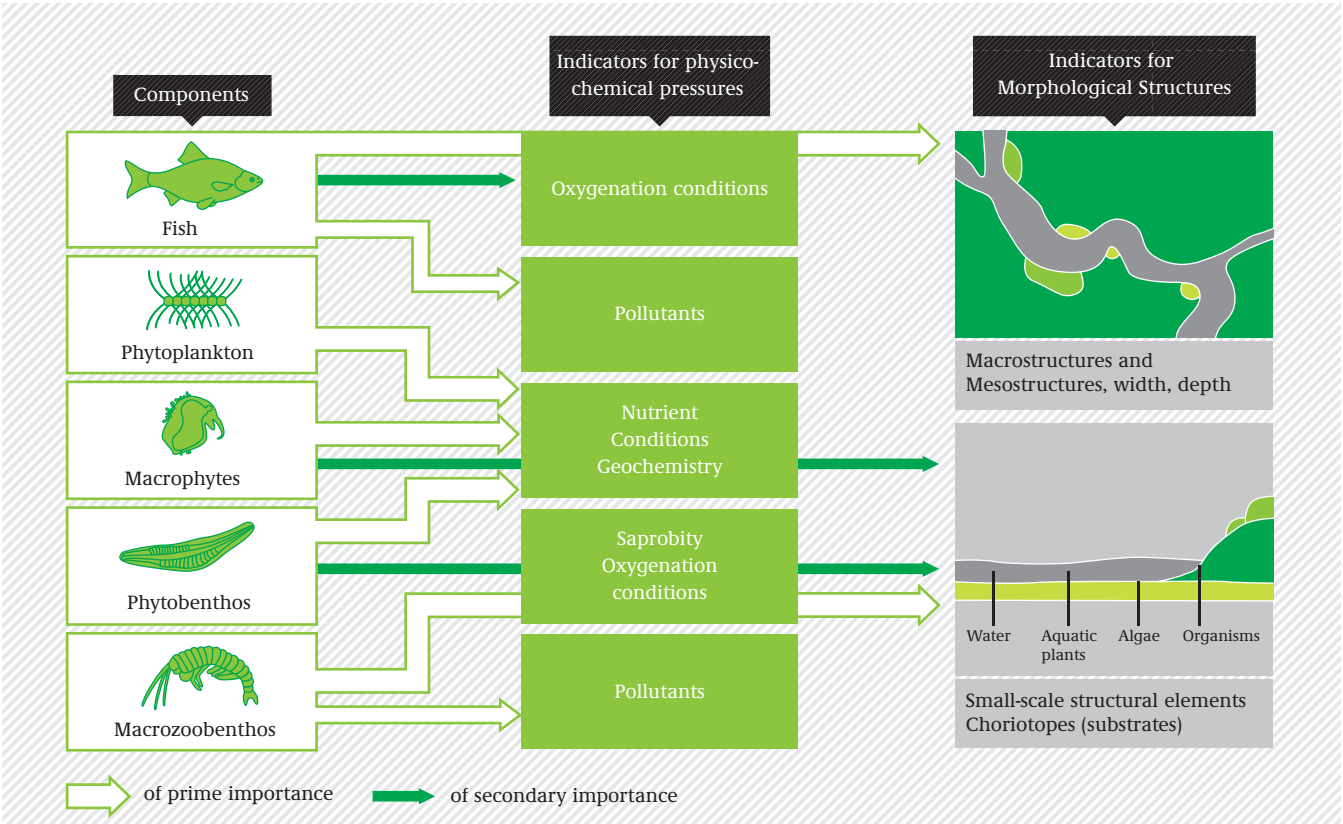
Hitherto, nutrient enrichment (eutrophication) of rivers and lakes used to be assessed primarily on the basis of nutrient levels. In oceans, additional criteria were applied assessing burdens on the ecosystem (algal populations, oxygen levels and higher organisms). The UBA contributed to the development of an EU guidance document which harmonised, on the basis of the WFD approach, the assessments of eutrophication in the EC Directives on nitrate and urban wastewater and in the conventions for the marine environment such as OSPAR and HELCOM [7].

FIG. 10 CLASSIFICATION OF THE ECOLOGICAL STATUS OF WATER BODIES ACCORDING TO THE WFD



Source: Umweltbundesamt (Federal Environment Agency)

FIG. 11 BIOLOGICAL COMPONENTS OF THE ECOLOGICAL STATUS AND PRESSURES, WHICH THEY INDICATE



Source: adapted from Braukmann et al., 2001

What remains to be done?

For water bodies to achieve good ecological status, the competent authorities have to choose the most effective and cost-effective measures from the range available. In 2004 the UBA published a manual on the subject [8]. This manual was supplemented by more recent guidance documents.

- EU CIS Guidance documents describe the political and technical possibilities of improving the hydromorphology balanced against hydropower, shipping and flood control [9]. Germany (the UBA) headed the work jointly with the UK and the EU Commission.
- The brochure entitled 'Water Protection in Cooperation with Agriculture' [9a] describes the legal requirements, burdens and concepts relating to reduction measures in agriculture. In addition, practitioners will find detailed descriptions in the brochure entitled 'Landbewirtschaftung und Gewässerschutz'. This brochure illustrates effective and cost-effective measures which in some cases can even contribute to cost savings [10]. On behalf of the UBA, the effectiveness of political and technical measures in agriculture was examined by the Wuppertal Institut für Klima, Umwelt, Energie in cooperation with the Kuratorium für Technik und Bauwesen in der Landwirtschaft and the Forschungsgesellschaft für Agrarpolitik und Agrarsoziologie [11].
- Commissioned by the UBA, a consortium headed by Planungsbüro Koenzen produced a DWA Fact Sheet and a brochure setting out an appropriate contemporary type of management approach for small watercourses [11a]. The approval of the Fact Sheet was subjected to the usual voting procedure applied by the DWA (Deutsche Vereinigung für Wasser, Abwasser und Abfall).
- The Planungsgruppe Ökologie + Umwelt Nord was commissioned by the UBA to formulate rules compatible with shipping for an ecological enhancement of the waterways of the German Federal Republic. This model illustrates a spectrum of feasible, transport-compatible measures for waterways which experience intensive use. As a result, it contributed to the realisation that, in principle, measures for hydromorphological improvements can be both feasible und state-of-the-art [11 b].
- Jointly with the Federal Agency for Nature Conservation, the UBA produced the BMU (Federal Environment Ministry) 'Guidelines for hydropower tariffs' charged by new and modernised hydropower plants under Germany's Renewable Energy Sources Act. The manual identifies measures suitable for application with regard to hydropower plant at the same time as contributing to significant improvements in the ecological status [11 c].
- To extend the basis for analysing suitable measures, under an overarching research project (IGB Berlin, Universität Karlsruhe and Fraunhofer ISI), the UBA commissioned, for the first time, the development of a homogeneous set of tools for identifying the major sources and key loads for a variety of relevant groups of substances (nutrients and priority substances) in large-scale river basins [12].

The next step: a strategy for protecting the marine environment

The EU Marine Strategy is designed to achieve better protection of marine environments. The strategy is based on the ecosystem principle.

All relevant biological quality elements of marine food webs are to be monitored and assessed by means of ecological quality targets. A new development is that the utilisation of marine ecosystems will be incorporated into the Marine Strategy. This requires a more 'integrative' or holistic approach which involves establishing a relationship between sectors so far considered as discrete - such as shipping, fisheries, offshore energy, marine protection, and development of coastal regions in respect of their utilisation and protection. The objective is for Europe's marine regions to achieve 'good environmental status' by 2020. The technical implementation of this strategy has been in progress since 2009 in the context of a common European approach which closely follows the model of WFD implementation. The UBA is involved in all major working groups and, jointly with the EU Commission, has taken a leading role in the working group charged with establishing criteria for good status of the marine environment [13]. Climate change exposes marine ecosystems to particularly high stress. These ecosystems tend to respond to rising temperatures and CO_2 levels. Organisms adapted to constant temperatures are unable to tolerate shifts in temperature which, by the same token, can favour mass reproduction among alien species. Ocean acidification deprives organisms with calcareous shells (such as corals, diatoms) of their basic requirements for life (for a detailed description please see [14]).

Summary:

The objectives laid down in the Water Framework Directive and the Marine Strategy Framework Directive are based on communities of organisms adapted to their environment; in other words, they are based on biodiversity criteria. In order to achieve these objectives, it is imperative to restore the conditions for natural habitats, to decrease nutrient loads and to adapt some water utilisation practices to ecological requirements.

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LEAF DIVERSITY

Acid rain made leaves to turn brown, and fall before autumn. But these days are gone.

FRESH AIR AT LAST

‘Blue sky above the Ruhr valley’ as demanded in the 1970s, has become a reality, and no-one talks about forest die-back nowadays, but the air still habours threats to biodiversity.

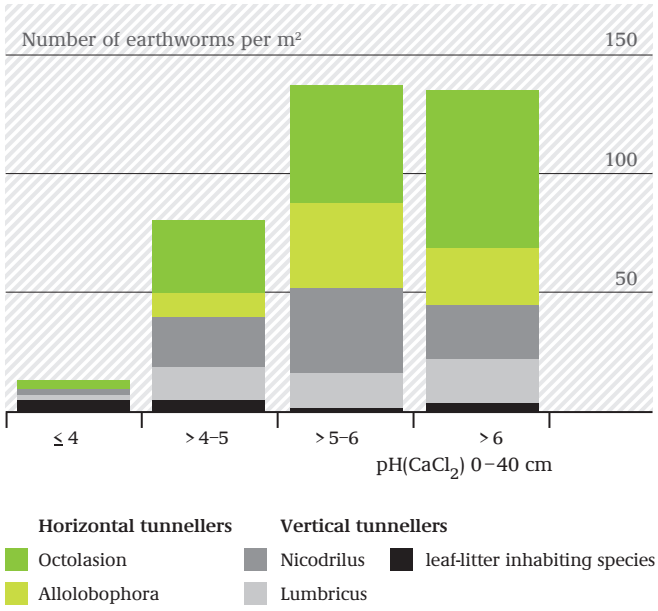
Atmospheric inputs of sulphur and nitrogen as well as high levels of ozone continue to be a major threat to biodiversity worldwide.

The effects caused by excessive nutrients and pollutants

Ground-level ozone is a toxic photo-oxidant. It attacks biological compounds and causes visible leaf damage, accelerated ageing processes and reduced productivity. In Central Europe, it is beech, larch, pine and a significant number of wild herbaceous plants that are considered to be highly ozone-sensitive species. In particular, montane grassland, dry grassland, woodland margins, heaths and wetlands contain a high proportion of ozone-sensitive plants [1]. Sulphur and nitrogen compounds released in combustion processes and subsequently dissolved by rain or mist, will fall as acid rain onto plants and soils. Ammonia (NH_3) emitted by agricultural activities does not only act as a source of nitrogen inputs into the soil; it also increases soil acidification. This produces grave impacts on the soil properties. Clay minerals in the soil are destroyed at pH levels of less than 5.0. As a result, this will further the loss of base nutrients such as magnesium, calcium and potassium, and the release of toxic aluminium and heavy metals. Ultimately, soil acidification will thus damage the soil flora and fauna. Most soil organisms depend on specific acidity levels (pH levels) which allow them to meet their nutrient requirements. Deep-burrowing earthworms cannot exist at levels of less than pH 4 – see Fig. 12. Ecologically speaking, there is no substitute for the function of earthworms. Humus-forming processes would simply not take place if it were not for earthworms mixing the soil and breaking down organic matter.

Emitted nitrogen compounds can be transported in the atmosphere over longer distances before eventually being deposited into ecosystems. In agriculture, nitrogen and phosphorus are added to the soil as important fertilisers. In natural ecosystems, however, higher-than-natural levels of nitrogen can directly lead to a reduction in plant diversity, as slow-growing plants are outcompeted by fast-growing nitrophilious species. In addition, excessive nutrient enrichments, referred to as eutrophication, induce increased vulnerability to short-term stress events such as frost, drought, pest infestation or water shortage and eventually cause dysfunction of ecosystems. For instance, the massive spread of grasses and shrubs as a result of a nitrogen surplus in forests can cause a shortage of water available to stands of trees. In areas with low precipitation levels, the consequences of climate change can therefore be exacerbated, as far as the water supply for stands and the replenishment of groundwater are concerned.

FIG. 12 RELATIONSHIP BETWEEN NUMBER OF EARTHWORMS AND SOIL ACIDITY



Source: Braun & Flückinger, 2004 [2]

What has the classical environmental issue of air pollution control to do with biodiversity?

Already in the early 1970s, scientists drew our attention to signs of alarming connections between air pollution and large-scale impacts on biodiversity, as for example, extreme cases of fish mortality in Scandinavian lakes, and forest damage in Europe as a whole. To reduce the negative effects of air pollution, the European states as well as the USA and Canada adopted 1979, under the auspices of UNECE (United Nations Economic Commission for Europe), the Convention on Long-Range Transboundary Air Pollution (LRTAP Convention) [3]. Since then, 50 states and the EU have become signatories to this Convention. The majority of these signatories are actively involved in the scientific assessment of impacts and signed additional, more far-reaching political agreements that have been laid down in a total of eight protocols on long-range transboundary air-pollution. The Göteborg Protocol adopted in 1999 is based on effect-oriented and ecosystem-specific threshold values for ground-level ozone and 'critical loads' for sulphur and nitrogen compounds. The level of tolerable inputs or concentrations is in each case dependent on the specific sensitivity of the ecosystem concerned. Exposure levels below the threshold values should preclude adverse effects on the ecosystem's flora and fauna. Whether the threshold values are adequate for any comprehensive protection of biodiversity, is to be examined by the Working Group on Effects (WGE) [4] in the context of scientific impact assessments under the LRTAP Convention.

The Göteborg Protocol under the LRTAP Convention aims at improving the protection of the environment and human heath against risks of adverse effects from acidification, eutrophication and ground-level ozone through controlling emission levels of sulphur dioxide (SO_2), nitrogen oxides (NO_x), ammonia (NH_3) as well as Non-Methane Volatile Organic Compounds (NMVOC). The member states of the European Union pursue these objectives on the basis of Directive 2001/81/EC dated 23.10.2001 (NEC Directive) [5] which specifies national emission ceilings. In Germany air pollution control essentially pursues three strategies in order to implement the international aspirations mentioned above.

- Establishing air quality standards under the Federal emission control regulation (BImSchG) [6].
- Requirements for the reduction of emissions from relevant sources consistent with the best available technology (BAT).
- Emission ceilings for restricting national emission totals. Under regulation BlmSchV 39 emission ceilings are specified ensuring national implementation of the EU's NEC Directive.

Likewise, Germany's National Biodiversity Strategy (NBS) identifies nutrient and pollutant inputs as an essential driving force behind the loss of biodiversity. Accordingly, the strategy requires that by 2020 the critical loads for acidification and eutrophication must be complied with in order to achieve sustainable protection of sensitive ecosystems. Furthermore, the strategy proposes measures required for achieving those objectives such as implementing agri-environment schemes or compensation measures in order to decrease agricultural nutrient losses. The EU Biodiversity Strategy too focuses on the reduction of nutrient burdens on natural ecosystems. The EU Initiative entitled Streamlining European Biodiversity Indicators for 2010 (SEBI2010) [7], specifies eutrophication as one of the leading causes for the loss of plant biodiversity in Europe. For this reason, SEBI 2010 uses the exceedance of critical nitrogen deposition rates (critical loads for eutrophication) by the actual atmospheric input as a key indicator of the risk of biodiversity loss. At a global level, the CBD uses nitrogen deposition (atmospheric input) as an indicator for threats to biodiversity [8].

Areas at risk

The emissions of reactive nitrogen from agriculture, transport and industry, are one of the principal driving forces behind the loss of biodiversity through eutrophication and acidification. In recent decades, air pollution control measures have succeeded in substantially reducing the emissions of nitrogen

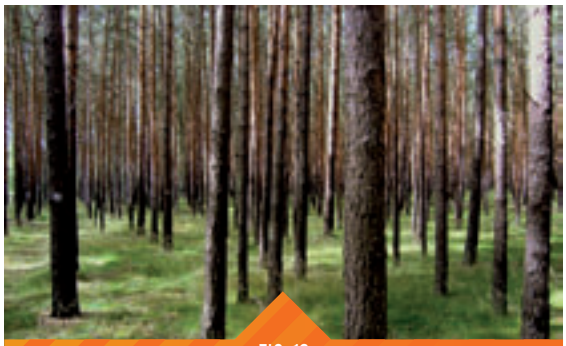


FIG. 13
PINE STAND IN NORTH-EASTERN GERMANY SHOWING NO VISIBLE SIGNS OF N IMPACTS

FIG. 14
ANIMAL BREEDING FARM AT DOBBERZIN BY ANGERMÜNDE: DENSE UNDERGROWTH OF ELDER AND OTHER N INDICATORS AS A RESULT OF INCREASED N DEPOSITION

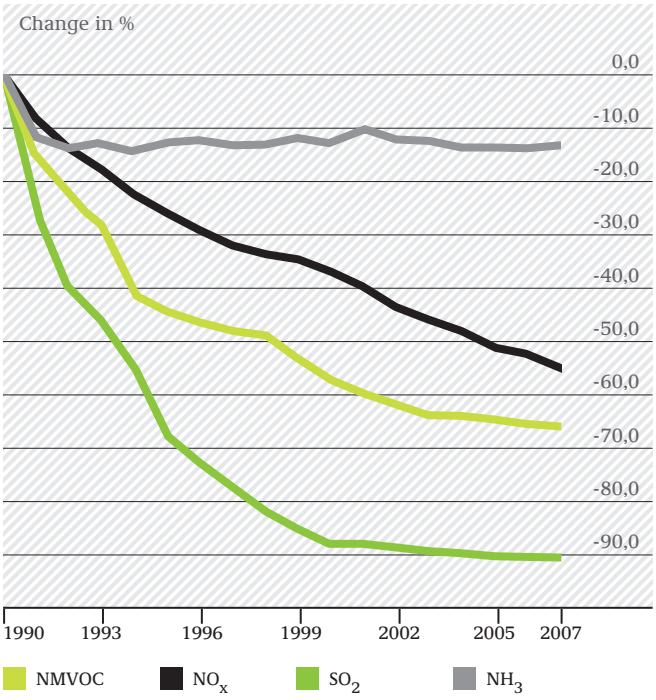
and especially sulphur compounds produced by transport and industry. Compared to 1990, the use of low-emission fuels and modern technology such as filtration and flue-gas cleaning systems in industrial facilities as well as in vehicles have helped us to achieve reductions in the emission of air pollutants (Fig. 15).

