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Responsibility in a finite world

Chapter 10:

Integrated monitoring

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Forword

This is a chapter of the Environment Report 2012 on “Responsibility in a finite world” published by the German Advisory Council on the Environment in June 2012. Guiding principle of that report is that environmental limits should be taken seriously. Unlimited physical growth is not possible in a finite world. This means that the dramatic reduction of our resource and energy use and their environmental impacts are becoming a key question of the 21st century. The report has eleven focal themes[1], ranging from the new growth debate, the protection of important ecosystems such as peatlands, forests and oceans to a strengthening of integrated environmental protection.

With its Environmental Report 2012, the SRU extends the perspective beyond the energy transition towards other important future-oriented issues in German and European environmental policy. Using a “horizon scanning” approach, the seven council members of the SRU identify important unresolved problems and point towards specific options for political action. The starting point of the report is that serious impacts for economy and society have to be feared if safe planetary boundaries and environmental limits are being exceeded. Exploiting all potential for decoupling economic growth and environmental impact is therefore a matter of priority. Such an innovation strategy would offer at the same time considerable economic opportunities for German industry.

Analysing a number of intractable problems, the SRU highlights the potential for a reduction of environmental impacts, for example:

- The use of metallic and mineral raw materials can be reduced, for example through systematic introduction of closed-loop processes. The SRU proposes in this context mandatory deposit schemes for selected electronic devices. Raw material extraction – which tends to be very energy intensive – could become more climate-friendly if ambitious reduction targets are set for the European emissions trading system (the EU 30 % target for 2020) and if exemptions are cut back.
- Even the still growing goods transport could meet ambitious climate policy targets through a comprehensive electrification on the basis of renewable electricity. In addition to a shift from road to rail, the option of an overhead-cable system for electric-powered HGVs (“trolley trucks”) should be seriously pursued. The technology has already been tested in demonstration projects.

- In the area of food, policy should also provide effective incentives for decoupling. Bringing down food losses by 50 % until 2025 could decrease the environmental impact of our food consumption. Moreover, the high meat consumption which has equally negative impacts on the environment and on health, should be significantly reduced. Abolishing the reduced rate of value-added tax on animal products and introducing a tax on saturated fatty acids are therefore options to be investigated.

Despite this large untapped potential, a sufficient degree of decoupling may not be achievable. As part of a precautionary strategy, policy and society should therefore also reflect on conditions of social and political stability under conditions of low economic growth.

Ecosystems such as forests, oceans and peatlands do not only supply important resources, energy and food, but they also make important contributions to climate protection and provide other ecosystem services, including habitats for many species. These services, which are not rewarded by the market, are under threat unless economic pressures are reduced. German forests, for example, may soon reach a point where they release more greenhouse gases than they store. For this reason the SRU recommends introducing limits on forest biomass use to secure the long-term status of forests as carbon sinks. In addition, a comprehensive and integrated monitoring should be established as an early warning and evaluation system.

Environmental limits can only be observed if the remit and authority of environmental policy vis-a-vis other policy areas are considerably strengthened. As a basis for this, the SRU recommends the establishment of an encompassing national environment programme with ambitious targets which would give a new impetus to other policy areas.

[1] The Environmental Report covers eleven topics: the new growth debate, decoupling prosperity from resource use: metallic and mineral resources, food consumption as a policy issue, freight transport and climate protection, mobility and quality of life in urban agglomerations; appreciating the value of ecosystem services: environmentally sound use of forests; peatlands as carbon sinks, cross-sectoral marine protection; reinforcing integrative approaches: Integrated environmental protection: the example of industrial permitting, integrated monitoring, environmental and sustainability strategies.

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10 Integrated monitoring

10.1 Introduction

575. Humans are not only part of the ecosphere – the living environment – but are also dependent on it, and especially on air, water and food. The term “ecosystem services” seeks to illustrate and make clear this societal benefit of nature and its functions. But even today, ecosystems are already being overused and are no longer able to provide their services for man and nature (cf. Section 1.2.4). Human activities can give rise to pressures on the environment, and consequently to harmful impacts, which may also cause health disorders. Targeted measures to protect the environment can be used to combat these adverse effects. It is therefore important to examine the environmental situation to identify any signs of negative tendencies. Environmental protection measures focus on protecting the quality of the environmental media water, soil and air and on conserving biological diversity. The term “protection” implies different harmful mechanisms and hence a problem-oriented approach. This results in further differentiation of the environmental media – in the case of water, for example, into surface water, groundwater, seawater, or in relation to humans into drinking water and wastewater – and it is in these categories that they are addressed in the environmental authorities. With regard to biodiversity, harmful impacts can occur at various levels, and may range from disturbances to population stability to destabilisation of communities. Effective monitoring has the task of identifying and documenting complex connections and interactions.

However, the function of monitoring is not confined to recording the current status quo. It should also make it possible to draw conclusions about whether the targets laid down by political decisions will be achieved. These targets should always be based on sustainability, and accordingly they should at least comply with environmental limits (cf. para. 98, Section 11.2.3). In line with the precautionary principle, however, compliance with these limits should also include a safety margin.

10.2 Importance of monitoring for environmental policy

576. Biological diversity is the foundation on which the existence of human life is based (BMU 2007, p. 9). This makes it necessary to monitor its status and the factors impacting on it. Political and economic decisions have to be geared to the goal of conserving or restoring good ecosystem status (cf. Section 1.2.2). The Biodiversity Strategy adopted by the German government in 2007 identified area-wide diffuse substance discharges, along with climate change, as significant environmental influences on biological diversity (BMU 2007, Chapter B 3.1). Anthropogenic discharges of substances from households, businesses and industry into ecosystems and their impacts continue to be a persistent environment problem that makes a substantial contribution to loss of biological diversity (ISENRING 2010). Annex 1 to the

Convention on Biological Diversity (CBD) stipulates the monitoring of ecosystems and habitats (both protected areas and normal countryside), species and communities, genomes and genes. Thus observing impacts on biodiversity is a highly complex task, especially since many facts and interactions have yet to be adequately researched and assessed.

In the context of the changes in biological diversity that are expected to result from climate change, the National Biodiversity Strategy requires that an indicator system for the impacts of climate change on biological diversity be developed and established by 2015 (BMU 2007, Chapter B 3.2). Furthermore, biological diversity is to be protected against hazards arising from genetically modified organisms (op. cit., Chapter B 1.21, B 2.4). In addition to the environmental factors mentioned (discharge of substances, climate change and genetically modified organisms), biological diversity is also largely influenced by land consumption and changes in land use. Ambitious reduction targets also exist for factors such as land take and landscape fragmentation and adverse effects of invasive species. These are included in the set of indicators of the national strategy (SUKOPP et al. 2010).

The national strategy on biological diversity sets out the overarching objective to “improve the database regarding the status and development of biological diversity in Germany” (BMU 2007, p. 27).

577. The call by the German Advisory Council on the Environment (SRU 1991) for integrated observation of the environment is acquiring fresh relevance as a result of the national biodiversity strategy. Sound, up-to-date information on the status and development of biological diversity is the basis for an effective nature conservation and environmental protection policy, and also for climate policy (e.g. in the context of the implementation and further development of the German Strategy for Adaptation to Climate Change (Federal Government 2008)). The main tasks of environmental observation are (BAFU and Umweltrat EOBC 2009):

- recording and assessing the status of the environment (analytical function),
- identifying and assessing risks in good time (early warning function),
- checking the progress of environmental and nature conservation measures (progress review function) and checking the achievement of environmental and nature conservation objectives (goal achievement review).

“Environmental observation makes data and assessments available as a basis for policy decisions and for informing the public. Data and assessments are obtained by recording and balancing resources, environmental status information and material flows, and by investigating habitats and their communities. Balances relate to settlement areas, habitats and natural spaces, businesses, activities, products or health” (unofficial translation; BAFU and Umweltrat EOBC 2009).

Access to facts and figures on the environment can also help to mobilise the potential for innovation in civil society and industry and make it easier for citizens to take part in politics (European Commission 2012; Umweltrat EOBC 2011). Thus on the one hand monitoring performs an early warning function for developments of great concern, while on the other it assesses the success of measures in terms of their effectiveness for the protection targets and protected assets, and at the same time involves the interested public in the discussion.

10.2.1 Monitoring in the context of sustainability and precaution

578. This section first looks at the reasons why biodiversity is of decisive importance for strong sustainability, and then explains why monitoring is indispensable for maintaining biodiversity. Strong sustainability means long-term conservation and sparing use of the natural basis of life. The resilience of ecological systems (their elasticity in relation to disturbances) is a necessary condition for sustainability (SRU 2002, para. 28). That is why, for example, the national strategy on biological diversity states that discharges of substances are to be reduced to an ecologically tolerable level. To this end, for instance, ecosystem-related effect thresholds for pollutants outlining their effects on biological diversity are to be specified by 2015 (BMU 2007, Chapter B 3.1). To determine effect thresholds, it is necessary to identify and assess the risks associated with substances and to estimate the long-term impacts. Substance-related risk management also includes risk minimisation and the relevant monitoring (FÜHR et al. 2006, p. 4). This includes detecting the environmental effects of chemical substances in situ – i.e. directly in the environment – and assessing chemical pollution by means of indicators.

Conserving biodiversity

579. Recent research findings on the connection between biodiversity and the functional capacity of ecosystems and ability to provide their “ecosystem services” (cf. Section 1.2.2) indicate that the typical diversity of species for a given location should be conserved as completely as possible (for grassland types ISBELL et al. 2011). This follows from the consideration of large spatial and temporal scales in a changing world. The extinction or local loss of any individual species can restrict ecosystem functions and ecosystem services. For example, low site-typical diversity of plants and algal species reduces the capacity of ecosystems to make productive use of light and nutrients (CARDINALE et al. 2011). The analyses by CARDINALE et al. (2011) show that, to maintain only 50 percent of productivity, it is necessary to conserve 92 percent of species. The reason for this is the complementary nature (“division of labour”) of the species in time, space, functional effects and functional responses. Species extinction does not – as hitherto supposed – primarily affect the sensitive species at the top of the food chain (SCHERBER et al. 2010). Plant diversity has strong bottom-up effects on the interaction networks in ecosystems, in other words it particularly

affects the lower levels of the food chain. Soil organisms are less seriously affected by biodiversity loss than surface species (or react more slowly).