By contrast, the concentration of ground-level ozone in remote areas of Central Europe is at least twice as high as a hundred years ago. In the emission-free altitudes of mountain ranges, data even suggest a five-fold increase. Consequently, biodiversity in those regions is particularly at risk. Another reduction in the emission of precursor substances such as nitrogen oxide and Non-Methane Volatile Organic Compounds (NMVOC) would help to improve the situation with regard to the protection of biodiversity. The most serious problem is caused by constantly high nitrogen emissions (NH_3, NO_3^-, N_2O) produced in agriculture. These are reflected in persistently high nitrogen surpluses on the field and farm level resulting from an imbalance of nitrogen supply (e.g. fertilisers) against nitrogen removal (e.g. through commercial products) from agricultural systems (Table 2). In sensitive ecosystems the critical loads for nitrogen are still being exceeded which poses a serious risk to biodiversity. In 2004 a striking 95 % of (semi-) natural terrestrial ecosystem areas in Germany were subject to nutrient nitrogen deposition leading to eutrophication. 63 % of the ecosystem area received nitrogen depositions exceeding the critical loads for eutrophication by more than 20 kg of nitrogen ha^{-1} a^{-1} (Fig. 16).

Current situation and future developments to be expected with regard to legal frameworks

The Göteborg Protocol of the LRTAP Convention, and the NEC Directive set country-specific emission ceilings for SO_2, NO_x, NH_3 and NMVOC based upon the environmental impacts of these emissions and their abatement costs. From 2010 onwards, these emission ceilings will have to be complied with by EU member states. The NH_3 emission ceiling for Germany amounts to 550 kt ammonia per annum. Compared to 1990, this is equivalent to a reduction of 28 %. Currently Germany is unlikely to meet this target in time. As 95 % of the ammonia emissions are attributed to agriculture additional measures in the agricultural sector are needed in order to comply with the NH_3 emission ceiling. Germany anticipates meeting the emission ceilings for NO_x (by a small margin) and SO_2, while the NMVOC

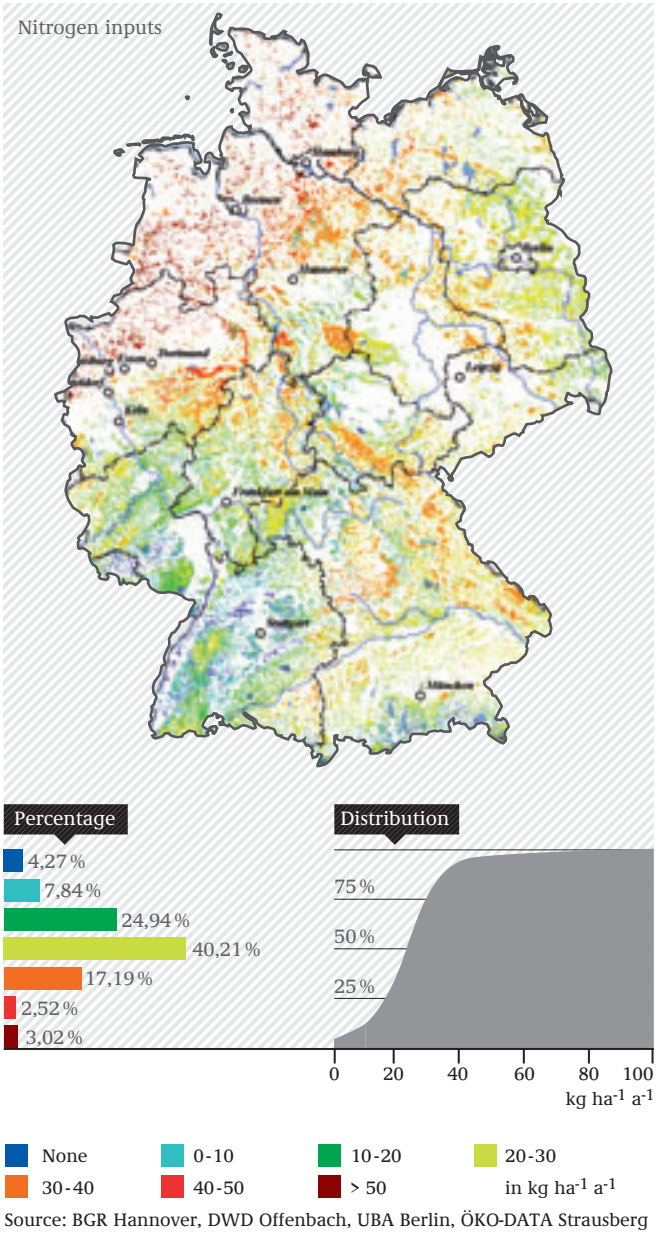
FIG. 15 CHANGES IN EMISSIONS IN GERMANY COMPARED TO THE BASE YEAR OF 1990



Source: Umweltbundesamt, 2009 [9]

ceiling will probably be missed. In order to make further progress towards the long-term objective of no-exceedance of critical loads and levels both, the LRTAP Convention and the EU are currently negotiating new emission ceilings for NH_3, NO_x, SO_2 and NMVOC to be achieved by 2020. It remains to be seen whether by 2020 the newly negotiated, more stringent emission ceilings will prove sufficient in order to achieve the NBS objective of protecting all sensitive ecosystems.

FIG. 16 EXCEEDANCE OF CRITICAL LOADS FOR EUTROPHICATION IN GERMANY 2004 [12]



Source: BGR Hannover, DWD Offenbach, UBA Berlin, ÖKO-DATA Strausberg

The UBA plays its part in meeting the specified targets

The UBA participates in the work of various bodies of the LRTAP Convention. The joint collaboration within the convention aims, for example, at advancing the scientific understanding of the harmful effects of air pollution. The UBA regularly prepares national reports to the LRTAP Convention [13] on pollutant inputs and the sensitivity of ecosystems. The data are used for calculating the exceedance of critical loads (Fig. 16), in connection with the impact assessment under the LRTAP Convention. The current and projected critical loads exceedances are used as effects-related information for guiding international negotiations resulting in new emission ceilings for NH_3, NO_x, SO_2 and NMVOC. The data are used, in addition, for updating the EU biodiversity indicators (SEBI2010), the core indicator system (KIS) applied by the UBA and the critical-loads-exceedance indicator of the NBS. Moreover, the UBA contributes to the further development of the critical loads concept [14]: Improved models will advance the assessment of combined impacts of atmospheric nitrogen deposition and climate change on the structure and function of ecosystems. For a given site, these models can predict temporal trends of soil-chemical conditions and floristic diversity for specific climate and deposition scenarios. Furthermore the empirical critical loads for nutrient nitrogen [15] are currently updated in a European project supported by the UBA.

In Germany large animal husbandry units can only legally operate if a permit is issued. Such a permit may be refused if project-related nitrogen depositions lead to significant adverse effects in sensitive ecosystems. To assess the adverse effects of nitrogen depostions critical loads may be used. As a result of an initiative taken jointly by North-Rhine Westphalia and the UBA, an expert panel including representatives of the federal government and the Länder formulated a reference guide intended to assist the approving authorities in assessing any impacts to be expected from nitrogen inputs [16]. A principal contribution of UBA in this respect is to provide access to critical loads and deposition data for such assessments. Currently a similar reference guide for the impact assessment of transport-related nitrogen depositions in areas of the Natura2000-network is formulated by an expert panel working on behalf of the Federal Ministry of Transport, Building and Urban Development (BMVBS).

Apart from eutrophication and acidification, reactive nitrogen compounds have numerous other negative impacts on the environment. In addition, reactive nitrogen compounds are highly mobile. In a process

TAB. 2 TREND FOR AGRICULTURAL NITROGEN SURPLUSES - FARM-GATE NITROGEN BALANCE FOR GERMANY AND EMISSIONS INTO THE AIR AND SURFACE WATERS

Year	Farm-gate nitrogen surpluses in Germany [10] (3-year average in kg/ha agricultural area/year)	Nitrogen emissions [11] (in 1000 tonnes N per annum)			
		INTO THE AIR		INTO SURFACE WATERS	
		Transport/industry/ energy industry	Agriculture	Treatment plants (domestic sewage + industrial effluent)	Agriculture
1955	45				
1965	90				
1975	155				
1985	150			420	510
1990	112	930	710		
1995	114	710	605	230	410
2000	117	590	605	130	460
2004	105	510	600	105	400

known as the nitrogen cascade, reactive nitrogen compounds may undergo chemical reactions to sequentially exert different effects at different places. Therefore, regulations focusing on a single emission source category or environmental compartment, or on reducing a single effect, may be of little use. Hence, the UBA developed an integrated strategy for the reduction of nitrogen emissions [17] which focuses on the whole nitrogen cascade and offers mitigation options leading to a simultaneous reduction of all nitrogen pollutants in all environmental compartments. The strategy was introduced and discussed at an international workshop and was submitted to the Federal Ministry for the Environment (BMU) for further interdepartmental negotiations on the reduction of emissions.

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THE FROG
Pesticides pollute
its habitat!

PLANT PROTECTION PRODUCTS

RISKS AND SIDE EFFECTS ON BIODIVERSITY

In our environment, we are confronted with a vast number of chemicals. However, no other group of substances is released into our environment on a similarly large scale or in the same targeted manner as plant protection products.

The use of plant protection substances is on the increase

With domestic sales of approximately 35,000 tonnes of plant protection substances in 2008, Germany plays a leading role in the European market [1]. Since 2005 the sales of plant protection products have experienced again a marked upswing [2] (see Fig. 17). Approximately 250 chemical agents incorporating more than 600 approved products are used especially in agriculture, fruit-growing and horticulture. Municipal administrations, domestic gardeners and allotment holders also use considerable amounts of plant protection products.

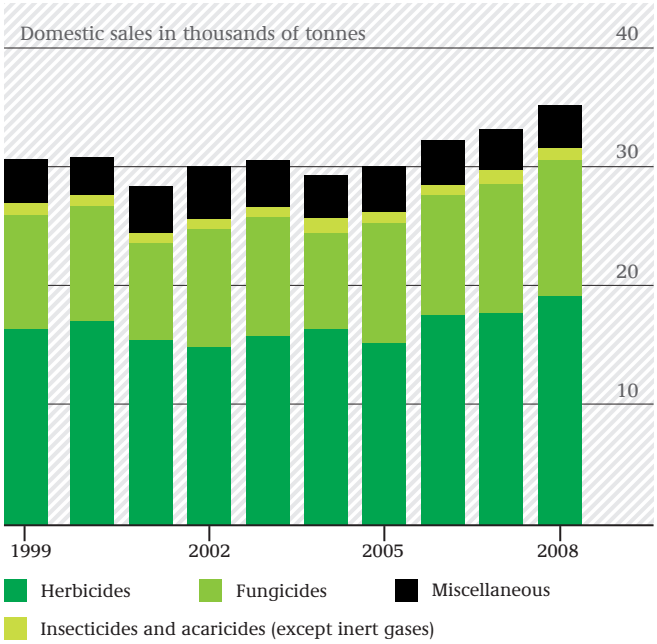
Plant production products are used for the purpose of destroying or rather controlling organisms which might damage crops or ornamental plants. They are divided into four main categories in respect of the type of target organisms to be controlled: insecticides/acaricides (for insects and mites), fungicides (for fungal pathogens), herbicides (for plants) and rodenticides (for rodents). Together with biocides - which in contrast to plant protection products are used with the focus on non-agricultural fields of application - these agents are collectively known as pesticides. During the application there is always a risk that plant protection products reach terrestrial habitats or water bodies adjacent to the treatment area via spray drift or drift of contaminated dust from dressed seeds. In addition, these habitats can later on be exposed to run-off from fields that have been treated. Most plant pesticides show a relatively broad spectrum of action. It is therefore impossible to be certain that harmful effects on other than pest organisms, so-called 'non-target species', can be excluded. These undesirable side effects related to the application of plant protection substances can represent a real problem, not just for adjacent natural habitats but also for the arable land itself. Examples are, for instance, potential influences on soil fertility owing to damaged soil organisms, or animals which only temporarily use treated areas, such as vertebrates or pollinators searching for food. The extremely high damage potential, combined with large-scale application in agricultural landscapes, illustrate why pesticides are considered to be one of the major causes for the persistent threat to biodiversity in our agricultural landscapes [3].

Assessment of environmental risks and compliance with environmental risk mitigation measures – basic requirements for an efficient risk management of plant protection substances

Considering the high environmental hazards of plant protection substances for both, humans and the environment, the high requirements in the legal regulation of pesticide use are clearly justified. This is why a plant protection product will not be authorised until the UBA concludes in its risk assessment that the environmental risks related to that product are acceptable. In this context it might be necessary for the UBA to restrict the application of a plant

protection product by imposing specific environmental risk mitigation measures. Such risk mitigation measures might include for instance buffer zones for water bodies or field margins. Often the users of plant protection products find such environmental risk mitigation measures as too far-reaching and too complicated. Owing to the low acceptance, it frequently happens that environmental risk mitigation measures are flouted or infringed, e.g. during the application of products or with regard to cleaning the spraying equipment on an unsuitable surface in the vicinity of water bodies. The results of a research project carried out on behalf of the UBA in 2007 made it clear that there is insufficient compliance

FIG. 17 SALES OF PESTICIDES IN GERMANY FROM 1999 TO 2008



The marked increase since 2005 is due mainly to herbicides. One of the herbicides used most widely is glyphosate. It contains metabolites which now increasingly pollute water bodies. Many glyphosate products are suspected of endangering amphibians and upsetting the hormone balance of animals.

Source: www.bvl.bund.de

with risk mitigation measures by users during their practical work, in particular with respect to buffer-zone obligations. Such cases of misuse are among the main reasons why in real life, critical loads of plant protection substances in the environment are regularly exceeded thus damaging biodiversity. The key elements for an effective environmental risk regulation are therefore the implementation of fairly intensive counselling and training sessions for users of pesticides in order to strengthen their sense of responsibility for the consequences of misuse. Furthermore, adequate checks made by the competent authorities in the Länder of the Federal Republic are necessary, so that it is possible to call users to account when they endanger public environmental goods through the misuse of plant production products.

Furthermore, the UBA also supports the development of more realistic risk assessment methods which allow a better adaptation of the buffer-zone obligation to site-specific conditions [4, 5]. In this context, the use of GIS tools facilitates the exact localisation of sections of those water bodies or edge habitats which are particularly at risk from pesticides. Specific risk mitigation measures might then be taken, such as the establishment of buffer zones or hedges to protect water bodies or terrestrial biotopes against entries of plant protection products. Moreover, the permanent protection of such highly threatened areas affords the possibility to reduce buffer-zone obligations defined by the nation-wide authorisation of a product without jeopardising the protection of nearby water bodies and edge habitats.

What kind of additional risk management requirements should be introduced for controlling the risks of damage to biodiversity caused by direct and indirect impacts from plant protection products?

There were numerous cases that came to public attention in the past, such as the worldwide decline in the numbers of birds of prey, partly caused by DDT and other organochloride pesticides. These continue to be mentioned in the media as examples for environmental damage caused by plant protection products. However, there are also more recent cases indicating that there is still a risk of biodiversity loss from the use of plant production substances.
For example, the Bundesamt für Verbraucherschutz und Lebensmittelsicherheit (BVL) has attributed mass bee deaths in the Rhine valley in Baden-Württemberg in 2008 to bees coming into contact with dust particles from dressed seeds. During the process of sowing maize treated with insecticides, contaminated dust particles from the sowing equipment were released into the environment. The intoxication of bees and other insects by the use of plant protection substances, did not only result in economic losses to beekeepers, but also led to a dramatic loss in biodiversity. There is also much discussion about the more insiduous weakening of bees as a result of absorbing insecticide residues transported within plants, such as nectar, pollen, honey dew, or from the water secreted by plants, as for instance by guttation. Overall the decline in pollinators is seen to be related to direct exposure to plant protection substances as well as their impact on the temporal availability as well as diversity of floral resources [6].

It is well-documented in numerous scientific studies that owing to the intensive use of pesticides, the occurrence of long-term impacts on plant and animal communities is not infrequent [7, 8]. A study carried out on behalf of the UBA confirms these observations in respect of field margins [9]. Scientists from Aachen University have demonstrated that only a few robust grasses were able to prevail, whereas formerly typical plants and animals of field margins are now absent from the affected areas. The biodiversity losses observed were attributed to agricultural use including the use of plant protection products.

In Germany, the general conditions for the application of pesticides has dramatically changed during past decades owing to the expansion of arable land as well as the intensification of land use management. Apart from the intended minimisation of weed and insect pests, the intensive and wide use of highly effective broad-spectrum herbicides and insecticides inherently leads to the reduction of much of the food resources required by birds, mammals and other animals living in an agricultural landscape. Numerous scientific studies [10, 11, 12, 13] indicate that such indirect effects of plant protection products on the food chain are among the main causes for the decline in populations of various species of field birds such as skylarks and partridges. The objective of controlling pest species is always closely related to the unintended reduction of the food supply for wildlife. Those effects can only be minimised by restricting the application of herbicides and insecticides on intensively managed agricultural land to the absolute minimum while supporting increases in areas used for ecologically sustainable farming. At the same time, a sufficiently high proportion of ecologically valuable set aside areas has to be provided to compensate for the inevitable effects resulting from the use of plant protection products.

Risk regulation within the authorisation procedure is strictly constrained by the fact that, apart from other considerations, each plant protection product has to be assessed individually for every potential use (product authorisation for indications/ 'Indikationszulassung').

On one hand, this makes it possible to prohibit the application of particularly hazardous substance. On the other hand, negative impacts such as the reduction of food resources for wildlife are intrinsic to the concept of chemical plant protection and can extend over major timeframes, especially where plant protection products are applied regularly during the whole growing season. The authorisation process involves the imposition of risk mitigation measures for individual plant protection products. It is therefore impossible to avoid potential cumulative effects which result from applying a combination of different plant protection products at the same site. To solve this problem, it would be necessary to establish integrated management strategies which incorporate not just aspects of the use of plant protection substances but also other aspects of land use and associated consequences in terms of biodiversity.

FIG. 18
AGRICULTURAL AREAS IN USE NEAR MINOR WATER BODIES

Areas under agricultural use are often located right beside minor water bodies. The farmer has to comply with buffer-zone requirements in order to prevent any harm to aquatic organisms from drifting pesticide spray intended for crop plants.

Apart from problems with indication-based or rather single-product authorisation, there exist furthermore deficits in the underlying concepts of environmental risk assessment. These would have to be overcome in order to make the protection of biodiversity more effective. Uncertainties in environmental risk assessment are due to the fact that impacts on plant and animal communities in the wild are usually assessed on the basis of ecotoxicity tests from a few standard laboratory species. Especially with regard to highly endangered species groups such as amphibians, the accuracy of the risk prognosis might be questioned if it has to be based on toxicity data available from mammals, birds or fish. Since for endangered species slight damages can already result in grave consequences for the whole population. The UBA therefore advocates the special consideration of endangered species in the risk regulation. Currently, the UBA, supported by research projects, is working on the improvement of accuracy in risk prognosis for amphibian species as well as for other legally protected species encountered in agricultural landscapes. Part of this work is the development of reasonably

FIG. 19
THE COMMON SPADEFOOT TOAD

Common spadefoot toads frequently colonise cultivated fields as their summer habitat, where, hidden underground during the day, they spend their nights foraging on cultivated land. Apart from the loss of suitable spawning grounds, common spadefoot toads suffer from the relentless intensification of agriculture. This process makes them particularly vulnerable to risks from the caustic effects of fertiliser salts and adverse impacts of plant protection substances.

practicable risk management approaches. Another source of uncertainty in risk assessments is due to the fact that often there is insufficient knowledge on the habitats affected by plant protection products and on the kinds of species which typically occur in those habitats and therefore need to be protected. Furthermore, it would be useful to know which species, on account of their high ecological sensitivity to plant protection substances, might be suitable as indicators for adverse effects on the entire species community. Research projects have been commissioned in order to examine these issues with regard to soil organisms in cultivated fields, as well as aquatic organisms and arthropods in exposed habitats adjacent to cultivated land.

The new EU Regulations on Plant Protection Products – opportunities and challenges for better incorporation of biodiversity into risk regulation

The UBA has always regarded biodiversity as an integral part of the protection goals hitherto considered and taken it into account as part of environmental risk assessments. When the new EU pesticide regulations came into force in late 2009 [14], the protection of biodiversity was introduced as an explicit target of risk regulation of plant protection substances. The UBA expects that this innovation will revive efforts made so far in terms of enshrining biodiversity as a target in risk regulation, both within the authorisation process for individual plant protection products as well as with regard to protection and compensation measures across the authorisation procedures for single products.

One of the essential prerequisites is the formulation of suitable criteria in order to 'translate' the definition of the protection goal of biodiversity into the every-day practice of risk regulation and to make compliance more feasible. With regard to the implementation of other innovations in the EU regulation such as the ban on the authorisation of active substances with particularly hazardous characteristics, it will also be necessary to revise and specify the existing stipulations. In future, it is intended to ban, on principle, any active substances which combine persistency, bioaccumulation potential as well as toxicity characteristics or are persistent organic pollutants (POP). This will also apply to substances that have to be classified as carcinogenic, mutagenic or endocrine-disrupting substances. For the UBA it will be important to actively contribute to the specification of these 'cut-off' criteria, and to carry out accompanying research projects.

The new EU regulation on plant protection products lays down the regulatory framework for the risk assessment and authorisation of plant protection products and their active substances, while the EU Framework Directive for sustainable use of pesticides really opens up a new perspective for tackling also those environmental problems which cannot be regulated by authorisation procedures alone. Under the framework directive, member states are obliged to create the necessary prerequisites for minimising the risks related to the use of plant protection products, and to encourage the development and introduction of pest management methods with the least possible use of pesticides (in particular the practice of integrated pest management) as well as alternative approaches or techniques in order to reduce dependency on the use of pesticides.

The individual member states of the European Union are obliged to implement the objectives set in the framework directive by means of 'National Action Plans'. Regarding the implementation of the National Action Plan, the UBA will see to it that action fields which are important for achieving the objectives set in the framework directives are named unambiguously and that ambitious targets are set in association with appropriate timeframes. Under the current agricultural conditions, with intensive farming still the dominant form of land use, a sustainable use of plant protection products is ruled out on environmental grounds. This conclusion is justified on account of the evidence collected for direct and indirect impacts of plant protection products on natural habitats and their associated species communities. Consequently, progress depends on whether ambitious measures can be agreed which can help to achieve the crucial objectives set in the regulatory

framework. Only with these measures will it be possible to reduce the use of plant protection products and related risks. Not least, it is hoped that it will be possible to formulate a regulatory framework which will facilitate better compensation for environmental impacts. Maintaining the status quo with regard to chemical plant protection would mean increasing further the risk of not achieving crucial targets set in the National Biodiversity Strategy [15]. These targets envisage that we safeguard and, better still, improve the biological diversity in our agricultural landscapes. Considering the current agricultural conditions, even a stronger promotion of 'integrated pest management' practices seems to be insufficient for achieving our targets. From the UBA's point of view, a future National Action Plan (NAP) should therefore ensure sustainable use of plant protection products; in particular, it should more strongly promote the conversion to ecologically sustainable farming systems without, or at least with low input of, chemical pesticides. Furthermore, the NAP should enhance the ecological recovery potential of agricultural landscapes by creating an adequate proportion of ecologically valuable compensation set aside areas.

Of course, the necessary budgets have to be in place in order to be able to meet these demands. This could be achieved by tying the financial resources - available under the EU's agricultural environment policy – more closely to the provision of ecological services to society as a whole. This approach might at last bring about more environmentally compatible forms of land use [16].

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CEREALS
Their production must not jeopardise the quality of our water.

THE IMPORTANCE OF AGRICULTURAL POLICY

For a long time, agriculture was seen as being essential for maintaining or even creating biodiversity. Without agriculture, large parts of Germany would still be covered by relatively species-poor beech forests.

According to this perception it was agricultural use which by opening-up the dense pristine forests created the essential prerequisites for the diversity of species and habitats. The 1976 version of the German Federal Nature Conservation Act reflected this perception in its so-called agriculture clauses. These gave agriculture and forestry a privileged position over nature conservation by 'arguably assuming' [1] that a positive link exists between the two; in other words, this was taken to be certain unless proven otherwise. Section 1 states that as a rule agriculture – where properly conducted – serves the objectives of the law: the protection of nature and landscape. In Section 8 this is further specified by the provision that agriculture and forestry, properly conducted, shall not be considered an intervention in nature or landscape.

I. Point of departure: Agriculture as a threat to biodiversity

It became clear as early as the 1950s, however, that reality in the field was developing in quite the opposite direction. In her famous book 'Silent Spring', Rachel Carson investigated pesticide use in agriculture addressing, in particular, its impacts on humans and the environment, with a special focus on birds. In 1985 the SRU (German Advisory Council on the Environment) addressed the matter in a comprehensive special report, underpinned by a wealth of scientific facts. This seminal report entitled 'Umweltprobleme der Landwirtschaft' [2] remains highly acclaimed to this day. In this report the council, chaired by Prof. Wolfgang Haber, stated that the extraordinary intensification in both crop and live stock production over the past decades has led to a problematic situation which would make a reorientation of agricultural and environmental policies seem necessary. The cultural landscape was in danger of becoming an agricultural desert, because:

- ever-larger and more powerful equipment required a compatible landscape, i.e. a landscape devoid of 'obstacles'; more often than not spinneys, hedges, field margins as well as other natural habitats and landscape elements had to be removed for the benefit of mechanised systems;
- high-yield crop varieties needed optimal growing conditions, meaning that high nutrient levels and moderate soil moisture had to be provided almost everywhere;
- undesirable competitors such as plant and animal pests which threatened to reduce profit margins were controlled rigorously and decimated by means of chemical pesticides.

Other authors such as Priebe first spoke of subsidised stupidity [3], and later of subsidised destruction of nature [4] when referring to the traditional agricultural policy. As one of various countermeasures,

the SRU demanded in 1985 the introduction of a habitat network connecting extensive ecological priority areas by smaller – patch and linear – habitats in order to enhance the migration, dispersal and genetic exchange of wild species. It was expected that by interconnecting an adequate number of havens and refuges it would be possible to provide sufficient habitats for wild animals and plants to survive in agricultural landscapes.

This demand was incorporated into the amended version of 2002 of the Federal Nature Conservation Act (BNatSchG), in the form of a mandate to the Länder (federal states). These were required to establish a network of interlinked biotopes covering at least 10 % of the total area of each Federal Land. However, so far this measure has not been rewarded with much success. Judging by a recent report compiled by the EU's Directorate-General for the environment, the conservation status of all types of habitat associated with agriculture is distinctly worse than that of non-agricultural habitats (AGRA-EUROPE 30/09, 20th July 2009). It follows that it has proved impossible to halt, let alone reverse, the trend of species decline in agricultural landscapes. Nevertheless, both are objectives proclaimed by the UN as part of our celebrations in 2010 of the International Year of Biodiversity.

II. Agriculture as a prerequisite and opportunity for increasing biodiversity

There was and still is yet another contrary development in agriculture impacting biodiversity. The SRU (1985) identified the abandonment of land use, i.e. the discontinuation of agricultural practices, as one of the main causes of species decline, ranking it in third place, directly behind the elimination of special sites and drainage. Extensive forms of land use at so-called marginal sites which are barely profitable and thus unsuitable for modern commercial farming provide viable habitats for a great variety of rare plants and animals. One notable example are orchids encountered on extensively managed grassland in upland and highland areas. When these forms of land use are abandoned as a result of increasing economic pressure, the very special vegetation and the associated animal communities are inevitably lost. Of late, such socially desirable but economically unacknowledged effects have been summarised under the umbrella concept of 'ecosystem services'. It would be essential to acknowledge these in economic terms, in order to make them attractive also in agricultural terms. For some time hill farming schemes have been conducted for this purpose not just in the interest of species conservation but also for the promotion of tourism.

III. How have these issues been reflected so far in agricultural policies?

Agricultural policy did respond to the economic (surpluses, market organisation costs) and ecological crisis of the 1980s, but in the face of considerable resistance, it did so hesitantly and in small steps. As part of the CAP Reform in 1992 (also known as McSharry Reform, after the EU's Commissioner for Agriculture of that time) and reflecting the economic trends of those days, the obligatory set-aside scheme and the agri-environmental programme were introduced, the latter by way of 'accompanying measures'. Those measures were intended not only to help relieve market pressures and to mitigate the problem of surpluses by means of transition to extensification and lower yields, but also to protect the environment and natural habitats [5]. As a result of rising food prices and the demand for energy biomass, set-aside has since been abolished. Many environmentalists regretted this - the DUH (German Environmental Aid Association) even referred to a 'worst-case scenario for ecological diversity in the cultural landscape' [6] – and called for compensatory measures. In contrast, agri-environmental measures have meanwhile become an integral part of rural development – the so-called 'Second Pillar of the Common Agricultural Policy'[1] – and receive funding from the European Agricultural Fund for Rural Development (EAFRD). Among classical Agri-Environmental Measures (AEM) are the promotion of field margins, extensively managed grassland and the conversion to organic farming.

Measures under the Second Pillar (rural development) have one significant disadvantage: unlike the measures under the First Pillar, they have to be co-financed at national level. Although the German Federal Government makes a financial contribution under the Joint Task 'Improvement of Agrarian Structures and Coastal Protection', the onus falls primarily on the Länder, which, unfortunately, gives rise to budgetary issues at that very level. Also, farmers claim the problem of increased red tape. On the other side, in a special report [7] issued already ten years ago, the European Court of Auditors expressed dissatisfaction with the inadequate targeting of agri-environmental measures and called for improvements. This criticism could hardly be ignored by agri-environmental policy without placing the entire rural development at risk financially. Properly targeted measures unfortunately involve more effort in terms of monitoring and control. Agri-environmental measures have to be carried out in a way that is acceptable also in formal and administrative respects, especially as they represent the core mechanism for implementing the Bird and Habitat Directives (establishing the EU-wide ecolo-

gical network Natura 2000) by means of compensatory payments, for which the EU did not establish a separate financial mechanism.

IV. Interim results and 'new challenges'

What are the interim results we can see now, in the International Year of Biodiversity? To put it bluntly, there is no cause to be satisfied or complacent. As mentioned above, it has so far not been possible in Germany to reverse the harmful trend in respect of biodiversity. The regulatory and funding measures taken have obviously not been sufficient; some of these measures are:

- the Use of Fertilisers Ordinance (Düngeverordnung), intended to ensure efficient management of nitrogen and to protect water bodies and adjacent habitats from nutrient inputs, was issued and recently amended and tightened,
- the requirements for the authorisation of plant protection products, with UBA as consent authority, were tightened,
- the German Federal Nature Conservation Act was revised, tasking the Länder with establishing a network of interlinked biotopes,
- the German Federal Soil Protection Act was revised to include provisions on good agricultural practices,
- direct payments were decoupled from actual production thus reducing the pressure towards intensification, and
- direct payments for agricultural activities were linked to compliance with legal requirements and to maintaining acreage in good agricultural and good ecological condition (cross compliance).

Nor has there been much success so far with agri-environmental measures, regarded by many as dubious attempts to repair the damage inflicted by the First Pillar, i.e. caused by market regulation and financial support. As part of the Common Agricultural Policy health check (here, mid-term review of AGENDA 2007, i.e. the policy for budget years 2007 to 2013) in 2009, adjustments were made in the area

of rural development (i.e. the Second Pillar of the CAP) which were meant to benefit biodiversity as well. A total of five 'new challenges' were identified in this process: climate change, renewable energy, water management (the implementation of the Water Framework Directive), biological diversity and, in addition, the restructuring of the milk sector for adaptation to the free-market economy (the current, market-regulating quota regime is due to expire in 2015), with special measures to ease potential hardships by buffering the most extreme effects.

The intention is to tackle these (actually not so) new challenges by means of (in EU-speak) 'specific projects for certain priorities'. This would include supporting innovative schemes which promise to have the potential of meeting the challenges better than the instruments currently in place. In order to provide member states with the opportunity to choose from a number of options, these innovative ideas were summarised in a detailed list. For this purpose, the EAFRD Regulation was amended accordingly and supplemented by Annex II. From 1st January 2010, the member states are expected to incorporate such projects into their development programmes in harmony with their own specific requirements and targeted at the priorities mentioned above (the 'new challenges'). The priority 'biodiversity' includes, among other things, organic farming which in this context is expected to help maintaining species-rich types of vegetation and to contribute to the protection and conservation of grasslands.

The Council of the European Union had emphasised already in December 2006 that the protection of biodiversity continues to pose major challenges exacerbated by climate change and the demand for water, and that it will take renewed efforts by the Community to reach its biodiversity objectives for 2010. Financially, rural development has been strengthened by a massive gradual increase in so-called 'modulation'. With this mechanism a proportion of the 'direct payments' are sliced off and transferred from the First to the Second Pillar of the CAP. As a result, this adds 1.2 billion Euros annually to the funding available for rural development.

V. Where do we go from here? What remains to be done?

What can agricultural policy do in future to increase its contribution towards improving the situation of wild plants and animals in agricultural landscapes, thus helping to achieve the desired trend reversal?

Another round of CAP reforms beckons for the years of 2014 to 2020, which is already being hotly debated. Approximately half of Germany's national territory is under agricultural use. Thus, the future of species conservation and natural diversity will depend greatly on what happens in agriculture. It would, however, go beyond the scope of this document to describe the current reform debate in detail.

Minimum requirements

On the occasion of the International Green Week Berlin 2010 (fair for food, agriculture and horticulture) the UBA published a background paper with minimum requirements from an environmental and nature conservation perspective [8] which may serve as a useful aid for incorporating the objective of maintaining and improving biodiversity into agricultural policy in a more sustainable manner than has been the case to date. The UBA publication covers the demands and proposals listed below:

- increase the proportion of land areas with ecological priority. The SRU and the UBA call for a share of 10 % priority ecological area per farm as an additional cross-compliance obligation (i.e., as a condition for receipt of 'direct payments'). Abandonment of particular types of use is neither intended nor in general necessary; but the management of these priority areas must not hinder but should support the development of good ecological conditions.
- Greater predictability when planning agri-environmental measures. Farmers with a focus on AEM must enjoy the same planning certainty as any other operator. The mechanism of national co-financing must not become a factor of uncertainty acting as a barrier on the intended measure. To achieve this, a uniform co-financing rate should be established for all agri-political measures extending just as much to market regulation and financial support as to rural development with agri-environmental measures as its second focus.
- More money for measures in relation to the Second Pillar, i.e. rural development and the associated AEM. Social acceptance of 'direct payments' is on the wane, and their historical justification (compensation for the reduction in guaranteed prices as a result of the McSharry Reform in 1992) no longer sounds convincing today. In future the principle of 'public money for public goods' will take pride of place. This is why it will be safer for agriculture to redeploy funds available under the Common Agricultural Policy from the First to the Second Pillar. In the system applied by the World Trade Organisation (WTO), funds in the Second Pillar (rural development) are attributed to the 'green box', i.e. they are permitted subsidies. A note of caution may be appropriate

in this context: It is argued that the decoupling of direct payments from production under the First Pillar of the CAP has also made these payments compatible with the WTO 'green box', which would make redeployment to the Second Pillar superfluous. In order to give farmers certainty in planning, Pillar Two should be provided with a fixed budget. The current modulation mechanism disliked by many – especially in the new Länder characterised by large-scale agricultural structures – would then be superfluous.

Outlook: the concept of hope

Perceptions regarding the post-2013 structure of the Common Agricultural Policy currently differ widely. The European Commission has announced the publication of a White Paper in the autumn, after initial communiques had to be withdrawn on account of vigorous political resistance from the agricultural industry. One thing is clear – the reform will take place against the backdrop of empty coffers and the need for budget consolidation. This will apply at all three levels – the EU, the German Federal Government and the Länder. Furthermore, the EU wants to place greater emphasis on the objectives set in the Lisbon Strategy adopted in March 2000. This strategy envisaged the EU as becoming the most competitive and most dynamic knowledge-based economic area in the world. The EU wants to achieve this goal by placing its new long-term strategy 'Europe 2020 – a strategy for smart, sustainable and inclusive growth' at the centre of its political aspirations. With issues such as knowledge and innovation, careful use of resources, competitivenes, employment and social cohesion in the foreground, the Common Agricultural Policy is at risk of fading into the background. It is important, therefore, to ensure that the necessary prerequisites for improving biodiversity in agriculture and for achieving the goals of agri-environmental policy with regard to the protection of animals and the natural foundation of life, as required by the principle of environmental protection enshrined in the German Constitution, Article 20a, will be met and where possible continually improved, especially in terms of financial resources. If this is achieved, it may be possible to reverse the trend in favour of maintaining biological diversity, albeit with some delay.