In accordance with the precautionary principle, the site-typical diversity of species should therefore be conserved as far as possible, since it is not possible to predict the extent to which it will be necessary for maintaining the ecosystem functions in the future.

Monitoring as an early warning system in the context of the precautionary principle

580. Another reason for ensuring effective monitoring is to cater for the precautionary principle. This because environmental monitoring plays a crucial role in justifying and correcting precautionary measures. It also reinforces an environmental policy geared to environmental limits in that it serves to keep it under constant scrutiny. The precautionary principle can open up discretionary latitude even in cases where reliable experience-based knowledge about ecological stress capacity is not yet available, or where knowledge about hazardous properties and interactions is still subject to uncertainties. As shown by the SRU (2011a, para. 16 ff.) on the basis of the communication by the European Commission on the applicability of the precautionary principle (European Commission 2000), precautionary measures are legitimate in cases where a provisional risk assessment give rise to concern that there could be harmful impacts on man or the environment. In such cases the danger is presumed to exist – albeit subject to the proviso that it can be disproved. This is tantamount to reducing the level of proof (SRU 2011b, para. 40 ff.; for an earlier detailed treatment see also CALLIESS 2001, p. 223 ff.). However, since constitutional considerations alone make it necessary to avoid “random precautions”, even precautionary measures have to be based on scientific data that substantiate or uphold the grounds for concern. Thus before any precautionary measures are taken, it is necessary to determine and make a scientific assessment of the possible adverse effects. Precautionary measures already taken are subject to constant review, which gives rise to an obligation to actively monitor scientific developments. Such monitoring makes it possible to confirm or refute initial grounds for concern, but it may also detect unforeseeable long-term impacts that make additional measures necessary. In the context of the precautionary principle, environmental monitoring may thus serve to back up hypotheses, but it may also provide information of its own about grounds for concern.

Moreover, environmental monitoring may also – as provided in Section 16c of the Genetic Engineering Act (GenTG) for the placing on the market of genetically modified organisms – be carried out to accompany permits already issued, in order to identify and revise any incorrect decisions. A similar situation applies to measures enacted on the basis of environmental quality objectives (e.g. when implementing the Water Framework Directive 2000/60/EC (WFD)). These must always be accompanied by environmental monitoring to ensure that

misjudgements can be identified and corrected as early as possible (KÖCK 1997, p. 83).

The spirit of the precautionary principle makes it necessary to take action at an early stage, in view of the considerable time-lag between identifying and rectifying the reasons for loss of biological diversity. This is particularly important in view of the fact that the loss of extinct genetic sequences or even species is irreversible. Against this background it is necessary to draw up an overall concept that can be used to show the status of biological diversity itself.

10.2.2 Monitoring and assessment criteria

581. Monitoring can only take place if the assessment criteria to be used in measuring the pressures detected have basically been established. This section looks at the term “effect thresholds” that is used in the National Biodiversity Strategy. It sets it in a conceptual context and discusses how such effect thresholds can be given more concrete shape (for an in-depth discussion, see UBA 2000 and SRU 1994, Chapter 2).

Environmental quality objectives characterise a targeted environmental status. They combine scientific knowledge with societal judgements about protected assets and levels of protection. Environmental quality objectives are laid down on an object-related or media-related basis for man and/or the environment and are geared to the rate of regeneration of important resources or to ecological stress capacity, the protection of human health and the needs of present and future generations (UBA 2000, p. 8). One example of an environmental quality objective is the “good ecological status” defined in the Water Framework Directive.

However, it is not enough simply to define environmental quality objectives – they have to be made operational by means of environmental action objectives (UBA 2000, p. 12). One possible objective is that the targeted status of the environment remains below the effect thresholds determined. Some objectives, e.g. in the field of health protection, result from an accepted impact or impact intensity. For example, quantified and hence verifiable environmental quality and action objectives are laid down in the national strategy on biological diversity.

Environmental quality criteria (scientifically derived effect thresholds, critical rates of input of substances into environmental media, organisms, biocenoses etc.) serve as a basis for establishing environmental quality objectives and environmental action objectives (UBA 2000, p. 12). Assessment of both ecotoxicological risks and toxicological risks to humans are based on the assumption of effect thresholds. To protect biodiversity there is a need for ecosystem-specific monitoring of appropriate threshold values, e.g. compliance with critical loads for nitrogen pollution in ecosystems.

In a political process aimed at balancing interests, asset-specific environmental standards (e.g. immission limit values) and source-specific environmental standards (e.g. product requirements, emission limits) are set by society

on the basis of scientific environmental quality criteria and indicators. Environmental policy measures are laid down and enforced to ensure compliance with the environmental standards and to achieve the environmental quality and action objectives (UBA 2000, p. 12 f.). Indicators aggregate information from multiple status parameters, for example monitoring programmes.

To operationalise environmental quality objectives and environmental standards it is necessary in particular to record the qualitative status of the various environmental systems by means of comprehensive environmental monitoring (SRU 1994, para. 137).

10.2.3 Fragmented monitoring as a problem

582. The fact that the statutory requirements for monitoring are highly fragmented is a problem. Environmental monitoring programmes largely meet verification and reporting obligations arising from national legislation and international conventions. However, in view of the fact that environmental legislation is traditionally media oriented, it has no common system of objectives and therefore specifies a multiplicity of methods (UBA 2002). In the field of regulating substance discharges into the environment, for example, the effects of the individual statutory provisions on limiting specific substance discharges are examined separately (DIEHL 2010), and even biodiversity monitoring is not based on an overall nationwide concept (DRÖSCHMEISTER et al. 2006; DOERPINGHAUS and DRÖSCHMEISTER 2010).

Status quo of monitoring in Germany

583. The following provides an overview of existing monitoring programmes to demonstrate the fragmentation of monitoring. As examples, it looks at programmes in the fields of nature conservation, environmental protection and health protection.

In the field of nature conservation there are nationwide monitoring programmes for individual groups of species (e.g. birds, butterflies, “wild animals” (DJV 2009), seabird species in need of protection, marine mammals, benthic species and protected habitat types in marine biodiversity monitoring in the Exclusive Economic Area (EEZ)), and also programmes which fulfil reporting requirements (e.g. under the Habitats Directive 92/43/EEC), the Birds Directive 2009/147/EC, the Water Framework Directive or Regulation (EG) No. 1698/2005 on support for rural development (EAFRD Regulation) (BMU 2010, Chapter 2.1; DRÖSCHMEISTER et al. 2006)). There is however no standardised nationwide monitoring system in Germany for the normal countryside on the lines of Swiss biodiversity monitoring (Koordinationsstelle Biodiversitäts-Monitoring Schweiz 2009). As a result, nationwide information on the status of biodiversity in the various land use types (at the levels of ecosystems and habitats, species and communities, genomes and genes, as called for under the CBD (cf. para. 576)) is not possible, although urgently needed.

Data on pressures due to chemicals that impact on man and the environment can be found in the German Environmental Specimen Bank (www.umweltprobenbank.de/de) and various environmental monitoring programmes (KNETSCH and ROSENKRANZ 2003; KNETSCH 2011b). There is no comprehensive list. In 1998 38 programmes of various ministries with 50 monitoring networks, 788 parameters and 495 parameter variants were described at federal level (von KLITZING et al. 1998). In 2002 this figure was updated by a further 6 programmes (von KLITZING 2002), but there has been no further documentation since then. A search for “environmental monitoring programmes” in the Internet portal PortalU (metadata catalogue; www.portalu.de) reveals about forty federal environmental monitoring programmes (August 2011). This figure does not include the environmental monitoring programmes of the Länder, which can also be found there. In addition to differences in the parameters to be measured, the federal programmes also differ in the spatial focus of the existing monitoring regions or sampling areas (UBA 2002).

Status quo of monitoring in Europe

584. As at national level, fragmented monitoring programmes also exist at European level. This is largely due to the fact that the programmes are based on individual thematic strategies and legal acts, and that no attempt has been made to standardise them. To achieve this the European Commission, as part of its “EU Biodiversity Strategy for 2020”, calls for the development of an integrated framework for monitoring and assessing the status of the strategy’s implementation, including reporting. National, EU and global monitoring, reporting and review requirements are to be tightened up and harmonised as far as possible with the requirements of other environmental regulations (European Commission 2011a). At European level, monitoring programmes are being implemented for the directives mentioned above (cf. para. 583). In addition, the European Bird Census Council (EBCC) has published aggregated monitoring results from European states on breeding bird species every year since 2003 (EBCC 2012). The meta-database Biodiversity Information System for Europe (BISE) is intended to support the interchange of data and information with special reference to biodiversity.

Partially integrated monitoring, for example the ICP Forests (International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests), is carried on under the aegis of the Geneva Convention on Long-range Transboundary Air Pollution at UNECE (United Nations Economic Commission for Europe) (ICP Forests and European Commission – DG Environment 2011; ICP Forests 2010). The EU has also provided financial support for the surveys and assessments under a number of regulations. Nevertheless, there are also calls for better linking of the ICP Forests data with other monitoring databases (CLARKE et al. 2011).

At EU level there are also a number of monitoring programmes for chemicals, with different goals and concepts. Responsibility for monitoring chemicals rests with the four institutions DG Environment, DG Eurostat, Joint Research Centre (JRC) and the European Environment Agency (EEA). The existing programmes are based on EU legislation and international agreements, in some cases without any reporting requirements. In terms of the monitoring purpose and the matrix sampled, the programmes can be grouped in the categories emission monitoring, food and animal feed monitoring, environmental monitoring, human biomonitoring, and product monitoring (European Commission – DG Environment 2010).

Thus even at European level there is currently no attempt to ensure coherent and effective collection and linking of data on chemicals in the environment (and in human tissue). Not even the spatial frames of reference are coordinated in the survey programmes. This makes it more difficult to assess the severity of the pressures on man and the environment due to chemicals and their development over time.

585. In 2008 the European Commission drew attention to the need to design a shared environmental information system (SEIS) (European Commission 2008). The overall aim of SEIS is to “maintain and improve the quality and availability of information required for environmental policy, in line with better regulation, while keeping the associated administrative burdens to a minimum”. SEIS is to ensure more efficient use of available data and further streamline and prioritise the information requirements currently specified in thematic environmental provisions. In situ monitoring of freshwater, soil, land use and biodiversity in an ecosystem context are mentioned as examples of the need for cross-thematic coordination.