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GLOSSARY:

1 Pillar One promotes production; this involves 'direct payments' and market regulation

BLUE BUTTERFLIES

Worldwide 30 % of endangered butterflies belong to the group of blue butterflies.

SUSTAINABILITY REGULATIONS FOR BIOENERGY

A MECHANISM FOR THE PROTECTION OF BIODIVERSITY

'The emission balance for biomass equals zero'. This sweeping assertion is a quotation from the Treibhausgas-Emissionshandelsgesetz (TEHG/Federal act on greenhouse gas emissions trading) passed in 2004 [1].

However, the increasing use of biomass has triggered diverse and critical discussions on the ecological and social consequences of the cultivation processes involved. Questions are raised not just with regard to the said emissions, but also with regard to issues of competition for land, water and other resources. The worldwide increase of biomass production for energy purposes tends to conflict with food security (or rather the security of its supply) and with the protection of biodiversity. The UBA recognises its important role in formulating strategies in the field of renewable energy and in setting the relevant ambitious expansion targets (see Tab. 3). In its capacity as partner in the sustainability discourse, the UBA must address the criticisms and issues raised, and play its part in jointly finding solutions.

Potential burdens resulting from biomass cultivation

Apart from the direct competition for space with food and fodder production, there are also concerns regarding certain methods of cultivation, harvesting and processing. The problems mentioned in respect of biomass cultivation are very similar to those in the agricultural industry in general (see article 'The Weight of Agricultural Policy'). Table 4 [3] contains a summary of the major burdens and effects impacting on the shared natural assets to be protected. Likewise – in view of ongoing public criticisms owing to the increasing pressure on land use – forestry as a supplier of bioenergy will have to play its part in meeting sustainability criteria that have been in the public domain for a very long time [4]. Both nationally and internationally there is concern regarding the tendency to convert natural or near-natural mixed woodlands into fast-growing monoculture forests, and also regarding the trend for whole-tree utilisation [5] which contributes to a reduction in humus and nutrient depletion in woodland sites. Alarming reports on the large-scale logging of rainforests in South-East Asia and Latin America, partly motivated by the demand for bioenergy and the trend for oil-palm or soya cultivation, provoked vociferous protests which demanded a political response.

Further issues of concern comprise the massive greenhouse gas emissions arising from land use changes on carbon-rich soils, the thread new cultivation targets might impose to food security or the violation of social norms and land use rights.

There is growing competition between efforts made in respect of nature conservation and environmental protection on one hand (e.g. extensification efforts

with regard to agricultural and forestry production), and on the other, the drive to increase biomass production in order to meet production targets. In a German and European context this means that owing to high prices for agricultural products, current incentives and control mechanisms such as cross compliance or legally referenced good agricultural practices (GfP) etc. become less effective. Germany, too, is experiencing (increasingly ill-advised) changes in land use like the commercial re-use of potentially carbon rich and biodiverse grasslands, partly located on former peatlands such releasing extremely high amounts of GHG emissions.'

TAB. 3 EXPANSION TARGETS SET BY THE GERMAN FEDERAL GOVERNMENT FOR THE BIOENERGY PROPORTION OF RENEWABLE ENERGY ('RE') OVERALL [2]

	2007		2020	
	RE in total	bioenergy proportion	RE in total	bioenergy proportion
RE proportion compared to overall primary energy consumption (PEC9)	6,7 %	4,9 %	16 %	11 %
RE proportion compared to overall energy consumption	8,6 %	6,2 %	18 %	10,9 %
RE proportion compared to overall energy consumption (OEC)/power supply	14,2 %	3,9 %	min. 30 %	8 %
RE proportion compared to OEC for heating	6,6 %	6,1 %	14 %	9,7 %

Legal regulations stipulate sustainability

Already by 2007, it was noticeable that thea twofold demand for both food products as well as bioenergy feedstocks was going to increase pressure on natural resources and the need for imports of biomass. In this context, the German Federal Republic launched an initiative which called for sustainability. This initiative was intended as a first draft for a regulatory framework for biofuel, with one objective being the protection of biodiversity. The initiative was formulated in a way to ensure its relevance also in an international context. Subsequently, the European Union in Directive 2009/28/EC on the promotion of the use of energy from renewable sources, also made demands for sustainability in respect of liquid biofuels and bioliquids [7].

The German Federal Government adopted these requirements in their sustainability regulation on electricity from biomass (BioSt-NachV) and the sustainability regulation for transport biofuels (Biokraft-NachV) in accordance with the European model. Both regulatory frameworks embody a commitment which has been in force since 1.1.2010[2]. In line with this regulation, it is necessary to produce evidence of compliance with certain requirements before credit points are granted under the transport biofuel quota, and before tax benefits or any form of compensation can be granted in accordance with Germany's renewable energy laws. The evidence is produced by means of approved certification schemes, with counselling and monitoring from the accredited certification offices of the Bundesanstalt für Landwirtschaft und Ernährung (BLE). Both sustainability regulations mentioned above contain the following requirements with regard to environmental protection (prerequisite for certification): transport biofuels and liquid biofuels must not be made from raw materials produced on land which is of high value for biodiversity (see item 1, Sections 4 to 6). Exceptions can be made in cases where it is proven that the production or extraction of such feedstocks is not in conflict with the purposes of nature conservation.

More detailed legal requirements are listed below.

I. Protection of natural habitats (Sections 4 to 6)
- wooded areas (primary forest and other areas in their natural state - with indigenous tree species, without clearly visible signs of human activities or such areas where ecological processes are essentially undisturbed).
- areas designated for nature conservation,
- grassland with great biological diversity,
- areas with high carbon stocks, and
- peatlands.

II. Sustainable agriculture (Section 7)
Cultivation within the European Union is subject to Cross Compliance (CC) with stipulations on sustainable agriculture and subject to requirements pertaining to good agricultural and ecological condition.

III. Greenhouse gas reduction potential (Section 8)
In general, bioenergy providers currently have to submit evidence for greenhouse gas reduction potential in respect of fossil fuels of 35 %, then from 2017 onwards 50 % and from 2018 onwards 60 %.

IV. Other evidence to be submitted in respect of environmental impacts related to the production of the biomass concerned (Section 9)[3]
The following measures[4] are required:
- protection of soil, water and air,
- rehabilitation of degraded areas, and
- avoidance of excessive use of water in areas with water scarcity.

The aim is to submit reliable information on all the points mentioned above, on the basis of approved certification schemes, either at national level or at

TAB. 4 OVERVIEW OF BURDENS RESULTING FROM BIOMASS PROVISION AND IMPACTS ON NATURAL ASSETS REQUIRING PROTECTION [3]

Burdens: (especially resulting from the expansion of land under cultivation of rapeseed, maize, sugarbeat, potatoes)	**Natural assets affected**
Increased use of fertilisers	Imbalances due to surplus nutrient inputs into soils as well as the emission of nutrients into groundwater, surface water and air with consequential eutrophication of biotopes, acidification of soils; and increased emission of nitrous oxide and methane
Heightened use of pesticides and/or the expanded cultivation of crops with intensive use of pesticides.	Input of agents and metabolites into soil, water bodies and air, resulting in increased impacts on sensitive biocoenoses and the availability or usability of groundwater and surface water
Changes in land use or conversion of land use (e.g. ploughing up grassland in response to increased demand for arable land)	Peat cutting/mining and releasing large amounts of sequestered carbon from GHG sinks; loss of natural functions owing to increased erosion und rapid run-off of water; loss of habitats resulting in threats to species and biocoenoses; changes in the appearance of the landscape resulting in diminishing its recreational function; cultivation in sensitive areas (Natura 2000, areas designated for nature conservation/ landscape conservation and water conservation); loss of edge habitats and structural elements, for example by merging agricultural fields or land consolidation
Shortening crop rotation cycles and/or standardising crop rotation	Decrease in varietal diversity and traditional varieties, trend towards monoculture; loss of habitats for species which depend on certain types of land management
Cultivation of water-hungry crops in dry sites (e.g. plantations under short-crop rotation cycle management)	Reduced availability of water; change in groundwater level; reduction in the rate of groundwater replenishment; need for irrigation (especially on permeable soils)
Removal of organic material including residues (straw, leaf litter, deadwood)	Humus-sapping and negative humus balance; acidification, rapid water run-off; habitat loss (especially in case of removal of deadwood and residual wood from woodlands); impacts on GHG sinks
Use of genetically modified organisms (currently just on a trial basis)	Risk of genetically modified material spreading throughout soils, organisms and plant populations

EU level. As far as non-member countries are concerned, the intention is to conclude bilateral or multilateral agreements in order to ensure the procurement of evidence on compliance with sustainability criteria. In this context it will be essential to cover the protection of the environment (soil, water and air). Furthermore, safeguards will have to be put in place to ensure that the use of allegedly degraded areas for biomass cultivation as favoured by the Commission, cannot be misapplied in a manner that leads to detrimental changes in land use or even land theft.[5]

The practical implementation of sustainability criteria is fairly well advanced in Germany, with the publication of the two sustainability ordinances, relevant administrative requirements and guidance documents. The Bundesanstalt für Landwirtschaft (BLE) is charged with checking and authorising the certificating bodies and with subject-based training of environmental assessors. A research project sponsored by the Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz (BMELV) has already produced the first certification system [8].

What remains to be done?

Despite wide-spread appreciation of these first attempts to enforce sustainable production methods among bioenergy providers, by means of the regulatory measures and certification schemes mentioned above, the requirements as stipulated in their present form are not without critics. There are environmental organisations who criticise, for example, the choice of such a late reference year for submitting site-based evidence (1.1.2008). Furthermore, the very narrow focus on liquid biomass has attracted criticism. Even if the requirements are strictly adhered to and monitored, it is feared that, in future, the proportion of biomass used for energy, such as palm oil, will simply be procured from the old cultivated areas (taken into cultivation before 2008) whereas the new, uncertifiable proportion will be channelled via the utilisation of materials so far not subject to monitoring (e.g. via the cosmetics industry) or handled as a food product (e,g. for the production of margarine) [9]. Avoidance strategies of this kind, which are alleged to be pursued by producers in high-output countries such as Indonesia, Malaysia or Brazil, jeopardise the effectiveness of current sustainability regulations. Political parties and various interest groups therefore demand that in future certification should be extended also to solid and gaseous biomass and to agriculture and forestry in general [10]. The UBA shares the view that sustainability criteria should be substantiated and extended to other areas of biomass utilisation as an indispensable prerequisite for the effective protection of natural resources and biodiversity [11].

The UBA has used the research project 'Bio(masse)-Global' [12] to support the process of formulating the two sustainability ordinances. To this end, numerous investigations were carried out on the central issues involved in making sustainable biomass available. Some of the key themes dealt with were:

- basic approaches for the calculation of greenhouse gase balances including emissions from direct and indirect land use change (iLUC);
- water-related criteria for sustainable biomass production;
- legal issues in respect of the international biomass trade;
- global identification of areas with high nature conservation value, and
- evaluating conceptual and spatial demarcation of so-called degraded areas and determining their potential.

Of particular importance are the research results in respect of the globally available prospects for submitting site-based evidence, and the evaluation of these submissions, especially with regard to (agro-) biodiversity. (From the research) it could be concluded that consolidated and supplemented geo-referenced data, for example in respect of Global Agro Ecological Zoning – GAEZ)[6] and on protected areas (World Database on Protected Areas – WDPA)[7], have the potential to provided a preliminary foundation for ensuring compliance with sustainability criteria for biomass.

Once the legally binding sustainability requirements and relevant criteria have been formulated, it is necessary to set specific guidelines for the people and departments concerned in the bioenergy production and supply chains. It is important to specify clear

and measurable indicators as a working basis for suitable certification schemes. The UBA is actively involved in the repective standardisation processes under guidance of DIN, CEN and ISO. This process requires cooperation – at management level, but also at the level of various working groups – on issues such as environmental protection, nature conservation, certification or balancing GHG emissions.

The Global Bioenergy Partnership (GBEP) provides the UBA with a platform for participating in international discussions. The GBEP was founded on Italy's initiative at the G8 Summit in Gleneagles (07/2005, Action Plan). The GBEP is to support the cost-efficient utilisation of bioenergy and to promote the sustainable development of bioenergy, with a particular focus on less-developed countries where biomass use is widespread. The GBEP is also in partnership with the Commission on Sustainable Development (CSD). Owing to her strong commitment, also with regard to cooperation with UNEP, Germany has, over the past few years, spearheaded the work on aspects relating to environmental protection and nature conservation.

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GLOSSARY:

2 From 1st July 2010 onwards, evidence will be required where biomass is used for conversion into electricity. In cases where biomass used in liquid form in the second half of 2010, has been harvested prior to 1st January 2010 the plant operator will have to submit informal documentation confirming the veracity of the date of harvesting (BLE 2010, Leitfaden nachhaltige Biomasseherstellung).
3 Section 9 of the BiokraftNachV is n/a
4 according to article 18 para 3 item 3 of the EE Directive
5 The classification of an area as 'degraded' seems to suggest that it has no value for the local community either in terms of ecology or economy. This is often out of proportion with reality.
6 FAO and IIASA
7 IUCN, World Database on Protected Areas (WDPA)
8 WBGU: German Advisory Council on Global Change

THE DRAGONFLY

Dragonflies are indicators for climate-related shifts in plant and animal communities

BIODIVERSITY AND CLIMATE CHANGE

PROTECTION THROUGH CLIMATE POLICY AND ADAPTATION

Biodiversity is threatened worldwide by human activities such as the type and intensity of land use, anthropogenic pollution, the introduction of invasive species, as well as many other factors [1]. Worldwide losses in biodiversity resulting from those threats are further intensified by climate change.

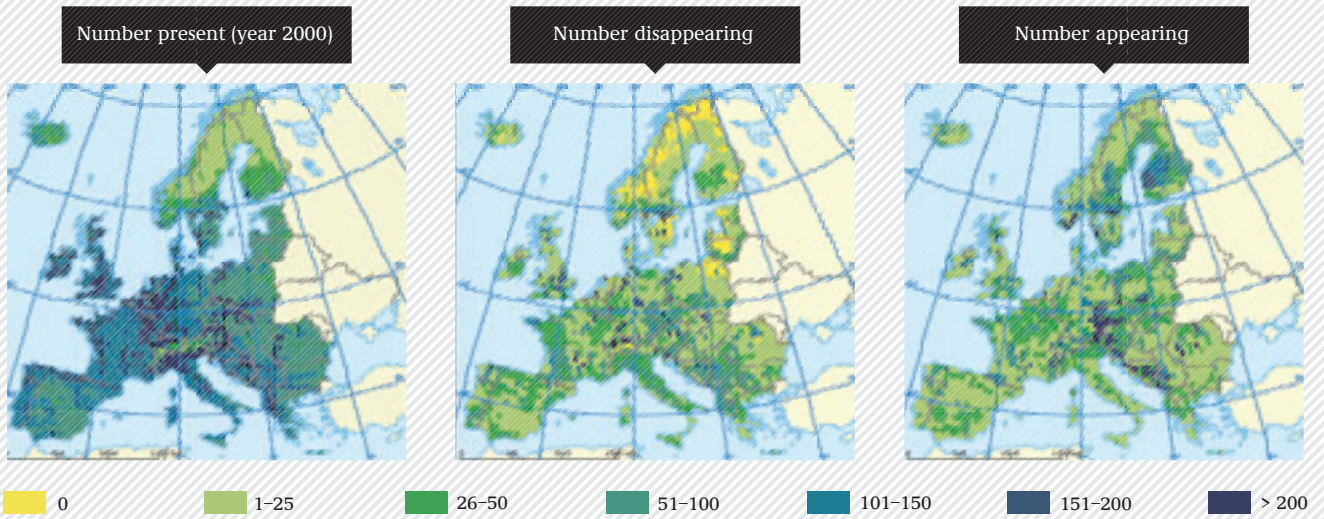
I. The threat of current and future climate change to biological diversity

In 2007 the Intergovernmental Panel on Climate Change (IPCC) published the highly acclaimed Fourth Assessment Report (AR4) on current and future climate change and the consequences to be expected [2]. Among other things, the AR4 addresses the relationship between climate change and biodiversity [3]. For example, observations from all continents and most of the oceans indicate that numerous natural systems are affected by changes in the regional climate, especially increases in temperature. Terrestrial ecosystems, for example, exhibit evidence of a poleward shift in the geographical distribution of plant and animal species and a shift to higher elevations.

Other impacts of regional climate change on the natural environment which are occurring across the globe, are difficult to identify on account of adaptation to and interaction with non-climatic driving forces. This is illustrated by examples such as the loss of coastal wetlands and mangroves, caused by sea level rise and human exploitation. Not just individual organisms, but entire habitats and ecosystems are affected by these worldwide changes. Despite having some measures in place, i.e. bird monitoring, Germany so far has not implemented any comprehensive scheme for the continuous observation of changes in biodiversity. As a result, it has been difficult, in particular because of the complex correlation of effects, to obtain a systematic overview of the current extent to which biodiversity is affected by climate change [4].

However, individual studies indicate the following changes: the shift in habitat conditions leads to gradual migration of plant and animal species. In the long run, species with limited ability to migrate and species which are inhibited by obstacles such as mountain ranges and water bodies or lack of connectivity with other habitats, are therefore at risk of extinction. Detrimental consequences are expected especially for species in montane and coastal regions as well as for those species which are adapted specifically to water bodies, wetlands or special sites limited in size. In 2003 it was observed in the Palatinate Forest (in Germany) that greater variability of precipitation resulted in higher probability that small bodies of water, springs or upper reaches of streams would dry up. This can bring about a localised or regional extinction of limnic (freshwater) species[8] [5]. According to estimates, between 5 % and 30 % of plant and animal species in Germany are

FIG. 20 PROJECTED CHANGES IN THE NUMBER OF PLANT SPECIES BY 2050 [8]



Projected changes in plant species in 2050, compared to reference year 2000
Results for stable area per grid cell, using the EuroMove model with HadCM2 A2 climate scenario.