To improve data availability and networking, the following data infrastructure centres for the field of nature conservation and environmental protection have already been set up at EU level: European Environment Information and Observation Network (EIONET; environmental data), Infrastructure for Spatial Information in the European Community (INSPIRE), EU-wide monitoring methods and systems of surveillance for species and habitats of Community interest (EuMon). The MONARPOP project (Monitoring Network in the Alpine Region for Persistent Organic Pollutants) works on a theme-specific and transboundary basis (OFFENTHALER et al. 2009). The MODELKEY project undertakes integrated research into pollutants in freshwater and seawater ecosystems (BRACK 2011).

Conclusions

586. The largely media-oriented environmental legislation (para. 582, 602, 623) has resulted in sectoral surveys and measuring networks (monitoring of water, air, soil, surveys of species and structures). This applies to both national and European environmental monitoring programmes.

Environmental monitoring in Germany and Europe is therefore characterised by a large number of measuring networks, which are run separately on the basis of environmental media and administrative competencies. This frequently results in problems with coordination going beyond departmental and also national boundaries. In particular, there is a lack of harmonised minimum requirements for reviewing success in achieving the substance-specific individual targets (DOYLE and HEIB 2009). It is not possible to link data on the environment, human health and products, for example in the field of pesticides, by pooling the relevant data for specific active substances. Moreover, in many cases methodological problems make it impossible to undertake an overarching causal assessment of biodiversity status data using data on substance discharges. And the situation regarding availability of the data or rights of access to the data is often unclear.

The aim must therefore be to network and if necessary harmonise these programmes, not only in terms of content (cf. para. 642), but also as regards their assessment facilities and also as regards public access, both for individual authorities and for the general public. The goal should be a comprehensive monitoring system that covers all levels of biodiversity and can link them with status data on environmental media and land use (HEIB 2010).

10.2.4 Integrated monitoring as a solution

587. As already described, differences in the systems of objectives, data requirements and methods in the statutory regulations give rise to uncoordinated monitoring concepts (cf. Section 10.2.3). In the opinion of the SRU, the existence of both asset-specific and source-specific environmental standards indicates that the existing environmental monitoring approaches, which are still almost entirely sector oriented, need to be developed into an integrated environmental monitoring system (SRU 1991). Environmental protection should be more impact-oriented, i.e. geared to the protected asset. Industrial permitting legislation continues to be based on an almost exclusively emission-oriented approach, under which the precautionary approach is implemented by the concept of compliance with state-of-the-art technology. Here there is a need in future for additional integration of precautionary aspects with regard to the relevant assets for protection (cf. Chapter 9). A cross-sectoral approach and cooperation are prerequisites for presenting a comprehensive picture of the status of nature and the environment, for example with regard to problem substances, and are thus preconditions of an effective environmental policy. The appropriate instrument for this is integrated environmental monitoring.

Substance-specific monitoring should be designed on an integrated basis, in other words for cross-media investigation of mixtures of substances at the trophic stages in the ecosystem (AK Umweltmonitoring 2008). Integrated monitoring means comprehensive monitoring across several ecosystem compartments (environmental media). Since integrated monitoring may also consist in a combined investigation of exposure and effect, the terms

integration-oriented, cross-media, environmental or ecosystem monitoring are also commonly used for this concept in its broader sense (AK Umweltmonitoring 2008).

588. The need to design a monitoring concept on an interdisciplinary and cross-sectoral basis arises from the following effects, which are not covered by risk prevention measures that fail to take account of the overall picture (REESE 2010):

- Cumulative or matrix effects (mutually reinforcing effects that may originate from substances or genetically modified organisms),
- Additive effects (sum of several similar effects),
- Spatial and temporal distance of effects,
- Systemic effects: Effects arising in one area have impacts not only in this area, but also in other areas. Such interactions are not always linear and, above all, they are difficult to predict (LANGE et al. 2010).
- Harmful effects on nature conservation assets requiring protection: according to REESE (2010) there is no concept of damage that subsumes the elements involved for species, habitats and ecosystems. However, a concept of damage has been developed for nature conservation and environmental protection damage in the context of environmental risk assessment and monitoring under genetic engineering law (KOWARIK et al. 2008).

589. All in all, an integrated, interdisciplinary approach provides an opportunity to find common and comprehensive positions on controversial and topical assessment issues. The basis for this is biodiversity research, which seeks to explain the connections and interactions within ecological systems and between anthropogenic factors and environmental changes (MARQUARD et al. 2012). Under the Federal Nature Conservation Act (BNatSchG), national parks and biosphere reserves also serve the purpose of scientific environmental monitoring and research (Section 24 subsection 2 and Section 25 subsection 2 of the Federal Nature Conservation Act). For example, integrated environmental monitoring is carried on in the Bavarian Forest National Park under the international cooperation programme on the ecosystem impacts of transboundary air pollution and climate change (UNECE ICP Integrated Monitoring) (BEUDERT et al. 2007).

Intensive monitoring of certain environmental parameters on a current total of 88 selected long-term monitoring areas (Level II) in the forest under ICP Forests is being used to develop hypotheses about cause-and-effect relationships (BMELV 2011; BOLTE et al. 2008; cf. para. 602). The year 2008 saw the appearance of the “First integrated environmental report” as part of the research and development project “Model implementation and specification of the plan for ecosystem-oriented environmental monitoring, taking the example of the Rhön inter-state biosphere reserve” (Bayerisches Staatsministerium für Umwelt, Gesundheit und

Verbraucherschutz et al. 2008). Conversely, the design of monitoring programmes and the choice of parameters and measuring networks should at the same time be optimised by taking account of the results of ecosystem research.

10.3 Basic elements of an overall concept

590. On the one hand, monitoring fulfils an early warning function for developments which might be of great concern, while on the other it assesses the success of measures in terms of their effectiveness for the protection targets and protected assets. An overall concept should link use effects, substance pollution and climate change impacts with biodiversity status data and describe changes in the physical region. Another problem area for environmental monitoring concerns the possibility of genetic transfer following release of genetically modified organisms in habitats and natural spaces. The important thing is to identify both positive and negative trends in the status of nature and environment and draw conclusions about the need for action by politicians, society and industry. Ultimately, monitoring data on pressures and status should be used to justify whether active intervention is necessary to prevent harmful environmental impacts, or whether non-action combined with a reduction in the pressure of use is the better option.

The following section discusses the essential basic elements for an overall concept and describes necessary additional aspects.

10.3.1 General, representative biodiversity monitoring

591. In Germany there is no comprehensive biodiversity monitoring system that describes the status of biological diversity in its most important compartments. Thus the data situation is not sufficient to enable politicians to take sound decisions relating to the natural balance. To date, the concept of monitoring of ecosystem services has not been pursued at all systematically in Germany. A suitable monitoring concept that can be integrated in ongoing initiatives, like the international system of Environmental Economic Accounts, has yet to be developed.

592. Although biological diversity is acknowledged as the “existential basis for human life” (BMU 2007, p. 9), the indicator report on the national biodiversity strategy has only two indicators on the status of biological diversity (and an integrating status indicator: status of river flood plains) (BMU 2010, Chapter 2.1). The indicator “species diversity and landscape quality” is confined to achieving targets in the field of species (to date only breeding birds) and the six main habitat types. The indicator “conservation status of Habitats Directive habitats and species” is based on the Habitats Directive monitoring data on the conservation status of protected assets. The existing monitoring programmes are not sufficient for providing adequate policy advice or a sound scientific description of the status of biological diversity, and therefore need to be supplemented (DOERPINGHAUS and DRÖSCHMEISTER 2010; cf. para. 394).

Ecological area sampling as an instrument

593. However, suitable instruments already exist for full-coverage monitoring of biodiversity status: The tool of ecological area sampling was designed as a new instrument for nature conservation monitoring in cooperation between the Federal Statistical Office and the Federal Agency for Nature Conservation (BfN) (DRÖSCHMEISTER 2001; Statistisches Bundesamt and BfN 2000; BACK et al. 1996). The aim was to take account of the development of natural capital in the Environmental Economic Accounts. Ecological area sampling is an approach capable of nationwide application: survey attributes are determined using standardised methods in representative, randomly selected sample areas and extrapolated to the total area. The aim is to observe the environmental impact of land use with regard to biological diversity. Above all, the quality of the normal landscape (outside protected areas), which is predominant in terms of area, is fundamental to the conservation of biological diversity and is taken into account in ecological sample areas. The tool’s statistical relevance is based on a stratification of the sample areas in accordance with the physical structure of Germany. Monitoring under the ecological area sampling system is of modular structure. Level I identifies landscapes and biotope types and their size, distribution, structure and quality. Level II documents the quality of the biotopes, their species diversity and species composition (DRÖSCHMEISTER 2001). The tool is designed to document three forms of pressures: destruction, fragmentation and qualitative pressures.

A practical test of individual components was conducted in Brandenburg, Berlin and Thuringia in 1990 (Statistisches Bundesamt 1998). To date, ecological area sampling has only been used in North-Rhine/Westphalia (KÖNIG 2003; 2010). Baden-Württemberg is planning to introduce it (Ministerium für Umwelt, Naturschutz und Verkehr Baden-Württemberg 2011, p. 44).

Monitoring of ecosystem services

594. In future, ecosystem services are to be monitored as part of the implementation of the EU’s new biodiversity strategy (cf. Section 1.2.2). On the basis of the Millennium Ecosystem Assessment (MA) system the EEA has had a new classification system developed: the Common International Classification of Ecosystem Goods and Services (CICES) (HAINES-YOUNG and POTSCHIN 2010). CICES provides a means of integrating ecosystem services into existing initiatives, such as the international System of Integrated Environmental and Economic Accounting (SEEA), the Human Development index of the United Nations Development Programme (UNDP), the measurements of economic progress by the Organisation for Economic Co-operation and Development (OECD) or the regulatory framework planned by the EU for the environmental economic accounts (as called for in European Commission 2011b).

On the basis of MA and CICES, the Swiss Federal Office for the Environment (FOEN) has developed – as the first

country in Europe – an inventory that can be used to monitor ecosystem services of direct benefit to humans for prosperity-related environmental reporting (STAUB et al. 2011). This makes it possible to measure and communicate them. As a framework for sustainable landscape development, ecosystem services have been recorded on an exemplary basis using the MA scheme for various land uses in the biosphere reserves Oberlausitz and Schwäbische Alb. This has brought to light and created awareness of conflicts between various claims and demands on landscapes (PLIENINGER et al. 2010).