Source: Based on Bakkenes et al., 2006.

at risk from climate change [6]. In the long term, new plant and animal communities will develop. In other words, there will be new combinations of species, living interdependently or in a shared habitat. Sensitive ecosystems such as mudflats are at risk in the long term, if they are constantly inundated as a result of sea level rise and associated erosion, which destroys the habitats of important species [7].

Researchers of Joint European projects (such as ALARM)[9] and of research projects at national level e.g. from the German Federal Agency for Nature Conservation (BfN) are currently involved in projecting the consequences of climate change for biodiversity [9, 10]. In light of this, the 91 habitat types occurring in Germany were classified in accordance with the Europe-wide system of conservation sites (NATURA 2000). As a result, 23 habitats were classified as highly sensitive [11]. An estimate of further, climate-change induced threats to a group of animal species protected in Germany under NATURA 2000, indicated that the risk level of more than half of 157 species examined has increased to high or very high. The exposure to the risk of losing these species is increasing in direct proportion to the status of the species on the Red Data list. Species such as butterflies and beetles that require specific small-scale conditions seem to be at greatest risk, followed by species that require complex habitats such as water bodies and their associated environment, or species that need purely aquatic habitats [12]. A study analysing a wider spectrum of groups and species showed high risk for more than 50 highly protected animal species, especially in mire habitats, followed by species in woodlands and other dryland or wetland habitats. The North-East German lowlands, the South-West German mountain ranges and the foothills of the Alps were identified as particularly sensitive to climate change [13].

The speed and extent of climate change already caused by human activity, in combination with future climate change, may result in exceeding the adaptive capacity of biological systems. According to IPCC statements, it is to be expected that for each rise in the global average temperature by 1 °C another 10 % of species worldwide will be put at very high risk of extinction [14]. Losses in species and habitats are associated with adverse consequences for ecosystem services such as the self-regulation of water systems. This in turn results in the degradation of basic requirements for human life.

II. Protecting biodiversity through climate policy

The United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol provide the basis for international law regarding the reduction of greenhouse gas emissions as well as adaptation to climate change. The scope of work under the negotiations is based on Article 2 of the Framework Convention on Climate Change which called for a stabilisation of greenhouse gas concentrations at a level that prevents dangerous human interference in the climate [15]. Germany and the other EU member states have since clarified this level by specifying that the global average temperature must be limited to less than 2 °C above pre-industrial temperature levels [16]. This target was determined on the basis of tolerable risks to biological diversity, taking into account the globally acceptable economic and social expenditure on environmental measures. The National Biodiversity Strategy (NBS) adopted by the German Federal Government in 2007 makes direct reference to this target [17].

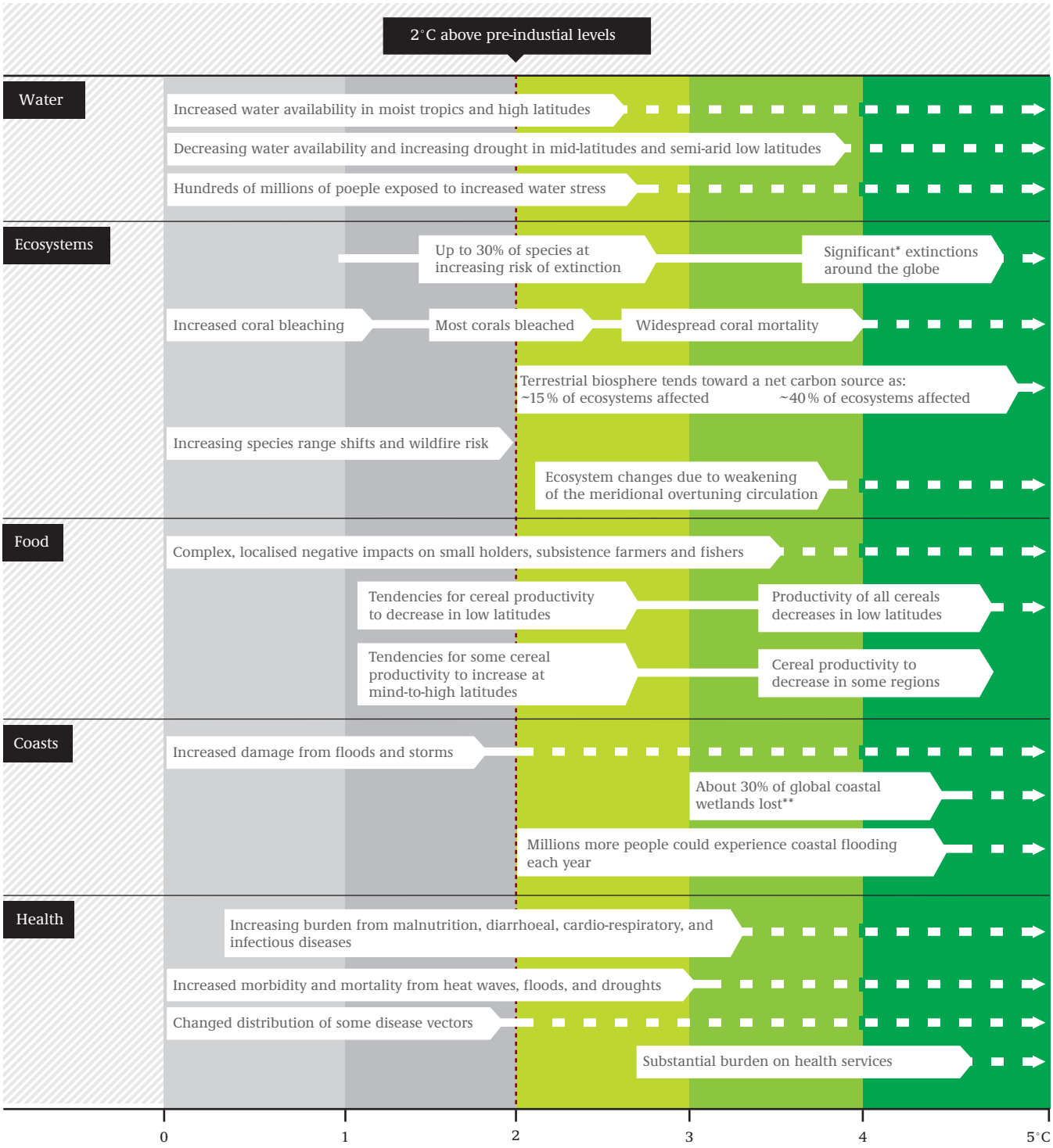
Temperature rise will have to be restricted to less than 2 °C worldwide, in order to prevent climate change spiralling out of control. To this end, especially with regard to biodiversity, the emission of global greenhouse gases must be at least halved by 2050 compared to 1990 levels. By 2020, industrialised countries alone will therefore have to reduce their CO_2 emissions by between 25 % and 40 % of 1990 levels, and from then on by between 80 % an 95 % by the middle of the 21st century. In the run-up to 2020, the developing countries, especially the larger, so-called emerging economies, will have to reduce their CO_2 emissions by between 15 % and 30 % compared to their predicted emissions growth ('business as usual'). In the period from 2008 until 2009, the Parties to the Convention have held intensive negotiations on the development of a new legally binding climate agreement in order to specify corresponding mitigation obligations. At the 15th Climate Change Conference in Copenhagen in December 2009 the negotiating states were unable to reach agreement. However, the 'Copenhagen Accord' [18] provides at least a political guideline for future negotiations. The signatories were thus given a basis for their work towards an agreement in the form of a package of decisions adopted at the subsequent Climate Change Conference in Mexico in November 2010. On that occasion, the 2 °C limit was at last established as an overall goal and guideline for reductions in emission levels.

The outcome of the Copenhagen Conference highlights the difficulty of coming to an agreement that considers the interests of all nations underneath one UN umbrella, even with regard to a general consensus on the urgent need for action in fields such as biodiversity. Germany, the EU and other industrial nations are obliged to support this Convention by setting their own ambitious and binding targets including those in respect of biodiversity. In light of the two-degree limit, the German Federal Republic set its own target for the year 2020 to reduce total CO_2 emissions by 40 % in comparison to 1990 [20]. In this respect, the achievement of the German national reduction target is therefore not only an important component of European climate protection efforts. Its achievement would also provide an encouraging stimulus to the negotiating process worldwide.

The challenge is to give proper consideration to the interests of all nations involved in the international negotiations on climate change. With this in mind, the UBA continues to analyse the technological feasibility, the ecological effectiveness (also in relation to biodiversity) as well as macroeconomic effects of various climate protection measures [21, 22]. Furthermore, the UBA raises these issues at discussions both at EU and the wider international level. The global destruction of natural forests occurs mainly in the tropics and reaches figures of approximately 13 million ha per year. This is responsible for approximately 20 % of global greenhouse gas emissions. It is therefore an important part of the Copenhagen Accord to establish a mechanism ('REDD+2')[10] for supporting developing countries in their efforts to reduce emissions resulting from deforestation and degradation of forests, as well as for the protection of the sustainable management of woodlands and forests, and for increasing carbon stocks. Not only are tropical and subtropical forests essential sinks for 25 % of the carbon in terrestrial ecosystems [23]; these natural forests also contain a third of all terrestrial animal and plant species,representing a significant part of the world's biological diversity. The UBA is committed to establishing incentives for the reduction of emissions by means of a REDD+ mechanism that additionally supports the goals of the CBD [24].

However, even if we consider the two-degree limit as an acceptable level of climate change, it would still signify a global loss of some animal and plant species as well as ecosystems, along with all associated functions and services. In a study evaluating the economic value of biological diversity conducted e.g. by Germany and the European Commission among others[11], it was reported in the autumn of 2009 that for coral reefs, one of the most important ecosystems worldwide, the critical threshold values have already been reached [25]. It was observed in major

FIG 21 EXAMPLES OF IMPACTS ASSOCIATED WITH GLOBAL AVERAGE TEMPERATURE CHANGE
(IMPACTS WILL VARY BY EXTEND OF ADAPTATION, RATE OF TEMPERATURE CHANGE, AND SOCIO-ECONOMIC PATHWAY)



* Significant is defined here as more than 40%. ** Based on average rate of sea level rise of 4.2 mm/year from 2000 to 2080.

Source: 4th IPCC (2007): Summary for Policymakers of the Synthesis Report of the IPCC Fourth Assessment Report by the Intergovernmental Panel on Climate Change (SPM SYR)

tropical reef systems that acidification caused by increased atmospheric CO_2 levels and temperature rise has resulted in coral bleaching on a massive scale. A further increase would lead to a serious decline in coral reef colonies. Also, if the global average temperature rises by more than 2°C, the long-term survival of coral reefs is no longer assured. As a safeguard against this development, CO_2 levels in the atmosphere must be reduced significantly and permanently. Although coral reefs cover only 1.2 % of the oceans' continental shelf regions, they have a key function in maintaining marine and coastal ecosystems: they provide habitats for one to three million species, including a quarter of all species

of marine fish. Furthermore, their use in terms of fisheries, coastal protection and tourism provides valuable ecosystem services to roughly half a billion people. As a result of human activities such as destructive fishing practices, anthropogenic pollution, the spreading of invasive species and diseases, as well as tourist activities, approximately 30 % of coral reefs have already suffered serious damage [26]. These findings on threats to biodiversity that are expected to be associated with a temperature rise of less than two degrees are based on assessment reports and special reports of the IPCC, and are used as a scientific basis for negotiations. The UBA is actively involved in the formulation of these IPCC reports[12] As one of several nations, Germany has adopted these findings to underpin its negotiating position within the EU in respect of an ambitious climate treaty.

III. Biodiversity conservation by adaptation to climate change

In order to make a comparison with other subjects of protection, the first comprehensive assessment of the vulnerability of biodiversity to climate change in Germany was carried out by the UBA in 2005 [27]. Prior to carrying out this assessment, it was necessary to determine the objectives. Judging by the present conservation status of individual species, as well as the present species diversity in Germany, their vulnerability has to be rated as high. Even if we accept changes in species composition, vulnerability must be rated between moderate and high, because the processes associated with anthropogenic climate change are most likely to exceed the capacity of many biological systems to adapt, thus threatening species diversity in general, biocenoses (plant and animal communities) and ecosystems as well as the sustainability of ecosystem processes and services. The situation calls for adaptation measures targeted at, above all, the protection and enhancement of the natural potential for adaptation. The BfN (Federal Agency for Nature Conservation) is currently examining the potential of proposals submitted for solving these problems [28]. Among these are concepts for the management of conservation sites [29], measures for facilitating migratory movements (e.g. creating habitat networks at local, regional, national and transnational level) as well as flexible protection concepts which allow for the natural dynamics of ecosystems, such as measures for maintaining or restoring the natural process of waterlogging in wetlands that are particularly at risk from climate change. As far as plantation forests are concerned, an appropriate start has been made with the restructuring process aiming at diverse near-natural species compositions and a broad genetic base.

In order to increase the chances of species and ecosystems adapting successfully to rapidly changing climatic conditions, it is necessary, in addition to nature conservation measures, to reduce the causes of other current or future threats. These include the disruption, fragmentation and destruction of habitats by means of land use such as settlements, transport, agriculture and forestry, excessive nutrient inputs and undesirable side effects of pesticide use, as well as processes by which indigenous species are displaced by invasive species some of which can profit from climate change. The implementation of diverse measures for the protection of biodiversity from the impacts mentioned above (as listed in the National Biodiversity Strategy and described elsewhere in this brochure) is another important strand of the German adaptation strategy to climate change (Deutsche Anpassungsstrategie an den Klimawandel/DAS) adopted by the German Federal Government in 2008 [30]. The Strategy pursues an integrated approach that offers the opportunity to exploit synergies between nature conservation, climate protection and adaptation, as well as providing support for the maintenance of biodiversity. For spring 2011, the German Federal Government plans the publication of an adaptation action plan (Aktionsplan Anpassung). The UBA is currently developing a technical proposal for a method of prioritising these adaptation measures across multiple action fields. The proposal is to provide a coherent set of stipulations according to the strategies adopted by the German Federal Government, such as the National Sustainability Strategy (Nationale Nachhaltigkeitsstrategie) and the NBS. In line with these concepts, the proposals for prioritisation criteria incorporate the results of an analysis of conflicts and synergies of adaptation measures for various action fields including biodiversity [31]. Apart from other consultation services, the KomPass section of UBA offers a platform on its website www.anpassung.net which contains expert advice on implementation with regard to aspects of climate change and biodiversity, climate scenario data (free of charge), information on DAS, as well as a catalogue of projects on impacts of climate change and adaptation in Germany. This catalogue of projects is accessible through the big German Environment Information web portal ‘Portal U’ [32].

IV. International efforts made to support the adaptation of biodiversity to climate change

In regards to adaptation to climate change under the Framework Convention on Climate Change, there are many interlinkages with biodiversity conservation which should be pursued more consequently and strengthened in order to support the CBD’s efforts. Due to their limited adaptative capacity,

developing countries are particularly vulnerable to climate change thus relying heavily on ecosystems in times of stress, putting an additional and enormous pressure on their ecosystems. Furthermore, stronger impacts of climate change are occurring and expected to occur in the developing countries. Together these driving forces cause much stronger impacts on biodiversity in developing countries than in industrialised countries [33]. This trend is likely to continue in the future. Despite emission reduction measures, climate change can no longer be avoided entirely. The international community therefore adopted adaptation as one of the building blocks of the Bali Action Plan (BAP) [34] in order to counteract the inevitable threats more vigorously under a post-2012 climate agreement. Germany contributed significantly to the development of an EU proposal for an adaptation framework. As part of its work in the EU Expert Group working on adaptation, the UBA contributed to ensuring that the protection of ecosystem functions and services is taken into account in the international adaptation policy. To this end, the UBA has proposed, for example, to structure future regional adaptation centres in a way as to enable participating countries to benefit from synergies between adaptation measures and from measures in other policy fields such as biodiversity. Furthermore, UBA continues to advocate the implementation of principles underlying the ecosystem approach in the transfer of knowledge to developing countries for the purpose of adaptation to climate change within the Nairobi work programme[13], and that this should be done in the spirit of the Convention on Biodiversity.

In the interest of bilateral cooperation, the German Federal Government has been financing since 2008, as part of the International Climate Initiative (ICI), projects on climate protection and adaptation to climate change in developing countries and in the transition states of Central and Eastern Europe. These projects are financed from the proceeds of auctioning emission trading certificates. The implementation of development programmes, spearheaded by the BMU, includes projects which support both climate protection and measures for maintaining biodiversity. As a member of the Steering Group, the UBA takes part in the strategic planning, evaluation and technical support of the ICI.

In April 2009, the European Commission published its White Paper entitled 'Adaptation to climate change' [35] which aims to strengthen the EU's resilience to climate change to an extent that enables member states to cope with the consequences of climate change. An Impact and Adaptation Steering Group will enable Germany to participate, with the UBA contributing the technical foundations, including aspects of biodiversity.

The European Topic Centre 'Air and Climate Change' (ETC/ACC) under the auspices of the European Environment Agency (EEA), with the UBA's participation, will formulate guiding principles for good adaptation to climate change ('Guiding Principles for Good Adaptation'). One of the main tasks will be to lay the foundations for decision-makers at local and regional level, for a successful adaptation process including the actual implementation of appropriate measures. One of the contributions to guiding principles submitted by the UBA will be the incorporation of the ecosystem approach into adaptation measures and the provision of information on best-practice examples for the protection of biodiversity.

V. Summary

Climate change accelerates the worldwide loss of biodiversity caused by the already existing threats to biodiversity. The speed of climate change already caused by humans, not to mention the change that is yet to come, could mean that the capacity of species to adapt to changed environmental conditions will be exceeded, so that important ecosystem processes and services will be lost. In the interest of biodiversity, Germany should continue to campaign for an ambitious climate convention under UNFCCC with the aim to at least limit warming to less than two degrees Celsius. To this end, it will be important for Germany to live up to its political role in the climate process, by committing to a clearly defined national obligation to reduce impacts and to implement the necessary measures within the timeframes agreed. It is clear from findings on threats to tropical coral reefs – of crucial importance for global biodiversity – that biodiversity is already at risk globally from an average temperature rise of 2°C. In the TEEB study therefore even more ambitious global efforts are demanded. Germany should campaign for further strengthening the links between UNFCCC and CBD both with regard to reducing greenhouse gases by means of the REDD+ mechanism and by means of adaptation, so that the targets set by both Conventions can be met. The most appropriate mechanism for achieving this is the CBD's ecosystem approach. It is important to assist ecosystems to adapt to climate change. It is therefore essential to take every opportunity in all policy fields relevant to biodiversity, and to go far beyond nature conservation measures in order to reduce the risks already threatening biodiversity, caused by land use, anthropogenic pollution and invasive species.

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35 European Commission: WHITE PAPER – Adapting to climate change: Towards a European framework for action on adaptation to climate change, 2009, available at: http://ec.europa.eu/environment/climat/adaptation/index_en.htm (last accessed: 28.05.2010)

GLOSSARY:

[8] Specialised types of moorland are disappearing (e.g. S.arcica, L.dubia); in their place it is possible to witness mass immigration of ubiquist species (such as Libellula depressa, Orthretrum cancellatum) colonising water bodies in great numbers. By virtue of their capacity of tolerating a wide range of variations in one or more environmental factors, ubiquists are less specialised. Dragonflies are therefore indicators for climate-related shifts in plant and animal communities

[9] ALARM = Assessing Large-scale environmental Risks for biodiversity with tested methods. This includes projections of future amphibian and reptile distributions in association with various climate scenarios in 2050.

[10] REDD = Reducing Emissions from Deforestation and Degradation. The plus (+) sign added to this abbreviation, signifies the protection and sustainable management of woodlands/forests and actively increasing carbon stocks.

[11] The Economics of Ecosystems and Biodiversity – TEEB

[12] The publication of the Fifth Assessment Report scheduled for 2013/2014, is currently in preparation.

[13] It is not possible to keep ecosystems going in a meaningful way, unless they are dealt with as one integral whole and protected in their entirety. Under the auspices of the CBD, the Malawi 1998 Conference of Signatories formulated, to this end, twelve principles specifying the ecosystem approach, as well as five application-based guidelines. They represent a 'strategy for the integrated management of water and living resources to promote the protection and sustainable use in an equitable manner' (Resolution V/6)

THE NEST

After a short winter, a returning migrant bird may well find its nest site already occupied by a resident bird.

WHAT IS TO BECOME OF BIODIVERSITY?

AN EVALUATION ON THE BASIS OF INDICATORS

The 'National Biodiversity Strategy' adopted by the German Federal Government in November 2007 specifies quality and action targets for all biodiversity-related topics.

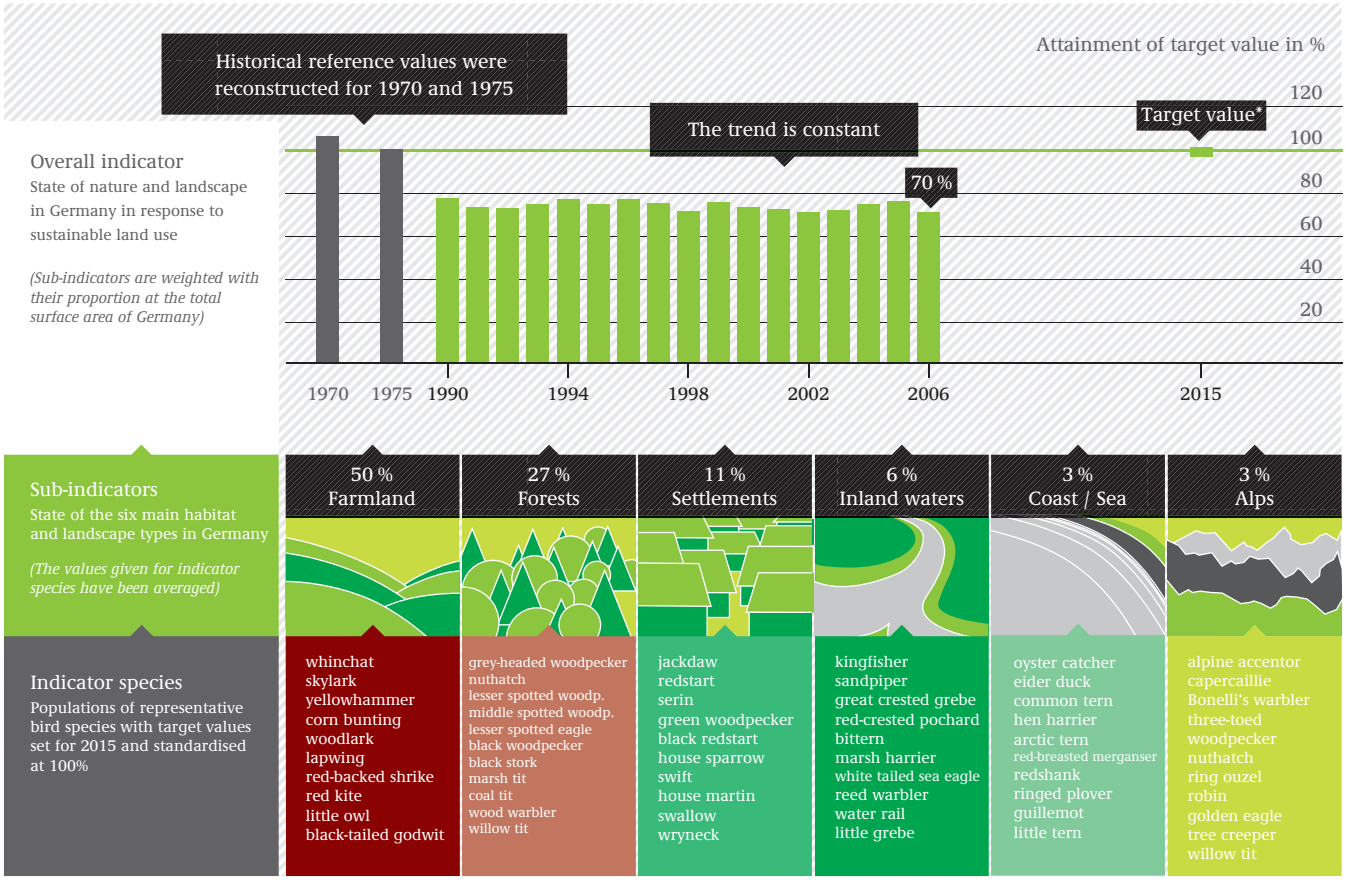
Once in every parliamentary term, the Federal Government will inform the public on progress made in the implementation of this strategy. The first of these reports is due in 2012. The summary assessment of results is to be underpinned by an indicator-based report on the implementation of the strategy. The first of these indicator reports has been published in 2010. The indicators are intended to give a wide-ranging overview of the topics covered by the Strategy. State indicators aim at identifying the current state of biodiversity and its individual components progress. Any changes that have occurred so far in respect of biodiversity are measured by means of impact indicators. The relevant monitoring programmes are yet to be formulated. There is, however, already a great number of characteristics available which illustrate factors that influence biodiversity. Pressure indicators measure impacts on biodiversity and have so far constituted the principal part of the indicator set. So-called 'response indicators' are used for identifying in what way policies and society respond to changes in biodiversity.

The indicator set contained in the National Biodiversity Strategy (NBS) is compatible with other indicator systems at international level, as well as the level of the German Federal and Länder governments. A number of indicators contained in the UBA's core indicator system (KIS) are incorporated in the NBS indicator set.

An essential characteristic for indicating the condition and any changes in German wildlife and landscape is the 'sustainability indicator for species diversity' formulated and collected by the Bundesamt für Naturschutz (Federal Agency for Nature Conservation) which calculates the gains and losses of populations of 59 representative bird species in six main habitat and landscape types in Germany. Provided the legal requirements for nature conservation and the guidelines for sustainable development are implemented in full, the target values for the individual indicators and the resulting total of all indicators will reach 100 %. The percentage reached by 2006 amounted to 70.2 % of the 2015 target. In 1990 the percentage was clearly below the values calculated retrospectively for 1970 and 1975. The value of the indicator total hardly changed in subsequent years. If this trend continues, the target will not be met by the relevant deadline, unless appropriate steps are taken at Federal, Länder und municipal level.

The major causes of the decline in species diversity are the intensification of land use for agriculture and forestry, the fragmentation and urbanisation of the landscape, the sealing of open areas, as well as inputs (e.g. acidifiers or nutrients). Equally, climate change will have serious effects on species diversity. The contamination of the environment with nutrients, in this case mostly eutrophication

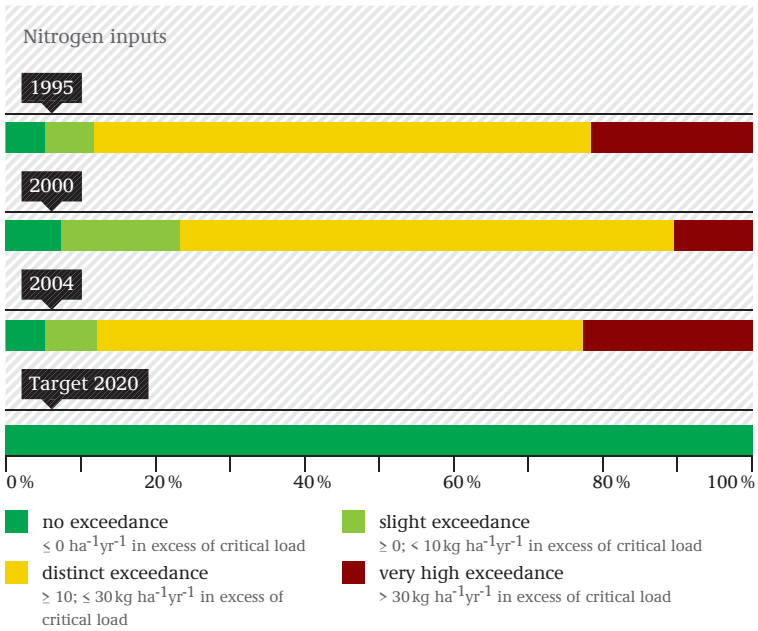
FIG. 22 SUSTAINABILITY INDICATOR FOR SPECIES DIVERSITY



* An expert panel has determined a target value of 100% for 2015

Source: Bundesamt für Naturschutz 2009 (Federal Agency for Nature Conservation) 2009

FIG. 23 CRITICAL LOADS: EXCEEDANCE OF EUTROPHYING NITROGEN LEVELS AFFECTING SENSITIVE ECOSYSTEMS



Source: ÖKO-DATA, Nationale Umsetzung UN ECE Luftreinhaltekonvention (Wirkungen), UBA-FKZ 204 63 252, UBA-Texte 39/2008

from nitrogen, is one of the major direct drivers for changes in biodiversity and ecosystems [1]. It is true that nitrogen compounds have their place in providing plant nutrients. However, excessive nitrogen inputs by means of agriculture, transport, energy production, industrial processes and many other activities affecting soil, water and atmosphere, have far-reaching impacts on natural systems. As a result, biodiversity is impaired because of acidification, eutrophication, nitrate pollution of groundwater, pollution of surface waters and oceans, and intensification of climate change. Owing to the considerable reactivity and mobility of reactive nitrogen compounds, environmental strategies and measures must be incorporated into one integrated nitrogen-emission reduction strategy, rather than focusing on one particular emission source category or environmental compartment, or on reducing a single effect.

The National Biodiversity Strategy aims at meeting the critical loads for nutrient inputs (critical loads for eutrophication) to safeguard the protection of sensitive ecosystems [2]. In 2004 (latest available data), the critical loads for eutrophication were met for 4.3 % of the surface area of sensitive ecosystems. To meet the target for the entire area containing

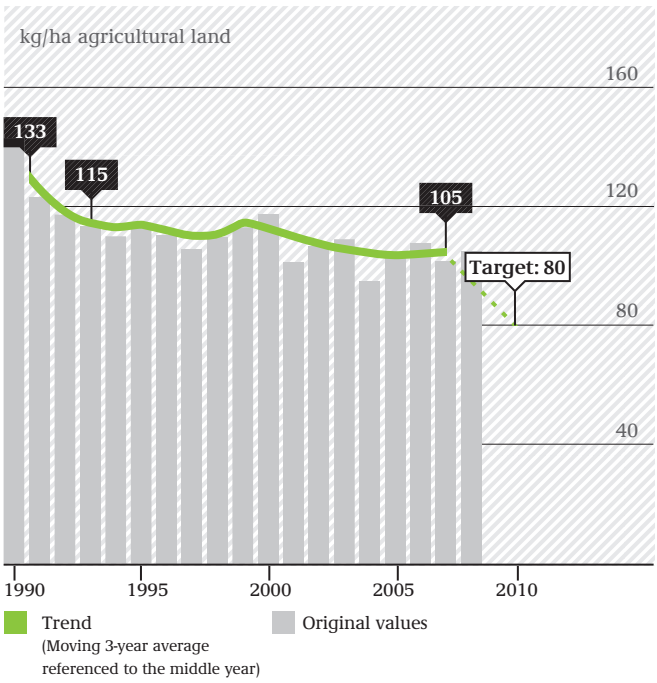
sensitive ecosystems, it is essential to reduce diffuse nitrogen inputs significantly. As it provides most of the causes of nitrogen emission, agriculture also has the greatest potential for reducing inputs. In order to reduce nitrogen surplus in agriculture, the German Federal Government has set a target of no more than 80 kg per hectare (ha) by 2010. Since 1991 the nitrogen surplus has been reduced from 133 kg/ha per year to 105 kg/ha per year in 2007 (three-year moving average). This equals a reduction in the annual surplus of more than 20 %. However, the reduction at the beginning of the timeframe is not due to increasing efficiencies in the application of nitrogen. It is, in fact, due to a decrease in animal farming in the new Federal Länder.

In total, the reduction that has been achieved within the period from 1991 to 2007 is not enough. The fertiliser regulation adopted in 2007 makes specific requirements for the use of fertilisers in agriculture and sets upper limits for the excessive use of nitrogen in agricultural processes. It is therefore to be expected that the measures coming into force will impose more rigid restrictions on the excessive application of nitrogen.

One major route for inputs of eutrophying nitrogen is via the atmosphere. It is essential, therefore, to target measures at the reduction in nitrogen emissions. This can be achieved by means of saving and making better use of energy, cutting down on and streamlining transport operations, optimising processes in industries such as steel, cement and glass or in the chemical industry. As far as emissions are concerned, differing trends can be observed: nitrogen oxide (NO_x) emissions dropped by 52 % between 1990 and 2008 especially from transport, whereas, over the same period, ammonia (NH_3) emissions primarily from animal farming dropped by approximately 13 % only. According to the stipulations made by the EU Directive on national emission ceilings (NEC Directive), Germany will have to comply with an emission ceiling of 1,051 k tonnes (kt) from 2010 onwards. On 23rd May 2007, the German Federal Cabinet therefore adopted a national programme for reducing ozone concentrations and for compliance with emission ceilings. Its implementation is intended to reduce ozone concentrations and achieve compliance with national emission ceilings for sulphur dioxide (SO_2), nitrogen oxides (NO_x), ammonia (NH_3) and non-methane volatile organic compounds (NMVOC). A further reduction in nitrogen oxide emissions is expected to be achieved primarily in the field of road transport, especially with regard to Heavy Goods Vehicles (HGVs), whilst other sectors are expected to contribute to a lesser extent. As far as ammonia is concerned, an emission ceiling of 550 kt NH_3 has been in force since 2010. In order to meet this target, the emission levels reached in 2008 will have to be reduced by a further 37 kt or 6 %. As far as agriculture is concerned, it is intended to achieve the reduction of ammonia emissions primarily by reforming the Common Agricultural Policy. Some of the measures are: the promotion of ecologically sound (e.g. bio-dynamic) agriculture, the implementation of recommendations for best practice, the promotion of low-emission technologies and the strengthening of agri-environmental measures.

The greenhouse gas (GHG) nitrous oxide (N_2O) contributes also to eutrophication. The main sources are related to the application of nitrogenous fertiliser in agriculture and animal farming, industrial processes in the chemical industry as well as stationary and mobile combustion processes. Adipic acid is used in the industrial production of synthetics as a basic material for the manufacture of solvents and softeners. Up until 1997 it contributed almost one third of all N_2O emissions. In 1990 emissions amounted to 226 kt N_2O, and by 1999 they had dropped by 28 %. Two thirds of this achievement is due to measures taken for the reduction of emissions from the production of adipic acid. To that end, German manufacturers voluntarily developed and installed equipment designed for emission control. Other reasons for the

FIG. 24 NITROGEN SURPLUS (GROSS BALANCE)



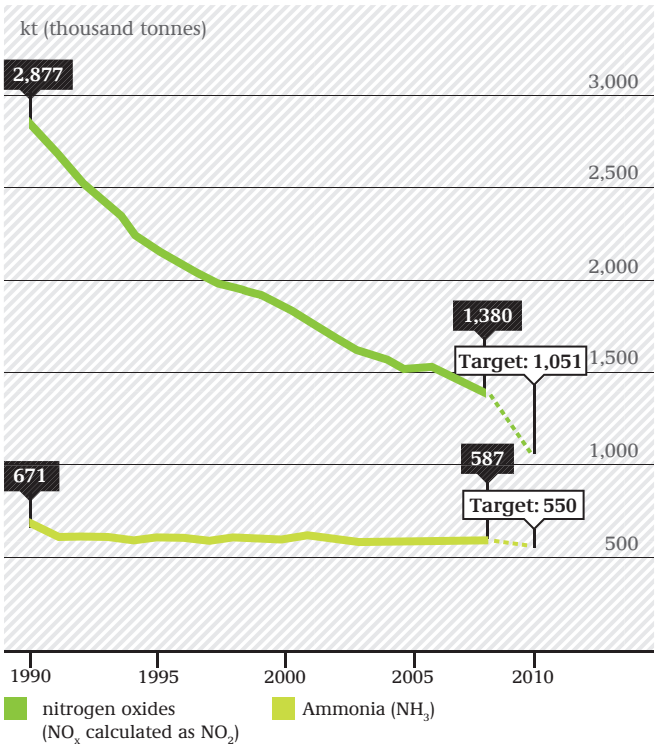
Source of data for 1990 partly unreliable; source of date for 2008 partly preliminary

Source: Institut für Pflanzenbau und Bodenkunde, Julius Kühn Institut (JKI) and Institut für Landschaftsökologie und Ressourcenmanagement, Universität Gießen, March 2010

drop in emissions is the decline in animal farming as well as the widespread practice of set aside and changes in land use in the new Federal Länder. Since 1998 the emissions trend has been marked significantly by the economic trend in the chemical industry (see Fig. 26).