10.3.2 Monitoring of climate change impacts on biodiversity

595. At present it is not possible to provide a description of the impacts of climate change on biological diversity or to draw a scientifically reliable dividing line between these and other impacts, such as the influence of land use. Extending the existing breeding bird monitoring system by introducing ecological area sampling nationwide would make it possible to monitor the impacts of climate change on biological diversity.

596. Anthropogenic climate change results in micro and macro climate changes (e.g. seasonality and severity of rainfall events or dry periods, temperature situation), which have effects on the distribution and composition of biocoenosis. A large proportion of research discusses the impacts of climate change on biodiversity at species level, mostly with the aid of “climatic envelopes” (range of climatic fluctuations within which a species can occur) (VOHLAND 2008). However, biodiversity is influenced not only by climate change, but also by land use. There is therefore a need to establish and use monitoring methods capable of large-scale technical implementation that can document and assess these combined effects of the two influences (GEBHARDT et al. 2010). Examples of this are ecological area sampling in North-Rhine/Westphalia and the German breeding bird monitoring system, which is also based on the statistical approach of ecological area sampling (op. cit.). In Switzerland there is a nationwide biodiversity monitoring system (BDM) which records mollusc species and their distribution, for example, in a systematically distributed grid. This has permitted an expansion of knowledge about the altitude distribution of numerous species, which is an important basis for monitoring the impacts of climate change (KOBIALKA et al. 2010). This means that in future it will be possible to study the decline of heat-intolerant species or shifts in their distribution. Similarly, this basic data permits systematic recording and assessment of the influence of management methods or air pollutants on biodiversity (op. cit.). Long-term monitoring is essential for investigating questions about the connection between climate change and species occurrence.

At the same time the nationwide introduction of ecological area sampling could also make it possible to verify the impacts of strategies for adapting to climate change, such as the expansion of wind energy use and the growing of energy crops and short-rotation plantations.

10.3.3 Monitoring in agricultural genetic engineering

597. To date, the SRU’s calls for *adequate* general and case-specific monitoring of genetically modified organisms (GMOs) have not been put into practice (SRU 2004a; 2004b; 2008, Chapter 12.3). It has therefore been impossible to implement environmental monitoring in the field of agricultural genetic engineering in the spirit of the precautionary principle.

The relevant authorities in Germany, Switzerland and Austria have approved a paper laying down the following principles of GMO monitoring (ZÜGHART et al. 2011), which are largely supported by the ecological area sampling approach:

- Satisfy minimum scientific requirements (with regard to parameters, methods, design, monitoring locations, time scale),
- Check the reliability of the risk assessment performed before authorisation,
- Strict conceptual and methodological separation of case-specific and general monitoring does not make technical sense and is difficult to implement,
- Recording exposure of the environment to GMOs and products made from them is an important element of monitoring.

Nationwide introduction of ecological area sampling in Germany would make sense to ensure better achievement of the objectives laid down in genetic engineering law in the field of monitoring.

598. Monitoring of the impacts of GMOs on the environment requires the observation of very complex ecological interactions at various levels of integration (e.g. intra-species diversity, populations, ecosystems) (ZÜGHART and BENZLER 2007; ZÜGHART et al. 2005; SRU 2004b, Section 10.2.3). If a GMO has been approved for the market (placing on the market), the GMO and its use must be accompanied by monitoring of possible impacts on the environment. This applies to imports, processing and growing of GMOs. Two monitoring approaches are distinguished here: general surveillance and case-specific monitoring (Annex VII to the Deliberate Release Directive 2001/18/EC).

The purpose of case-specific monitoring is to verify the assumptions made in the environmental risk assessment with regard to possible adverse effects of the GMO and its use on the environment and on human health. It only has to be performed if there are relevant pointers to risks or uncertainties. General surveillance, by contrast, must always be carried out. It serves to determine possible adverse effects on human health and the environment that were not covered by the environmental risk assessment.

599. In the EU there has hitherto been only one instance of crop-accompanying monitoring under the Deliberate Release Directive, namely for Amflora, a genetically modified starch potato variety (since 2010). By contrast, the monitoring plan for MON810, a maize variety resistant to the European corn borer, which was

negotiated for Germany and established in 2008, remains a national arrangement. In the growing of MON810 maize, nature conservation and environmental protection aspects were not taken into account adequately. For example, the effects of the Bt toxin produced in the maize plants (Bt = *Bacillus thuringiensis*) on butterflies and aquatic organisms were not investigated in crop-accompanying studies (BfN 2009). Since April 2009 a ban on cultivation of MON810 has been in place in Germany on the grounds that this maize could cause adverse effects on the environment (ZKBS 2009). These effects could not have been shown to exist in Germany with the monitoring methods used here.

600. The binding obligation to protect ecosystems – especially designated protected areas – and a reliable monitoring system that gives timely indication of ecological risks should be preconditions for the growing of genetically modified crops. When genetically modified animal feeds are placed on the market, monitoring should also cover the transport and processing paths and, where appropriate, the animal excreta and the consumption of the resulting animal products. Case-specific monitoring is based on information from the environmental risk assessment and therefore comprises different specific investigations in each case. The plans for general surveillance combine

- questionnaires for farmers focusing on agronomic aspects such as yield, pest problems etc. (no systematic recording of ecological parameters),
- evaluation of the literature,
- use of existing general surveillance programmes.

Against this background, good-quality nationwide information about the distribution of species, communities and habitats is a precondition for the cultivation of GMOs and for the monitoring approaches it inevitably involves (cf. para. 592). A monitoring system has been established in Austria which permits joint biodiversity and GMO monitoring and thereby creates technical and financial synergies (PASCHER et al. 2010; 2011). The monitoring system, entitled BINATS (Biodiversity – Nature – Safety), comprises 100 test plots in arable farming areas. At the same time this concept integrates supervisory surveillance in the national monitoring of biodiversity (PASCHER et al. 2007). The indicators are landscape elements and habitats, vascular plants, butterflies and grasshoppers. The biodiversity monitoring system in Switzerland (BDM) can also be used in synergies for GMO monitoring (BÜHLER 2010; RAPS 2007; BÜHLER et al. 2008). It observes animals (breeding birds, molluscs, butterflies) and plants (vascular plants, mosses) on 2,000 sample areas throughout the country (Koordinationsstelle Biodiversitätsmonitoring Schweiz 2006). Ecological area sampling could offer a similar starting point for GMO monitoring, because it can easily be supplemented by certain aspects needed for GMO monitoring (MIDDELHOFF et al. 2006). First attempts at model implementation have already been made in North-Rhine/Westphalia (FIEBIG 2010).

10.3.4 Substance-specific monitoring

601. Discharges of substances into the environment arise not only from direct application (e.g. of pesticides or fertilisers), but also from deliberate use (e.g. solvents, pharmaceuticals or other products), unintentional losses from production or operational workflows, accidents and – not least – waste disposal. As a result, substance discharges are many and various, and the environmental pressures due to substances relate to the environmental media (soil, water, air) and also have effects on biological diversity.

The present statutory implementation of chemicals legislation provides assessment criteria for assessing the risks of environmental pollution. The limit values now in place for substance regulation (air quality control, water law etc.) are socially defined risk standards, and compliance with them has to be verified by monitoring. To make it possible to take effective and targeted measures for handling substances and identify and correct deficits in the existing regulatory approaches, risk information on the individual substances needs to be supplemented by information on actual loads in the individual environmental media and the resulting impacts. The behaviour and whereabouts of substances released into the environment are an important basis for deriving criteria for early identification of environmentally relevant substances. In the interests of an efficient environmental policy it is therefore important to ensure feedback between information flows in environmental monitoring, environmental policy and law making. The interaction of environmental monitoring and enforcement is thus of vital importance. The aim is the most comprehensive protection possible for biological diversity throughout the entire life cycle of the substance, from production through use to disposal.

602. At present, pollutant loads on ecosystems are mostly recorded separately by discharges of substances into the individual environmental media (soil, water, air), and the stress capacity of biocoenosis measured in terms of a small number of priority pollutants. There are few monitoring programmes that merge physico-chemical information (e.g. pH, temperature, oxygen content, selected substances) with biological information (e.g. water monitoring, soil status surveys, environmental monitoring in forests (Level II areas (ICP Forests)) (cf. para. 589) or ecological area sampling in North-Rhine/Westphalia in conjunction with monitoring of substance discharges). Here there is a need for better linking of the information hitherto collected separately (Umweltrat EOBC 2011). Substance-specific monitoring should therefore be designed on an integrated basis, in other words for cross-media investigation of mixtures of substances at the trophic stages in the ecosystem (AK Umweltmonitoring 2008).

10.3.4.1 Characterisation of environmentally relevant substances

603. A large number of different substances exert pressure on nature and the environment. These pressures

may take the form of accumulation processes, substance transfers and substance interchange between the environmental media, and also indirect impacts. Substances of environmental relevance include not only those with particularly problematic properties, but also substances which are released in large quantities and overload the buffer capacity of the ecosystems. Thus a large number of substances are potentially relevant for substance-specific and integrated monitoring.

The choice of substances to be included in a monitoring programme should be made in the light of their occurrence in the environment and on the basis of substance properties that indicate a known or possible risk potential for man and/or the environment. The criteria of Article 57 of Regulation (EC) No. 1907/2006 concerning the registration, evaluation, authorisation and restriction of chemicals (REACH Regulation) with regard to the identification of substances of very high concern (SVHC) can be used to determine such substances. These are substances which:

- are classified as carcinogenic, mutagenic or toxic to reproduction in category 1A or 1B within the meaning of Regulation (EC) No. 1272/2008 on the classification, labelling and packaging of substances and mixtures (CLP Regulation) (CMR substances) (Article 57a–c REACH Regulation),
- are persistent, bioaccumulable and toxic (PBT substances) according to the criteria in Annex XIII of the REACH Regulation, or very persistent and very bioaccumulable (vPvB substances) (Article 57d and e REACH Regulation),
- are likely, on the basis of scientific findings, to have serious impacts on human health or the environment which are just as alarming as those of other substances listed under letters a to e, and which are determined in the individual case in accordance with the method in Article 59 – such as substances with endocrine properties or substances with persistent, bioaccumulable and toxic properties or very persistent and very bioaccumulable properties that do not satisfy the criteria of letters d or e – (Article 57f REACH Regulation).