One of the effects to be expected from worldwide climate change is that it will change biological diversity. In Germany and Europe climate change has become so significant by now that it is possible to observe the first impacts on flora. Apple trees, for example – indicators of the fullness of spring – blossom earlier (almost 5 days earlier per decade) and in

FIG. 25 NITROGEN OXIDES (NO_x) AND AMMONIA (NH_3) EMISSIONS



Source: Umweltbundesamt, Nationale Trendtabellen 2010

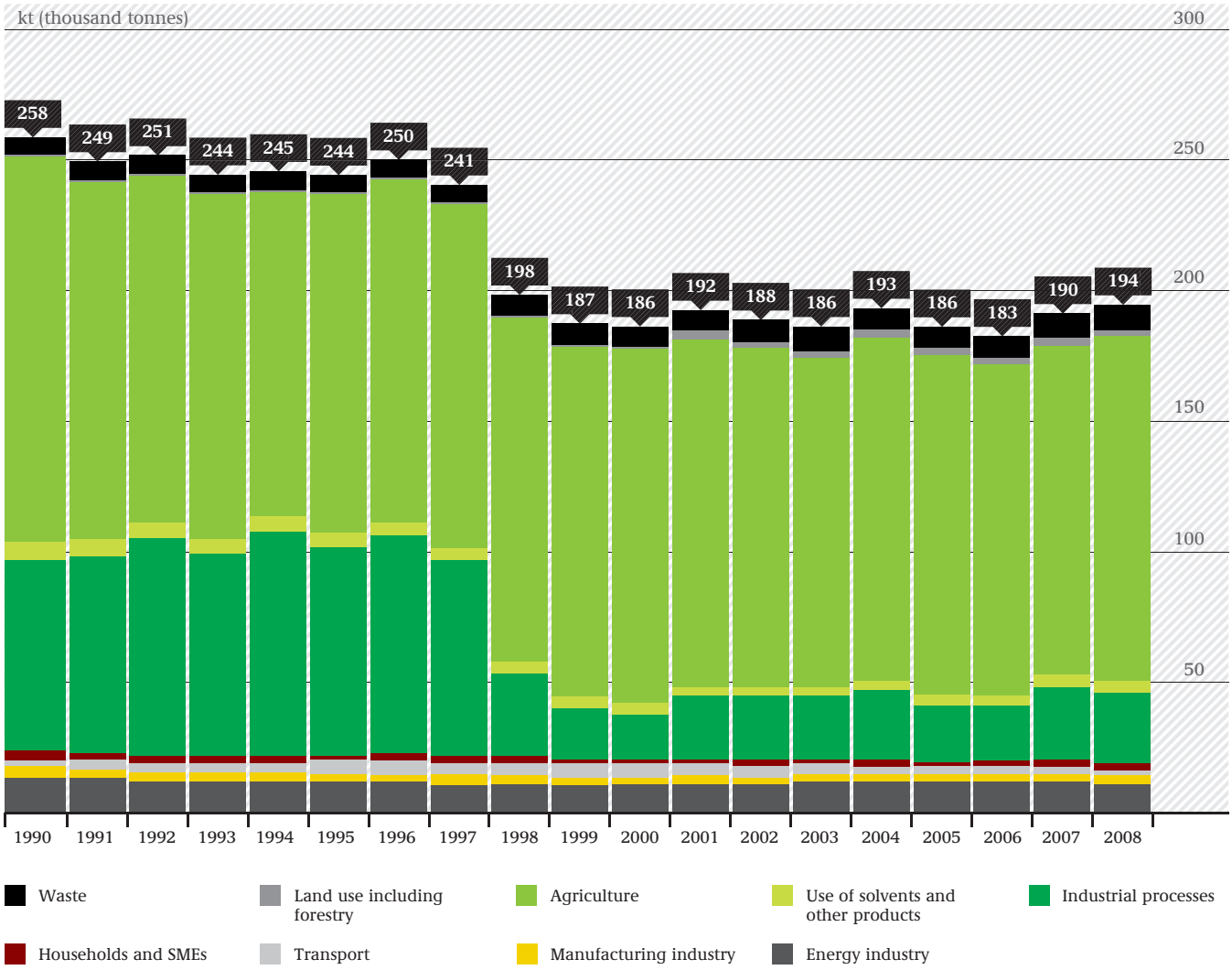
many European woodland settings, trees come into leaf earlier (approximately 5 days earlier per decade). This demonstrates that changes in temperature levels bring about changes in the beginning and duration of individual seasons. The spring phenophase is gradually advancing, i.e. the onset of flowering, breeding and migration is beginning a little earlier from year to year. This realisation is substantiated by new studies for the whole of Europe. These studies start from the premise that the beginning of spring and summer starts 2.5 days earlier every decade [3]. No distinct trend has been observed that would indicate a delay in phenophases in autumn. The onset of spring phases is largely determined by temperature levels. By contrast, the links with climatological parameters prevailing in autumn are weaker and more complex. In addition to temperature, an important role is played by the precipitation levels of preceding summer months as well as non-climatological influences such as the incidence of plant diseases and pest infestation.

The effects of shifts in phenophases on populations of plants and animals are complex and so far have not been examined in depth. While some bird species have more breeding success because they benefit from shorter winters [4], changes affecting the synchronicity in the life cycle of plant species and their pollinators [5] or predator-prey relationships [6] may have a negative effect on the success of populations of some species. If climate change means that some plant species begin to flower earlier in the year, possibly resulting in the flowering period being extended, this can also affect the health of people with pollen allergies, as the period in which they suffer from symptoms will then start earlier and last longer. The same can be said of the distribution of allergenic neophytes such as ragweed (Ambrosia artemisiifolia) which was previously unknown to occur in Germany. It is known for its strong allergenic potential. Such plants can trigger, especially at the height of flowering, an increased incidence of allergies thus extending the season for allergy sufferers.

In context with her obligation under the burden-sharing system adopted by EU member states, Germany has committed to a reduction in greenhouse gas emissions (GHE) by 21 % for the period of 2008 until 2012. By comparison, the minimum obligation specified under the Kyoto Protocol amounts to base year emissions of 1,232,429.543 kt CO_2 equivalent as reference value. By 2008, Germany had already met this target by means of a reduction by 22.2 % compared to the reference value. Initial calculations by the UBA indicate that in 2009, a reduction by 28.7 % was achieved, mainly as a result of the economic downturn. There is consensus, however, among experts, that in order to prevent dangerous anthropogenic impacts on the climate system, the reduction in emissions agreed in Kyoto are by no means sufficient. In fact, it is clear that, in the run-up to 2020, Germany will have to reduce GHG emissions by 40 % of 1990 levels [7]. In its climate policy draft, the UBA proposed to the German Federal Government [8] to aim at a reduction by 2050 with respect to emissions by 80 to 95 % of 1990 levels, and as far as the second half of this century is concerned, to set an objective for a GHG-neutral Germany.

The steady increase in land acquisition for urbanisation and transport purposes and the resulting fragmentation effects deprive large areas of their

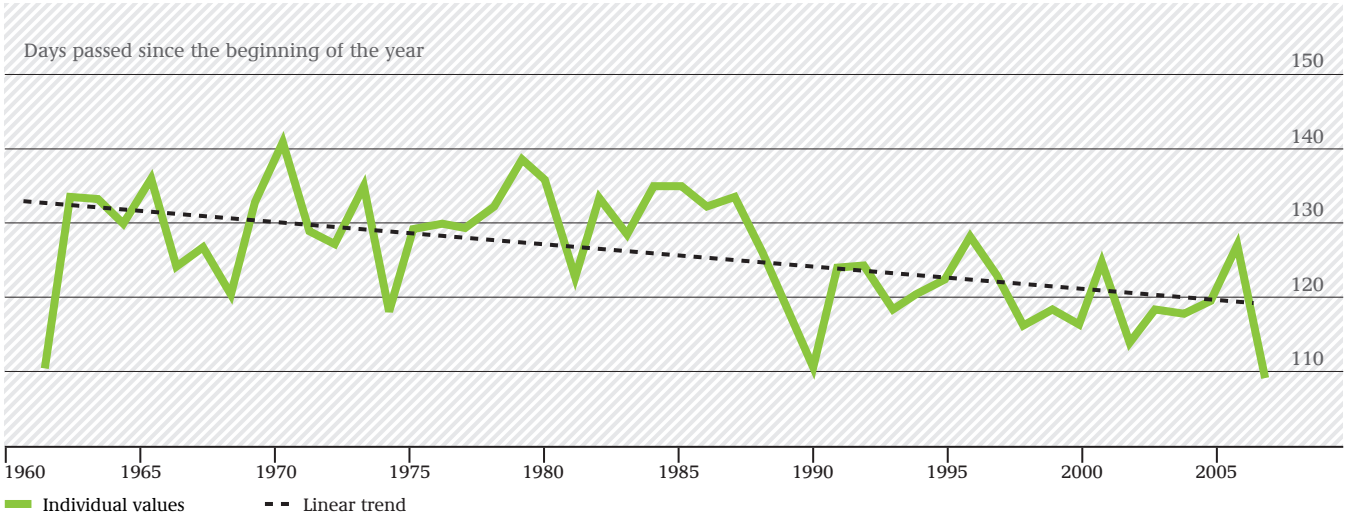
FIG. 26 NITROUS OXIDE (N_2O) EMISSIONS



Transport: excluding agricultural and forestry-related transport; Households and Small and Medium Enterprises (SMEs): including agricultural and forestry-related transport as well as military transport
Source: Umweltbundesamt, Berichterstattung unter der Klimarahmenkonvention der Vereinten Nationen 2010. Nationaler Inventarbericht zum deutschen Treibhausgasinventar 1990 – 2008. EU-Submission, Dessau-Roßlau 15.01.2010

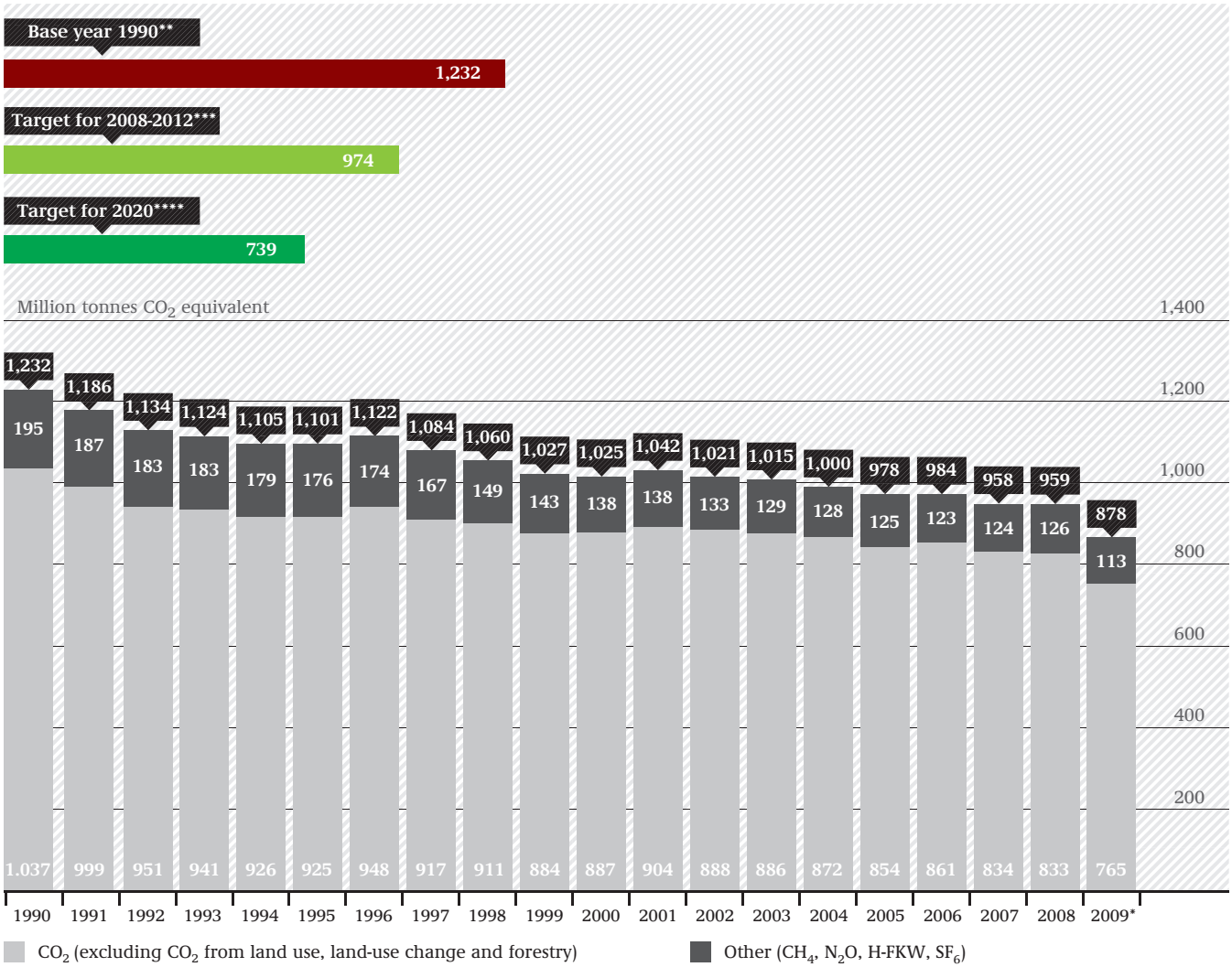
natural cycles and breaks up the habitats required by larger species. The joint working group of the Länder on soil protection (LABO) estimates that approximately 46 % of land in the vicinity of settlements and transport routes, i.e. approximately 6 % of the entire surface area of the Federal Republic of Germany, is 'sealed' [9]. Furthermore, urbanisation, transport generation and expansion of the road network (which in turn escalates urban sprawl), perpetuate an ever-increasing vicious cycle which produces increased demand for materials and energy. The Federal Government has resolved to reduce by 2020, the increase in land uptake by urbanisation and transport routes to approximately 30 ha per day. Currently this figure amounts to 104 ha per day as against 129 ha per day during the period from 1997 until 2000. The decline is essentially due to the economic downturn which led to a decrease in investments in the construction industry. This outcome is not to be mistaken for a genuine trend reversal. In view of the fact that land uptake continues to be dominated by urbanisation, any proposals for measures and mechanisms should be focused on curbing the urbanisation trend and associated development of transport routes. In general terms, it will be necessary, however, to implement a variety of coordinated measures, in order to achieve an effective reduction in more and more land uptake for urbanisation. Over the period from 1991 until 2007, the length of supra-local roads in Germany increased from 226,300 to 231,180 km (+4,880 km). When looking at these figures, it is important to remember that even some supra-local roads were downgraded to municipal roads without entirely losing their development potential or their function as trunk roads. Therefore, the increase in the supra-local road network resulting from new building developments is, in fact, even greater than stated above. If all road-building projects go ahead as visualised in the

FIG. 27 FLOWERING COMMENCEMENT OF INDICATOR SPECIES, IN THIS CONTEXT: THE ONSET OF APPLE BLOSSOM (AVERAGED FOR THE WHOLE OF GERMANY)



Source: Deutscher Wetterdienst, communiqué dated 25.09.2008

FIG. 28 GREENHOUSE GAS EMISSIONS (GHE)



short-term prognosis dated 05.03.2010, ** The reference value for the reduction obligation under the Kyoto target was fixed at 1,232,429.543 kt CO_2 equivalent.
*** 21% reduction as against the base year, **** 40% reduction as against 1990

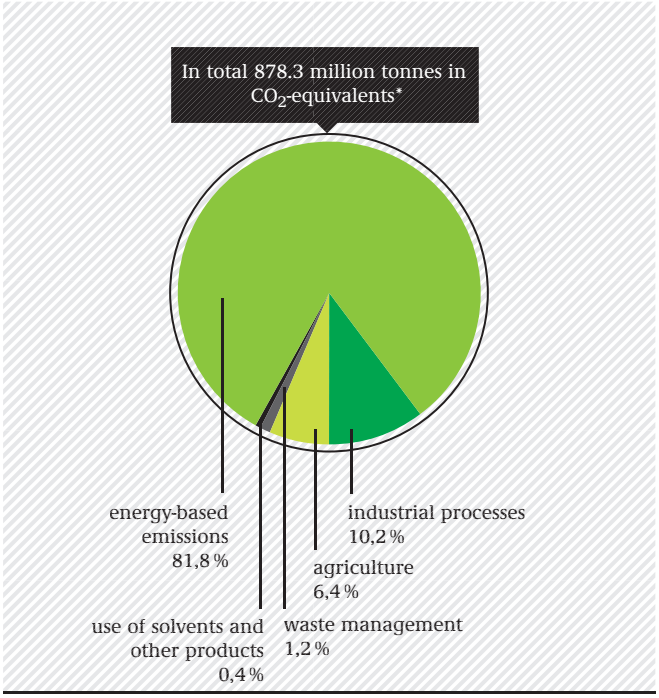
Source: Umweltbundesamt, Berichterstattung unter der Klimarahmenkonvention der Vereinten Nationen 2010. Nationaler Inventarbericht zum deutschen Treibhausgasinventar 1990 – 2008. EU-Submission, Dessau-Roßlau 15.01.2010 und Presseinformation Nr. 13/2010 dated 05.03.2010

2003 Federal Transport Infrastructure Plan, the German road network would be extended by a further 9,600 km.

For most plant and animal species the fragmentation and isolation resulting from the extension of transport routes signify the irreversible loss of habitat. Besides, for humans to experience nature and enjoy leisure activities, it is important to maintain significant tracts of open space that are neither fragmented nor diminished by noise pollution. Germany's Biodiversity Strategy aims at maintaining the current minimum size of 'unfragmented low-traffic areas' (UZVR) at 100 km² (10,000 ha). As indicated by 2005 statistics, approximately 26 % of the entire surface area of Germany still meets the criterion of UZVR covering a minimum of 100 km². This is equivalent to 562 UZVR areas of an average size of 168 km² (16,800 ha). In the Länder in the east of the Federal Republic, the proportion of UZVR areas compared to the overall area of individual Länder (between 23 % and 64 %) is significantly above the equivalent value in the western area states of Germany (4 % to 36 %). However, in densely populated areas and in the immediate vicinity of metropolitan centres, smaller unfragmented areas of less than 100 km² can still play an important role. The UBA proposes [10] that it is essential to maintain not only the major unfragmented areas in excess of 100 km², but also other unfragmented areas including those in excess of 140, 120, 80 and 64 km².