In the case of a number of potential PBT substances, the tests necessary for final evaluation are difficult or even impossible because of their chemical properties and high detection limits. It is not clear to date whether such substances are regarded as PBT substances, or how the PBT properties of these substances can be determined (SCHULTE 2006).

604. In the case of PBT and vPvB substances, their input into the environment and possible impacts on human health and ecosystems are decoupled in time and space. It is not possible to predict long-term impacts and assess possible harmful effects with the usual risk assessment methods (comparing assumed exposure and impact), because persistence and bioaccumulation do not permit any reliable forecast of exposure without measurements from representative samples. Another factor is a high

degree of uncertainty regarding possible longer-term effects. These can never be excluded in cases of high persistence and bioaccumulability. Harmful effects, once they have occurred, may often be irreparable (UBA 2009b). For this reason, minimisation of all releases is being targeted at international level for this category of substances. To date there is no monitoring system that lives up to this high standard of protection.

605. However, substance-specific monitoring can be used for other purposes than studying the distribution of known PBT or vPvB substances. It is also possible, in cooperation with researchers, to identify substances that have not hitherto been recognised as PBT or vPvB substances, for example by examining human samples from persons not subject to occupational exposure or environmental samples from regions with little human influence (Arctic) or organisms at the top of food pyramids (UBA 2009b).

606. Other criteria that qualify a substance for priority inclusion in a monitoring programme are high toxic potential, widespread use or large annual production quantity. Especially in the case of substances selected on the basis of the last two criteria, monitoring should also comprise any contaminants they may contain. Examples here include discharges of cadmium into soils through the use of phosphate fertilisers, and also discharge arising from historical forms of use – e.g. mining.

While the use of pesticides and pharmaceuticals in agriculture permits close crop rotation and intensive livestock farming, these substances are in themselves environmentally relevant or have impacts on biological diversity. They thus contribute directly to loss of biological diversity, in that herbicides destroy plants which provide beneficial organisms with food and a place to overwinter, or insecticides damage or kill animals that are not target organisms (HAFFMANS 2008).

The use of fertilisers results in increased discharge of nutrients into the environment with adverse impacts on most natural and near-natural ecosystems. For example, the share of the areas studied in Germany with no exceedance of critical loads of nutrient nitrogen came to only 4.3 percent in 2004 (SUKOPP et al. 2010). To assess the status of an ecosystem it is therefore necessary to monitor the nutrients present as well.

10.3.4.2 Examples of critical substances with special monitoring requirements

607. The following examples illustrate the contribution that monitoring makes or can make to protecting man and the environment from discharges of substances. Precautionary substance policy today focuses on substances with long-term risk potential (PBT substances and CMR substances) and substances that can, even in small concentrations, interfere with physiological regulation mechanisms of organisms (endocrine effects, cf. para. 612 f.). Although a number of problematic substance discharges have been minimised, researchers have identified new action mechanisms of known environmental pollutants and of substances hitherto not

classified as such, for example perfluorinated and polyfluorinated compounds. In other cases there is a need for further reductions, despite emission control successes, because the evaluation of possible health risks has yielded new findings, e.g. for the assessment of lead. From the group of substances especially critical for the environment, the section below looks at a heavy metal, a group of substances with persistent, bioaccumulable and toxic properties, the group of endocrine substances, and a common crop protection agent. Monitoring is necessary for these substances because of their toxic effects on humans and the environment.

Heavy metals and “new” impacts: Lead

608. Lead is a metal of known and widespread distribution. Unlike many organic substances, metals are not biodegradable; their distribution therefore takes the form of a cycle. To effectively reduce the pressures on man and the environment, toxic metals have to be removed from this cycle. Discharges of heavy metals into surface waters have harmful effects on aquatic communities. In spite of the 89-percent reduction in lead between 1985 and 2005, the suspended solids studies by the Joint Water Commission of the Federal States indicate ongoing problems with concentrations of heavy metals, including lead. In 2010 only 78 percent of measuring stations achieved water quality grade II for lead (UBA 2012). Monitoring of pollution of the individual environmental compartments is an indispensable tool for determining priorities for further reduction measures and for monitoring the success of such measures.

Today human exposure to lead, despite its persistence, is on the decline (IARC 2006). Recent studies of the effects of lead on children and juveniles have yielded new findings on health risks, because they included more groups with blood lead levels in the low-dose range below 100 µg/l. The studies show that lead has neurotoxic effects and possibly also endocrinal effects, for which children and juveniles are a sensitive population group because of their development stages (Kommission Human-Biomonitoring 2009). Lead and its inorganic compounds were recently re-evaluated with regard to their carcinogenicity as well: the International Agency for Research on Cancer (IARC) has classified them as probably carcinogenic for humans (Group 2A), and the MAK commission (MAK – German Research Associations Commission on occupational exposure limits) classifies them as carcinogenic for humans (Category 2) (IARC 2006; DFG Senatskommission zur Prüfung gesundheitsschädlicher Arbeitsstoffe 2007). These new findings show that in spite of successful reductions, lead pollution must be further reduced in line with the ALARA principle (As Low As Reasonably Achievable) and that this must be verified by monitoring.

609. Together with findings on a correlation between blood lead levels and increased incidence of cardiovascular disorders and chronic renal damage in adults (Kommission Human-Biomonitoring 2009), the findings on the effects of lead argue in favour of maintaining the efforts to minimise and optimise human

exposure. The success of the measures should therefore continue to be verified by regular pollution monitoring. The influence of terrestrial lead pollution on humans must be evaluated and, if necessary, reduced.

Persistent, bioaccumulable and toxic:

Perfluorinated and polyfluorinated compounds

610. Perfluorinated alkylated and polyfluorinated alkylated substances (PFAS) are a group of persistent environmental contaminants. Well-known examples of PFAS include perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA), which have been in production for over fifty years and are also known, along with other PFAS, as perfluorinated surfactants (PFT) or fluorosurfactants. Other PFAS include fluorotelomer alcohols (FTOH) and fluoropolymers such as polytetrafluoroethylene (Teflon®). Fluorosurfactants possess great chemical and thermal stability. In view of their water-repellent, fat-repellent and dirt-repellent action, they are used for surface enhancement of textiles and paper and construction products. They are widely used for surface coating in the electroplating industry, and are also used in cleaners, paints and fire extinguishing agents (ARENHOLZ et al. 2011; UBA 2009a; BfR 2006). Owing to their persistence, PFAS can now be detected worldwide in waters, air, and human and animal tissue. Their distribution paths have yet to be fully clarified (UBA 2009a).

The uptake of PFAS by the human organism has not yet been fully clarified either. Studies of persons who had consumed contaminated drinking water have demonstrated uptake of PFOS and PFOA, and also uptake of PFOS from contaminated fish. PFAS have been found in other foods such as meat, dairy products and eggs, and also in grain grown on contaminated ground. PFAS are also taken in via the lungs; for example, furnishings enhanced with PFAS could result in uptake via indoor air (UBA 2009a). In animal tests, PFOA and PFOS have a carcinogenic effect and are toxic to reproduction (OECD 2002; EPA 2005; FRICKE and LAHL 2005). However, there is some controversy about whether the animal test results are applicable to humans. There are, however, indications that PFOS and PFOA have adverse impacts on female fertility (FEI et al. 2009).

A study by the federal environmental specimen bank shows that blood plasma concentrations of PFOS in individuals not subject to occupational exposure have been falling since the beginning of the century, whereas PFOA concentration remain constant. At the same time this and another study show that the familiar PFAS, such as PFOS and PFOA, are being replaced by PFAS that are even less well researched (UBA 2009a).

To date the PFAS concentrations measured in water bodies have been well below the levels that would harm aquatic communities (UBA 2009a). As described, however, PFAS are very persistent. Discharge of these substances into the environment should therefore be minimised, especially since the industry is increasingly using short-chain PFAS. While these are less bioaccumulable, they are just as non-biodegradable and

their ecotoxicological potential cannot yet be estimated. In the interests of environmental protection, the Federal Environment Agency (UBA) proposes legally binding quality standards and reduction targets for water bodies, wastewater, sewage sludge and soil (UBA 2009a).

611. The findings on PFAS to date argue in favour of stepping up monitoring of the pressures on man and the environment due to this category of substances, on the one hand as load monitoring to verify not only the success of the minimisation efforts, but also to permit early identification of new PFAS that are particularly relevant from a quantitative point of view. On the other hand, effect monitoring is needed to identify potential impacts on man and the environment as early as possible, especially in view of the persistence of PFAS.

Endocrinal substances

612. For some time now, the effects of pollutants on the endocrinal (hormone) system have been playing a special role in the debate about substance-related risks. There are numerous chemicals that have been shown to have the potential for affecting the endocrinal systems of humans and animals. Here the focus is on pre-natal development, because hormones are of great importance as regulators in this sensitive phase of life. Development may be affected if they act in the wrong concentration or at the wrong time. Known examples of such substance groups with an endocrine impact potential are:

- PCBs (polychlorinated biphenyls), which used to be used as insulating fluids, hydraulic fluids and softeners for sealing compounds, and are now prohibited. Because of their persistence they can still be detected in the environment;
- Phthalates, which are used as softeners for plastics, paints and varnishes;
- Bisphenol-A, which is similarly used in the manufacture of plastics (polycarbonates), but also for other purposes, e.g. as a colour development component, and is present in food packaging and plastic bowls, for example;
- Tributyltin (TBT), which used to be used in particular as an antifouling biocide in ship's paints. The use of organotin compounds in antifouling paints has been banned worldwide since 2003 (EEA 2001; SRU 2004b; UBA 2010; BfR 2011b).
- Synthetic hormones for contraception and for treating hormone-dependent disorders (e.g. 17 α -ethinylestradiol), which find their way into surface waters via wastewater.

From experience with the long-term effects of the first synthetic oestrogen, diethylstilbestrol, which was frequently used for pregnant women until as late as the 1970s, it is known that high oestrogen doses administered to humans during pregnancy have adverse effects especially on pre- and post-natal sexual development and on male and female fertility, and may even have favoured cancers in female offspring (HOOVER et al. 2011). Although it is clear that certain environmental chemicals

can adversely affect normal endocrinal processes, there is little evidence that human health can be affected by exposure to endocrinal chemicals from environmental pollution. When it comes to ecotoxicological risk assessment, the focus is on effects of relevance to populations (HOFFMANN and KLOAS 2012).