Another important indicator for identifying landscape fragmentation into small patches is the effective mesh size (Meff in km²). This is a characteristic determined by calculations. It indicates the size of unfragmented space in a region that contains tracts of open space which have been carved up in multiple ways. On the basis of average values, this can also be said of Germany as a whole. It is possible, therefore, to discern creeping trends developing over time. For example, the mesh size in Baden-Württemberg has almost halved over the period from 1930 to the turn of the century, indicating a decline from 22.9 km² (2,290 ha) to 13.7 km² (1,370 ha) The UBA has also submitted proposals for action targets on the basis of the Meff indicator [11]. The Meff indicator was used by the Federal Agency for Nature Conservation (BfN) to develop an indicator for prioritising measures to re-establish connectivity between parts of the landscape that have been separated. Apart from demonstrating successful outcomes for environmental policies, the indicators employed also flag up areas where it is necessary to take further measures. In order to widen the range of topics that can be subjected to this reporting technique under the National Biodiversity Strategy and in order to fine-tune the relevant characteristics, the indicator set is being

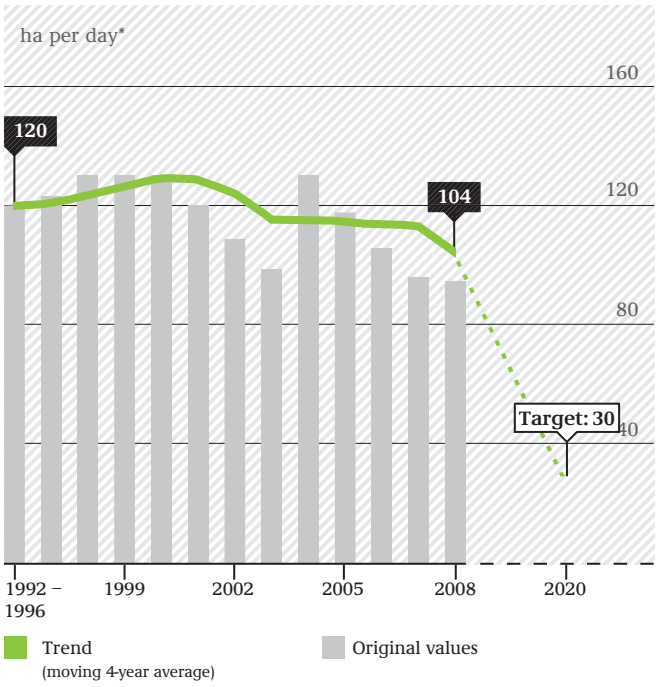
FIG. 29 PROPORTION OF SOURCE CATEGORIES INVOLVED IN GREENHOUSE GAS EMISSIONS (CALCULATED IN CO_2 EQUIVALENTS) 2009



* N_2O from Land Use, Land-Use Change and Forestry (LULUCF) 0.1% (not illustrated in this diagram)

Source: Umweltbundesamt, Presseinformation Nr. 13/2010 dated 05.03.2010

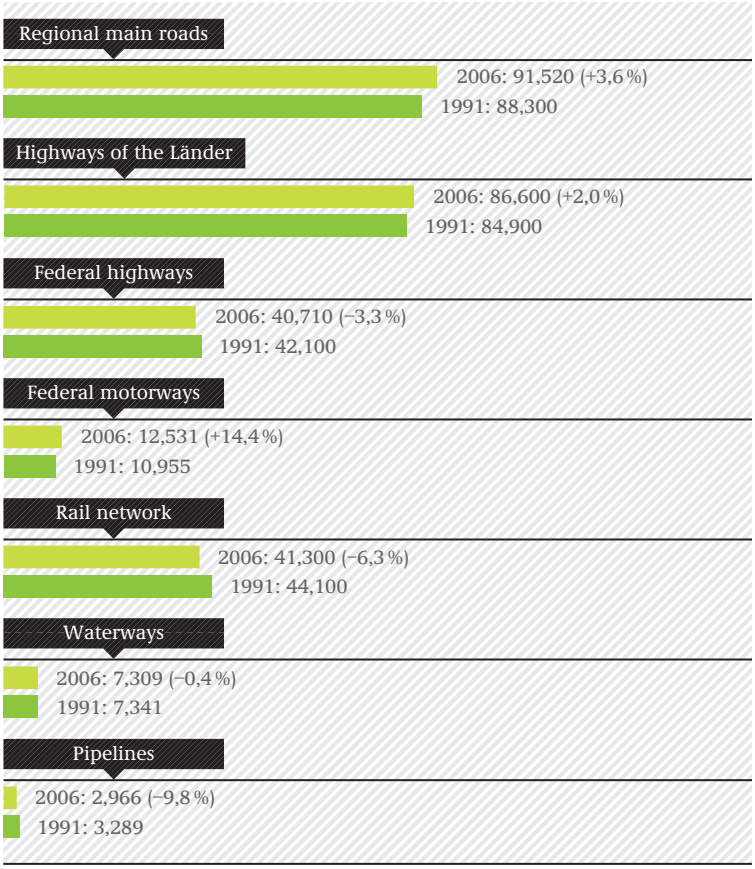
FIG. 30 LAND USE: INCREASE IN SETTLEMENT AND TRANSPORT AREA



* The area survey was based on the evaluation of land registers held by the individual Länder. Owing to conversion work carried out in land register offices (re-coding of land-use types in the course of digitisation), the increase in land uptake on the right-hand margin of the diagram (referring to recent years) is distorted

Source: Statistisches Bundesamt, Bundesamt für Bauwesen und Raumordnung 2009

FIG. 31 LENGTH OF TRANSPORT ROUTES IN KM***



Source: Bundesministerium für Verkehr, Bau und Stadtentwicklung (Federal Ministry for Transport, Construction and Urban Development) Traffic in figures 2008/2009

developed further. For example, the BfN will incorporate the latest research findings into its progress report on the biodiversity strategy for 2012. The UBA takes part in the content-related development of the indicator set and provides any relevant data. In parallel, the UBA is developing a technical proposal for an indicator set for progress monitoring in respect of the German strategy for adaptation to climate change (DAS). This indicator set will incorporate indicators for identifying consequences of climate change and for identifying adaptation measures with regard to the Biodiversity Action Field.

TAB. 5 LANDSCAPE FRAGMENTATION: DISTRIBUTION OF UNFRAGMENTED LOWTRAFFIC AREAS (UZVR) AND VALUES OF EFFECTIVE MESH SIZE (M_{eff}) IN 2005

Federal State [1]	Total land area in km² [2]	Inhabitants/km² [2]	M_{eff} (km²) [3]	UZVR [4] (in km²)	UZVR (in % of total area)	Number of UZVR areas [4]
Baden-Württemberg	35,752	299	35	2,736	8	18
Bavaria	70,549	176	69	15,026	21	86
Brandenburg	29,477	87	155	16,608	56	85
Hesse	21,115	288	38	2,097	10	12
Mecklenburg-Western-Pomerania	23,174	75	172	14,771	64	81
Lower Saxony	47,618	168	96	17,085	36	106
North Rhine-Westphalia	34,084	530	28	1,230	4	5
Rhineland-Palatinate	19,847	204	60	3,823	19	22
Saxony	18,414	235	70	4,176	23	22
Saxony-Anhalt	20,445	123	112	7,218	35	40
Schleswig-Holstein	15,763	179	71	3,182	20	21
Thuringia	16,172	147	103	6,190	38	33
Germany	**357,030**	**231**	**84**	**94,427**	**26**	**562**

1) Owing to their small surface area, the Saarland and the city states are not included in this table.

2) Statistical Offices at Federal and Länder level, 2005

3) Esswein, H. & Schwarz-v. Raumer, H.-G. 2005

4) 31 UZVRs > 100 km² lie in border regions between federal Länder and in terms of their area are attributed pro rata in each case to the federal Land concerned, although they are counted once only in the total for Germany. Accordingly, the sum of UZVRs in the Länder does not correspond to the number of UZVRs for Germany.

Source: Bundesamt für Naturschutz (BfN), Daten zur Natur 2004 and 2008

TAB. 6 INDICATORS USED IN THE NATIONAL BIODIVERSITY STRATEGY (NOVEMBER 2009)

Indicator	The indicator measures ...	The indicator is also contained in ...
Sustainability indicator for species diversity	State	NHS, KIS, LIKI
Endangered species	Impact	KIS
Conservation status of habitat types and habitat species under the Habitats Directive	State	LIKI (being planned)
Number of non-native fauna and flora species in Germany	Pressure	KIS
Size of strictly protected areas	Response	KIS, LIKI
NATURA 2000 area designations (this indicator is to be replaced by the Habitats Directive Indicator)	Action	KIS
Land use: Increase in settlement and transport area	Pressure	NHS, KIS, LIKI
Landscape fragmentation	Pressure	KIS, LIKI
Urban sprawl	Pressure	–
Agro-environmental subsidies (subsidised area)	Response	KIS
Organic farmland as a proportion of total agricultural land	Response	NHS, KIS, LIKI
Proportion of certificated forest land in Germany	Response	KIS
Nitrogen surplus (gross balance)	Pressure	NHS, KIS
Genetic engineering in agriculture	Pressure/Response	–
Water quality - proportion of waterbodies with at least good ecological condition	Impact	KIS (being planned)
Marine Trophic Index	Pressure	CBD
Populations of selected commercial marine species	Impact	–
Flowering season of indicator plants	Impact	KIS
Significance of environmental policy goals and tasks	Response	–
Proposals in respect of indicators to be amended		
High Nature Value Farmland (under development)	State	–
Condition of alluvial areas (under development)	Impact	–
Critical loads - exceedance of eutrophying nitrogen levels affecting sensitive ecosystems	Impact	KIS
Further climate indicators (under development)	–	–

NHS: National Sustainability Strategy; **KIS:** Core indicator system for the environment applied by the UBA; **LIKI:** Länder initiative on core indicators; **CBD:** Convention on Biological Diversity

Source: adapted from Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (2007), NationaleStrategie zur biologischen Vielfalt, p. 123

Author:

Dr. Jacqueline Burkhardt and Marian Pohl, Section I 1.5

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11 ibid

WHAT REMAINS TO BE DONE? LOOKING AHEAD

As illustrated by this brochure, the five main drivers identified in the global Millennium Ecosystem Assessment constitute the essential risks to biodiversity also for Central Europe.

From various contributions to this brochure it becomes also obvious that there are already extensive laws and regulations in force aiming to ensure the sustainability of biodiversity. In many cases, however, the protection of biodiversity was just one of many considerations when those regulations were negotiated. Integrated concepts to protect biodiversity are frequently obstructed by inadequate knowledge of the complex interdependencies concerning effects as well as by fragmented competences between the Federal Government, Länder governments and municipal administrations. And it is by no means true for all areas that a problem recognised is a problem solved. For example, it will be some years before German surface waters to reach good ecological condition. Yet, the option of legally permissable and well-argued delays must not delude us into thinking that we have time to wait and see: It is high time to take action, because the loss of biological diversity is progressing and in some cases is already irreversible.

While the Water Framework Directive has set the basic foundations for determining and assessing good ecological condition of water bodies, there is still no reliable methodology in place for assessing the integrity of terrestrial ecosystems. This is partly due to the fact that there are hardly any regions left which might serve for comparisons with truly natural conditions as our cultural landscape has been shaped essentially by human influences. All the same, it seems to be worth trying to analyse and curb the influence of a variety of stress factors which impinge on ecosystems, so that natural ecosystems can be maintained and those anthropogenically changed can be rehabilitated. Ever more already now we know enough about the effects of a number of stress factors, such as pollutants and nutrient inputs, to argue for their significant reduction. The progressive accumulation of these substances in ecosystems is incompatible with the objectives set by the National Strategy on Biodiversity. It is also important to remember in any risk assessment that we have passed the point where it would be possible to prevent one specific new risk to biodiversity, namely climate change, which threatens in particular those ecosystems that are already marked by major imbalances. It will not be possible in all cases for ecosystems to adapt.

In many fields, the protection of biodiversity makes it absolutely essential to take stock of the ‘targets’

to be protected. For instance, the expansion of biomass production must take place strictly within the confines of ecologically acceptable limits. We must examine the necessity of new settlement areas in the light of the potential of losing undisturbed seminatural ecosystems. Furthermore, it is crucial to control agricultural practices by means of improved monitoring and by directing the focus of financial stimuli in a way as to minimise any impacts on biodiversity.

A better realisation that all these steps must be taken might come by introducing a commodification of biodiversity. The economic value of biodiversity has so far not been sufficiently recognised by citizens - not only in developing countries and emerging economies, but regrettably also in Europe. The study entitled 'The Economics of Ecology and Biodiversity' – TEEB for short – shows the extend of the valuable services rendered to society by ecosystems. Some of the figures stated in this study may be rough estimates; nevertheless, it is an undeniable fact that our clean air and clear water would be much more expensive if it were not for nature's useful contribution in keeping it this way. The illustrations made in this brochure are evidence for the importance of protecting biodiversity across many and varied spheres of action. The incorporation of measures and objectives into the National Strategy on Biodiversity will help to improve the sustainability of biodiversity in various fields of environmental protection.

M. Wichmann-Fiebig,
Head of Department II 4

LIST OF ABBREVIATIONS

ALARM	Assessing Large-scale environmental Risks for biodiversity with tested Methods. (EU funded project).
AEM	Agri-Environmental Measures
BAP	Bali Action Plan
BBodSchG	Bundes-Bodenschutzgesetz (Federal Soil Protection Act)
BDF	Bodendauerbeobachtungsflächen (permanent soil monitoring sites)
BfN	Bundesamt für Naturschutz (Federal Agency for Nature Conservation)
BImSchG	Bundesimmissionsschutz-Gesetz (Federal Immission Control Act)
BImSchV	Bundesimmissionsschutz-Verordnung (Federal Immission Control Ordinance)
Biokraft-NachV	Biokraftstoff-Nachhaltigkeitsverordnung (transport biofuels sustainability ordinance)
BioSt-NachV	Biomassestrom-Nachhaltigkeitsverordnung (biomass electricity sustainability ordinance)
BLE	Bundesanstalt für Landwirtschaft und Ernährung (Federal Agency for Agriculture and Nutrition)
BMELV	Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz (Federal Ministry for Food, Agriculture and Consumer Protection)
BMU	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety)
BMVBS	Bundesministerium für Verkehr, Bau und Stadtentwicklung (Federal Ministry of Transport, Building and Urban Development)
BVL	Bundesamt für Verbraucherschutz und Lebensmittelsicherheit (Federal Office of Consumer Protection and Food Safety)
CAP	Common Agricultural Policy
CBD	Convention on Biological Diversity
CC	Cross Compliance
CLRTAP	Convention on Long-range Transboundary Air Pollution
CSD	Committee on Sustainable Development
DAS	Deutsche Anpassungsstrategie an den Klimawandel (German Adaptation strategy to Climate Change)
DDT	Dichloro-diphenyl-trichloroethane
EAFRD	European Agricultural Fund for Rural Development
EEA	European Environment Agency
EU	European Union
FFH	Flora-Fauna-Habitat (Habitats Directive)
Fraunhofer ISI	Fraunhofer Institut für System- und Innovationsforschung
GAEZ	Global Agro Ecological Zoning
GAP	Gemeinsame Agrarpolitik der EU (see CAP above)
GBEP	Global Bioenergy Partnership
GIS	Geographical Information System
GL	Greenfield sites
IGB Berlin	Leibniz Institut für Gewässerökologie und Binnenfischerei Berlin (Leibnitz Institute for Freshwater Ecology and Inland Fisheries, Berlin)

IKI	Internationale Klimaschutzinitiative (International Climate Initiative/ICI)
IPCC	Intergovernmental Panel on Climate Change
KBU	Kommission Bodenschutz beim Umweltbundesamt (Commission for Soil Protection of UBA)
KIS	Kernindikatoren-System des Umweltbundesamtes (UBA core indicator system)
KomPass	Kompetenzzentrum Klimafolgen und Anpassung (KomPass – Centre of excellence for Climate Impacts and Adaptation in Germany)
LABO	Bund-Länderarbeitsgemeinschaft für Bodenschutz (Joint Federal/Länder Working Group on Soil Protection)
LAI	Bund/Länder-Arbeitsgemeinschaft für Immissionsschutz (Joint Federal/Länder Working Group on Immission Control)
LF	Landwirtschaftlich genutzte Fläche (area under agricultural use)
LIKI	Länderinitiative Kern-Indikatoren (Länder initiative on core indicators)
LRTP Convention	Convention on Long-range Transboundary Air Pollution (see CLRTP above)
MSFD	Marine Strategy Framework Directive
N	Nitrogen
N_2O	Laughing gas, nitrous oxide
NABU	Naturschutzbund Deutschland e.V. (Registered association for nature conservation in Germany)
NBS	National Biodiversity Strategy
NEC	National Emission Ceiling
NEMS	Integrated nitrogen reduction strategy of the UBA
NH_3	Ammonia
NH_{4-}	Ammonium
NHS	Nationale Nachhaltigkeitsstrategie (National Sustainability Strategy)
NMVOC	Non-Methane Volatile Organic Compounds
NO_3^-	Nitrate
NO_x	Nitrogen oxide
O_3	Ozone
POP	Persistent Organic Pollutants
PSM	Pflanzenschutzmittel (plant protection chemicals)
REDD	Reducing Emissions from Deforestation and Degradation
SEBI2010	Streamlining European Biodiversity Indicators for 2010
SO_2	Sulfur dioxide
SRU	Sachverständigenrat für Umweltfragen (German Advisory Council on the Environment)
TA	Technische Anleitung (Technical Directive)
UBA	Umweltbundesamt (Federal Environment Agency)
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UZVR	Unzerschnittene, verkehrsarme Räume (un-fragmented low-traffic areas)
WDPA	World Database on Protected Species
WFD	Water Framework Directive
WGE	CLRTAP Working Group on Effects

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