613. Especially with regard to endocrinal active substances, which have only been partly covered by monitoring programmes, it is evident that monitoring is important to justify regulatory measures. These substances present the special challenge of a cumulative view of all substances with the same action, regardless of impact intensity. Above and beyond straightforward exposure/load monitoring, there is a need for integrated monitoring, including effect monitoring, in order to identify endocrinal substances that have hitherto remained undetected (cf. para. 587).

Widespread use of pesticides: Glyphosate

614. Glyphosate and its degradation product AMPA head the list of frequencies for findings of pesticides in surface waters and drinking water, for example in Schleswig-Holstein (Schleswig-Holsteinischer Landtag 2011). Originally, glyphosate and glyphosate-resistant crops were introduced on the grounds that they would reduce environmental pollution with herbicides, since glyphosate was less toxic and less persistent than other herbicides. But AMPA proves to be persistent in the soil and at least as toxic as glyphosate (MAMY et al. 2010; ANTONIOU et al. 2011). The results of scientific research have shown that glyphosate causes malformations in frog and chicken embryos in in-vitro studies, even at greater dilutions than occur in agricultural application (ANTONIOU et al. 2011; 2010).

For a series of broadband herbicides under the name Roundup® there is abundant evidence that the glyphosate contained in them and the individual auxiliaries have considerable effects on the development and survival of amphibians (BERNAL et al. 2009; MANN et al. 2009; RELYAE and JONES 2009). The severity varies depending on the concentration and the time of application (JONES et al. 2010).

Thus evaluation of glyphosate should be based not only on health assessments by the Federal Institute for Risk Assessment (BfR), but also on findings relating to ecotoxicity. The technical opinion of the BfR also draws attention to the fact that the main technical disagreement, however, lies in a fundamentally divergent scientific approach to assessing the health risks of chemicals. In the opinion of the BfR, such paradigm changes should be investigated by experts and the need for them should be discussed in international bodies (BfR 2011a). Although a review of the approval of glyphosate should have been made at EU level in 2012, the European Commission made an unscheduled extension of approval for glyphosate – and for 38 other pesticides – in November 2010 (Directive 2010/77/EU). This means that glyphosate can be used until 2015 without any further review (Deutscher Bundestag 2011a).

615. Integrated environmental monitoring is particularly necessary for a widely used pesticide active substance, in order to record not only data on environmental loads of the active substance and its degradation products, but also – by way of effect monitoring – to record effects on non-target organisms that may not have been detected in previous risk assessment processes.

10.3.4.3 Examples of knowledge gaps in the field of substance-specific environmental risk assessment

616. Substances of environmental relevance include not only those with particularly problematic properties, but also substances which are released in large quantities and overload the buffer capacity of the ecosystems. Above all, we do not have adequate knowledge about chemical pollution of the terrestrial and aquatic environment and the direct and indirect impacts of pesticides and industrial chemicals on biological diversity.

Inadequate knowledge about chemical pollution of the terrestrial environment

617. Knowledge about pesticides (ISOE 2010) and pharmaceuticals in the terrestrial environment is meagre, although they are environmentally relevant in themselves and are distributed on farmland via slurry and sewage sludge. Despite studies of the paths involved, unexpected effects are constantly occurring (ISENRING 2010), e.g. bee mortality in Germany in 2008 as a result of the insecticide clothianidin, or the extinction of three species of vulture on the Indian subcontinent due to the veterinary use of diclofenac (KNOPP et al. 2007). As a result of excretion into slurry by livestock, dung fauna can be adversely affected by residues of antiparasitic agents, such as ivermectin (KREUZIG et al. 2007).

Flame retardants are an example of the lack of environmental data on pollutants (ARCADIS Belgium and EBRC Consulting 2011). In a study of 42 flame retardants contained in consumer goods, environmental and health evaluation was only possible for 22 owing to lack of environmental data, and for 11 it proved impossible to make any risk assessment at all.

Inadequate knowledge about chemical pollution of the aquatic environment

618. The gap between chemicals monitoring and the assessment of small bodies of water that are particularly sensitive from a biological point of view is filled by the European MODELKEY project (BRACK 2011), which is concerned with linking chemical and biological status data. In the SPEAR Index (species-at-risk) it has developed a tool for assessing the impacts of pesticides on aquatic organisms which brings together chemical and biological data (von der OHE et al. 2009). The project also demonstrates the need for development in the field of monitoring.

Particularly for major bodies of water, nationwide information is available on chemical pollution, but primarily on “priority substances”. For small water bodies, which are especially valuable in ecological terms,

such data only exist, at best, at Länder level in the context of Länder-specific measuring programmes. Thus pollution measurements exist, though they are not readily accessible and do not use standardised methods.

Discharge of pesticides into surface waters may occur during or after their application, as a result of drift, surface runoff or drainage (Deutscher Bundestag 2011b; SCHULZ 2004). The chemical monitoring data available to the federal authorities do not permit any precise statements about pesticide pollution of surface waters particularly affected. Reasons include the small number of measuring stations, non-inclusion of minor rivers, and the limited spectrum of active substances measured. This means it is not possible to derive a suitable status indicator for pesticide pollution of all surface waters for implementing the National Action Plan (NAP) currently under development for the sustainable use of pesticides on the basis of the new Pesticides Framework Directive 2009/128/EC. Here it would be necessary to undertake representative monitoring of the status quo of pesticide pollution in agrarian streams/ponds in order to create the basis for progress monitoring of the NAP.

Inadequate knowledge about the impacts of pesticides on biological diversity

619. Synthetic chemical pesticides endanger the biological diversity of plants in particular, for example through the decline in the number of species in the seed banks of farmland soil (ROBINSON and SUTHERLAND 2002). Partly as a result of indirect food chain effects, which are not taken into account in risk assessments, the number of species of breeding birds on agricultural land has decreased (SUDFELDT et al. 2010). The numbers and species composition of non-target organisms such as soil organisms, aquatic organisms and amphibians are on the decline (examples and bibliographic references in HAFFMANS 2010; ISENRING 2010). Through their skin, amphibians interact strongly with the media that surround them. They therefore display sensitive reactions to direct contact with pesticide components. Moreover, their two-phase life cycle means that they are exposed to substances both in their aquatic (larval) stage and in the terrestrial environment (adult stage) (TODD et al. 2011). For example, 100 percent mortality of juvenile stages of amphibians was found to occur after field application of environmentally relevant fungicide levels (BELDEN et al. 2010).

A study in 2010 showed that pesticides are largely responsible for the reduction in animal and plant diversity on agricultural land in Europe (GEIGER et al. 2010). Furthermore, the use of insecticides indirectly reduces the effectiveness of biological pest control (op. cit.). Although it is a fundamental problem, there is currently no alternative to test systems that work with proxy organisms, fail to cover parts of the hormone system (e.g. adrenal gland, pancreas), and do not take account of “cocktail effects” or chronic toxicity (ISOE 2010). What is more, the contamination pattern of insecticides in the environment usually displays pollution peaks which only last for a few hours and are thus difficult to verify, but are

of great ecotoxicological relevance (Deutscher Bundestag 2011b).

620. Neither are indirect effects and cumulative risks taken into account in the authorisation of pesticides (WOGRAM 2010). Other aspects which are not adequately implemented are the protection of accompanying agricultural flora and fauna and the protection requirements of species that are specially protected by law (LIESS et al. 2010). Integrated monitoring accompanying the approval process would be important here as a “reality check”.

10.3.5 Regulation of discharge of substances

621. The way discharge of substances into the environment is regulated by the various legal acts differs not only in terms of protection objectives, but also with regard to how they are operationalised. Traditionally it is basically geared to protecting the various environmental media. The REACH Regulation takes a comprehensive approach to the extent that it accompanies substances throughout their life cycle and sets out requirements regarding their use. Above all, however, the REACH Regulation results in data being made available on substance properties, production quantities and also the use of the substances requiring registration. Such data have potential when it comes to improving the management of chemicals – including to the extent that they can be used to optimise the approaches in the legal acts – and may provide important information for substance-specific monitoring.

The design of environmental monitoring programmes must react to this complexity and provide data that can not only be used by the authorities for decisions in individual cases, but also permit conclusions about the need for improvements by the legislature.

622. The individual components of responsible use of substances in the environment should be linked together in the interests of achieving objectives:

- Collection and generation of risk information on substances,
- Development of measures to ensure compliance with environmental quality objectives, environmental quality criteria and environmental standards,
- Surveillance of measures by environmental monitoring, followed by corrective action where appropriate,
- Advising policy makers and informing the public by reporting on the findings of environmental monitoring programmes.

Only if meaningful interconnection is successful will it be possible to reduce environmental discharge of substances and hence minimise pollution of the environment.

10.3.5.1 Regulation in legal acts of the EU

623. Increasingly, the requirements for regulation of substance-specific environmental risks are being formulated at European level (cf. Table 10-1). The assets protected by the individual legal acts differ very widely. Whereas the Water Framework Directive (WFD), for example, confines itself to protecting aquatic and dependent terrestrial ecosystems, the Air Quality Directive 2008/50/EC takes a comprehensive approach that is intended to protect human health and the environment as a whole. There are also differences between the protection objectives of the individual legal acts. For example, the protection objective of the WFD is good ecological status, whereas the Biocide Directive 98/8/EC seeks to prevent unacceptable impacts on the target organisms. The different protection objectives are due partly to balancing with other interests – e.g. pest control – in individual cases, but also partly to different perspectives. Whereas some legal acts focus on the pollution source – i.e. substances –, others concentrate on the protected asset and hence the environmental media. This is due to the fact that substances are not only used for different purposes, but can also come into contact with a wide variety of environmental media. This results in corresponding differences in regulatory approach. Hence the WFD, for example, is to be operationalised in accordance with its protection objective, by drawing up environmental quality standards for priority substances. Regulation (EG) No. 850/2004 on persistent organic pollutants (POP Regulation), for example, provides for the release of certain substances to be discontinued in the long term. The approach of the REACH Regulation (cf. Section 10.3.5.2) is the most comprehensive, in that not only is the area of application – i.e. the scope of the substances concerned – very broad, but the entire life cycle of a substance is to be analysed to ensure a high level of safety for human health and the environment.

624. Accordingly, the individual regulations give rise to a large number of requirements regarding how to handle substances to protect the environment, and what objectives are to be satisfied in doing so. In order to review the success of the requirements and the measures derived from them, many legal acts require the Member States to report to the European Commission. To this end they have to undertake systematic progress checks. Ultimately these can only be guaranteed by monitoring that supplies appropriate data. To ensure comparability at European level, this must be done on the basis of internationally harmonised collection methods and standardised evaluation methods.

Table 10-1

**Important regulations governing discharge of substances into the environment
(legal acts of the EU)**

Legal act	Protected asset or protection objective	Regulatory approach
Sectoral environmental legislation		
Water Framework Directive, 2000/60/EC (WFD)	<u>Asset:</u> Inland surface waters, transitional waters, coastal waters, groundwater <u>Objective:</u> Good ecological status, good chemical status	Environmental quality standards for priority substances and other substances identified as being discharged into the body of water in significant quantities
Directive 2008/105/EC on environmental quality standards in the field of water policy	<u>Asset:</u> Surface waters, coastal waters, sediments and/or biota <u>Objective:</u> Good chemical status	Environmental standards for priority substances and certain other pollutants
Nitrates Directive 91/676/EEC	<u>Asset:</u> Inland waters, estuarine waters, coastal waters, marine waters, groundwater <u>Objective:</u> Reduce water pollution caused or triggered by nitrate from agricultural sources and prevent further water pollution	Designation of risk areas and establishment of action programmes
Municipal Wastewater Directive 91/271/EEC	<u>Asset:</u> Environment <u>Objective:</u> Protection from adverse impacts of wastewater	Collection, treatment and discharge of wastewater and target requirements for wastewater loads of phosphorus, nitrogen and biochemical parameters
Groundwater Directive 2006/118/EC	<u>Asset:</u> Groundwater <u>Objective:</u> Pollution prevention and limitation	Groundwater quality standards and threshold values for nitrates and active substances in pesticides and biocides
Air Quality Directive 2008/50/EC	<u>Asset:</u> Human health and the environment as a whole <u>Objective:</u> Avoiding, preventing or reducing harmful impacts	Assessing and controlling air quality and air quality plans for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulates (PM ₁₀ and PM _{2.5}), lead, benzene, carbon monoxide
Directive 2004/107/EC	<u>Asset:</u> Human health and the environment as a whole <u>Objective:</u> Avoiding, preventing or reducing harmful impacts	Target values for arsenic, cadmium, nickel and polycyclic aromatic hydrocarbons
Marine Strategy Framework Directive 2008/56/EC (MSFD)	<u>Asset:</u> Marine environment <u>Objective:</u> Maintain or achieve good status of marine environment by 2020	Describe good environmental status, lay down environmental objectives, and draw up and implement programmes of measures

Legal act	Protected asset or protection objective	Regulatory approach
Substance-specific environmental legislation		
REACH Regulation (EC) No. 1907/2006	<u>Asset:</u> Human health and the environment <u>Objective:</u> High level of protection	Life cycle analysis of chemicals from production through use to disposal; authorisation of substances of very high concern, bans and restrictions on hazardous substances
Biocide Directive 98/8/EC	<u>Asset:</u> Humans, animals and the environment <u>Objective:</u> High level of protection or no unacceptable impacts on the target organisms (such as resistance or unacceptable tolerance; in the case of vertebrate animals, no unnecessary pain or suffering), on human or animal health or surface waters and groundwater or on the environment	Authorisation of active substances and biocide products
Pesticides Regulation (EC) No. 1107/2009	<u>Asset:</u> Human and animal health and the environment <u>Objective:</u> High level of protection or no unacceptable impacts on human or animal health and no unacceptable impacts on the environment	Authorisation of active substances, safeners and synergists; provisions on additives and accompanying substances
POP Regulation (EC) No. 850/2004	<u>Asset:</u> Human health and the environment <u>Objective:</u> Protection from persistent organic pollutants	Prohibition, early cessation of or restrictions on production, marketing and use of substances covered by the POP Convention
Directive 2001/83/EC on the establishment of a Community code relating to medicinal products for human use	<u>Protected asset or protection objective:</u> Effective protection of public health	Authorisation of marketing of medicinal products; requirements regarding environmental risks
Regulation (EC) No. 726/2004 laying down Community procedures for the authorisation and supervision of medicinal products for human and veterinary use and establishing a European Medicines Agency	<u>Protected asset or protection objective:</u> Effective protection of public health	European authorisation of marketing of medicinal products; requirements regarding environmental risks
Soil Protection Directive	(does not exist yet)	
SRU/UG 2012/Table 10-1		

10.3.5.2 Potential of REACH Regulation for regulation and monitoring discharge of substances

625. Under the REACH Regulation, data on basic properties, production quantities and applications are provided for substances requiring registration. However, the data are initially collected on the basis of individual substances and manufacturers. Higher-level merging of the estimated environmental pollution between different spatially connected manufacturers is not envisaged. The testing requirement for environmentally relevant properties is only adequate for large production volumes. It is not readily possible to derive background levels, or possible addition or accumulation effects.

626. This section describes why and how the REACH Regulation in particular possesses great potential for better regulation of the monitoring of substance inputs. As will be explained, this can to some extent be done merely by eliminating deficits in the regulation. The REACH

Regulation is intended to ensure a high standard of protection for human health and the environment with the aim of sustainable development. It sets out to gradually close gaps in existing data on the environmental impacts and exposure of substances by 2018, and pursues a largely cross-sectoral approach. Accordingly, simply manufacturing and/or importing substances gives rise to a basic obligation to collect and generate substance data and perform an initial risk assessment. On the basis of this, official measures can, if the need arises, be taken under sectoral environmental legislation or under the REACH Regulation itself (authorisation or prohibition or restriction). Below the thresholds that trigger official measures, the chemical industry itself is responsible for identifying, applying and communicating measures for appropriate control of substance risks (own responsibility of chemical industry).

This approach offers potential for the future, in that in future there will be a wealth of data on the properties and effects of substances that ought to be used not only

regulating monitoring, but also for improving monitoring design and methods. However, to enable this potential to be exploited, there is a need for further development within the REACH Regulation (eliminate registration deficits). In addition, interface problems with other legal acts should be resolved and steps taken to ensure that data collected as part of substance monitoring are included in chemicals management under the REACH Regulation (improve chemicals management). Finally, ways should be created of making information collected under the REACH Regulation available for environmental monitoring programmes (use registration data).

Eliminating registration deficits

627. The instrument used by the REACH Regulation for collecting risk information on substances is the registration requirement for producers and importers. Under this requirement, the European Chemicals Agency (ECHA) must be provided with a technical dossier for quantities of 1 t per annum or more, plus – for quantities of 10 t per annum or more – a substance safety report (Article 10 REACH Regulation). The data to be included in the technical dossier are graded according to quantity (Article 12 REACH Regulation). The scope of the substance safety report depends above all on the hazardous properties of the substance and hence also on its PBT or vPvB properties (cf. para. 603) (Article 14 paragraph 4 REACH Regulation). Thus the registration process collects extensive information of importance for chemicals management, but there is still a need for improvement in certain areas:

- The technical dossier requires data on substance properties for quantities of as little as 1 t per annum. However, the grading of data requirements results in a situation where it is not possible, with the REACH criteria, to recognise PBT substances below 100 t per annum as critical (SRU 2008, para. 734). To permit appropriate measures to protect the environment, the data requirements should make it possible to identify PBT substances and vPvB substances even at low tonnages.
- Although the technical dossier requests information on exposure, exposure scenarios for the individual applications only have to be made in the context of the substance safety report, and then only for hazardous substances. However, if PBT substances below 100 t per annum are not identified as critical, it is unlikely that exposure scenarios will have to be drawn up for them in the substance safety report below this threshold. Exposure scenarios are the starting point for identifying and assessing any exposure that occurs, and they cover all stages in the life cycle of a substance and its various uses – which means they are essential for chemicals management. The uses can be described in a standardised structured form with the aid of the “Use Descriptor System” (BUNKE 2011, p. 169). The ECHA Guidelines (2008) recommend a standard format for the final exposure scenario. It is basically possible to make use of modelling techniques. Although these are based on very conservative

estimates, they do not provide a very adequate picture of reality. Furthermore, when deriving exposure levels only the intended use is to be taken into account and it may be assumed that all recommended safety measures are taken (INGEROWSKI 2009, p. 170). To prevent or reduce discharge of pollutants into the environment, exposure scenarios should be drawn up for quantities below the threshold of 10 t per annum. Where they are based on modelling, they should be verified by data from substance monitoring.

- Identification of harmful impacts on the environment also forms part of the substance safety report (Article 14 paragraph 3 REACH Regulation). This includes deriving the “predicted no effect concentration” (PNEC) for the relevant substance. Here it is important to remember that, of necessity, impacts on complex systems are modelled, which means that unforeseen effects may emerge later (MAXIM and SPANGENBERG 2009, p. 44). Where the PNEC values are derived by the chemical industry, the lack of independent quality assurance means that they cannot simply be used to justify measures in other legal sectors. Quality assurance of the data would be useful here (SRU 2008, para. 743).

Monitoring data for optimisation of chemicals management

628. While the REACH Regulation provides valuable data for chemicals management, these data are generated by the chemical industry on the basis of laboratory tests and modelling. They may not only trigger measures pursuant to the REACH Regulation, but may also help to justify measures in the sectoral environment. To this end there is a need to eliminate methodological differences and barriers to access. Moreover, these data exist alongside data collected in the course of environmental monitoring, and are thus only one pillar of effective chemicals management. In order to improve chemicals management, the data obtained from monitoring should also be used in substance assessment. The following approaches are possible:

- Measures are taken on the basis of a substance assessment. Responsibility for a large proportion of substances rests with industry (cf. para. 623), whereas the authorities concentrate on prioritisation of substances subject to regulation. This division of labour is not catered for by the fact that only the substance assessment authorities, but not the manufacturers and downstream users have to take account of background levels, combined effects and mixed exposure in substance assessment and risk management. The chemical industry’s measures for appropriate risk assessment are not based on the actual environmental loads. Because the exposure scenarios are based on modelling, they should be refined with the aid of data from monitoring. This applies particularly to establishment of the “specific environmental emission categories” (LÜSKOW et al. 2010, p. 15 ff.).
- The REACH Regulation only focuses on the individual enterprise or substance. To check progress and prevent

problem shifting, it is also necessary to take account of interactions (e.g. additive or cumulative effects). Here the registration data alone are not sufficient, because they do not provide any concrete information on discharge of substances into the environment. They should be supplemented by environmental data from a monitoring system.

- Particularly in the case of PBT and vPvB substances, input into the environment and impact on the environment are separated in space and time. Moreover, it may only transpire at a later stage that substances are of very high concern. Environmental monitoring can yield additional information here.

Using registration data for substance monitoring

629. Monitoring of substances in the environment involves a great deal of work. It is therefore not expedient, partly because evaluation would not be a realistic proposition, to depict the environmental pollution for all substances. Instead, the emphasis should be on an early focus on priority substances. The data generated under the REACH system can be used – as already started in some cases – to select substances that ought to be included in monitoring programmes. This because the registration process not only collects data on production quantities and exposure, but also checks for hazardous or PBT or vPvB properties. On the one hand it therefore makes sense to check the success of these measures by observing those substances which are subject to chemicals management under the REACH Regulation (authorisation or prohibition or restriction). On the other hand, monitoring should also include those substances for which risk management has to be undertaken by the industry on its own responsibility to ensure appropriate control of risks (Article 14 paragraph 6 and Article 37 paragraph 6 REACH Regulation). This would make it possible to measure the success of the regulatory approach that assigns responsibility for the safe use of substances primarily to the chemical industry.

10.3.6 Linking integrated monitoring with health-related environmental monitoring

630. Implementing integrated monitoring would also have advantages for health-related environmental monitoring. Factors of special importance for “human health” as the object to be protected are changes in the environment as an early warning of possible risks to human beings (Risk Commission 2003, p. 29). Environmental monitoring systems are a major source of information for such early warning systems.

631. The fact that man is integrated in the natural environment results in close connections which can be used for assessing ecotoxicological and human toxicological risks, such as information on exposure. The relevant pollutant input paths for humans are air, food and drinking water. In addition, substances in products (e.g. cosmetics) and substances in indoor situations also play a role.

At the level of ministries and higher federal authorities, the Environment and Health Action Programme (APUG) networks the environmental, health and consumer protection policy sectors. Under this programme, several ministries and higher federal authorities are cooperating and promoting research projects and information campaigns. Health-related environmental monitoring determines the pollutant loads to which the public is exposed (load monitoring), and effect monitoring measures the biological parameters that react to these loads or indicate their effects (BADER and LICHTNECKER 2003). Susceptibility monitoring measures modulating properties of certain genes or gene groups on the metabolism and the toxicity of foreign material. Practical health-related environmental monitoring surveys are conducted as part of the environmental surveys and data collection undertaken by the German Environmental Specimen Bank (www.umweltprobenbank.de).

10.4 The road to integrated monitoring

632. A wide variety of diffuse pressures due to substances, climate and structural factors act on nature and the environment. Diffuse pressures due to substances may take the form of accumulation processes, substance transfers and substance interchange between the environmental media, and also indirect impacts. For example, land uses or interference with the water balance give rise to structural changes. In order to identify, analyse and assess environmental changes and their causes, there is therefore a need not only for media-specific assessment of the status of the compartments soil, water and air, but also – and above all – for integrated environmental monitoring and assessment (cf. Section 10.2.4). The overarching goal of integrated environmental monitoring is continuous collection of changes, trends and pressures in the environment as a whole. Not only for the environmental authorities and the chemical industry’s own responsibility (under the REACH Regulation), but also for the interested public, this would permit a feedback loop linking socially established quality standards with up-to-date data from the environment and make it possible to verify compliance.

Integrated environmental monitoring is concerned with impacts on organisms, ecosystems and the functions of the natural regime, and for this purpose it links biological, chemo-physical and other data from various measuring networks. It is therefore important that chemical analyses (exposure/load monitoring) be linked more closely than in the past with biological effect monitoring (AK Umweltmonitoring 2008). To this end there is a need to evaluate the existing instruments and methods with regard to the common departmental objectives.

The primary data of a monitoring programme must not only serve the central purpose of the programme, but must also be capable of aggregation to permit user-specific processing. Linking with other measuring networks or their contents must be possible to the greatest possible extent. It must also be possible to use the primary data in

the search for causal relationships, which means they must be accessible to the public. Innovative objectives include the definition of ecosystem-specific effect thresholds within the meaning of the National Biodiversity Strategy (BMU 2007, Chapter B 3.1), to ensure that ultimately the environmental limits are complied with.

Objectives for substance monitoring at EU level

633. Consistency between enforcement tasks is also a major goal of the European Commission and its scientific bodies (SCHER 2010). The methodological discussions should no longer be separated by enforcement tasks or environmental media, but should in future be geared above all to impact properties. The Scientific Committee on Health and Environmental Risks (SCHER) supports the approach of testing the effects of all hazardous substances on the basis of a harmonised basic scheme and establishing consistency between the existing methodological guidelines. Where specific action mechanisms are involved (especially in the case of pesticides, biocides, medicinal products), uncertainties should be reduced by using targeted refinement steps.

634. At EU level the EEA (2007) recommended developing a harmonised chemical information system. In view of the low detection limits and the possibility of combined effects, chemicals monitoring should be supplemented by biological monitoring with potential toxicity as its end point (op. cit., p. 29).

Germany will not be able to ignore this development. This means there is a need for timely design of and organisational preparations for the development of an integrated monitoring system. The necessary steps are outlined below.

10.4.1 Development of an integrated monitoring system

635. The focus of environmental monitoring in a coordinated network of programmes should be on the following themes, which individually also fulfil their political significance of checking compliance with socially established quality standards:

- developing biodiversity with its three levels (genetic, species and ecosystem level),
- chemicals safety,
- impact of climate change and adaptation measures on biodiversity,
- safety in the use of genetic engineering,
- connection between health and environment.

To this end there is a need for harmonisation and coordination of the environmental monitoring programmes of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) at federal level with other ministries – especially the Federal Ministry of Food, Agriculture and Consumer Protection (BMELV). The basic framework for this should be the

modular introduction of ecological area sampling in all federal Länder.

A structural approach needs to be established for the overall concept and the task of filling data gaps which are due to the media-specific structure and which present obstacles to ecological modelling and evaluation (UBA 2002). The following are essential for integrated monitoring:

- an inventory of environmental monitoring programmes, their measuring networks and their individual methodologies, and also their spatial distribution and representativeness,
- identification of the interfaces, so that the different monitoring concepts can – at least in part – be made capable of integration,
- methodological adaptation and, where appropriate, merging of the environmental monitoring programmes in the federal Länder,
- content-oriented or geographical/spatial addition of missing environmental monitoring programmes or missing individual aspects (e.g. addition of effect monitoring, extension of programmes to include relevant substances or addition of sample areas of missing natural spaces),
- establishment of suitable data management systems (cf. Section 10.4.3.2).

This cross-media and cross-sectoral approach should be organised in an interministerial working group. This presents challenges for all concerned. In particular, it needs their good will to coordinate their own monitoring programmes with others and ensure unrestricted availability of the data (BANDHOLTZ 2004). First of all, the data must be processed and their validity, reliability and plausibility (Table 10-2) demonstrated. This ties up personnel. In some cases it will also be necessary to clarify the situation regarding disclosure of data.

10.4.2 Ecological area sampling as a basic network for monitoring

636. Nationwide introduction of ecological area sampling would be a meaningful step to make it possible to describe the status of biodiversity on a full-coverage and statistically relevant basis in normal countryside as well and indicate the causes of changes (cf. Section 10.3.1). The basic ecological area sampling network already forms the nationwide basis for the indicator “species diversity and landscape quality” (MITSCHKE et al. 2007) and is the basis for monitoring to underpin the HNV farmland indicator (HNV – High Nature Value) (under the EAFRD Regulation). Nationwide expansion of ecological area sampling would also

- provide hitherto non-existent statistically reliable information about biological diversity in normal countryside, such as a picture of biodiversity in farmland, settlements and forests (species composition, spatial and population developments (including

problem species/neophytes)) (KÖNIG et al. 2008; KÖNIG 2008; WERKING-RADTKE et al. 2008),

- make it possible to prepare distribution maps with information about use changes and climate change impacts (SANTORA 2011),
- make it possible to show the effects of agro-environmental and contract-based nature conservation measures (WERKING-RADTKE and KÖNIG 2011),
- make a contribution to reporting requirements under the Habitats Directive (KÖNIG and BOUVRON 2005), and
- provide a basis for a supervisory and case-specific system for monitoring the placing on the market of genetically modified organisms; in the special case of genetically modified organisms it could be supplemented by relevant aspects (FIEBIG 2010).

637. The SRU therefore recommends the nationwide introduction of ecological area sampling as a basis for monitoring the conservation and sustainable use of biological diversity.

10.4.3 Operationalising an integrated monitoring system

638. Monitoring the conservation of the natural basis of life is the responsibility of the public sector. An overarching central organisation that acted as an information and coordination body regulating data collection and use across the various administrative levels would be desirable (cf. Section 10.4.1). This would ensure that divergent data interests – e.g. from the point of view of nature conservation or environmental protection – were evident and coordinated from the outset. The establishment of the Ecological Monitoring Network (NEM) in the Netherlands at the National Bureau of Statistics (Centraal Bureau voor de Statistiek) could be a possible organisation model (SOLDAAT 2011).

The German Federal Statistical Office is already entrusted with preparing the national environmental accounts, which analyse and process the factors energy, raw materials, emissions, land use, environmental indicators and environmental measures. Moreover, every two years the Federal Statistical Office prepares the indicator report on the sustainability strategy (Statistisches Bundesamt 2011). This supports the German government's sustainability strategy. Organisational attachment of an integrated monitoring system to the Federal Statistical Office would also make sense in view of the European Commission's plans for a regulatory framework for the ecosystem services to be covered by the national environmental accounts (cf. para. 549). The Federal Statistical Office with its proven experience in the field of data preparation is thus a suitable neutral "broker" for information. At the same time its long-standing publication service ensures the provision of high-quality information to the public.

639. These steps will not be possible without institutionalisation. As long ago as 1991 the SRU (1991,

para. 109) suggested that environmental monitoring be institutionalised as has long been common practice in the field of national economics. At that time it was proposed that the federal and Länder authorities should make additional personnel available. In the end, reorganising environmental monitoring would probably make it possible to save costs.

10.4.3.1 Improving cooperation

640. There is an urgent need for better coordination of the existing approaches and instruments. Environmental administration bodies at federal and Land level and in the sectorally structured administration departments have to perform complex tasks in the fields of planning, assessment and balancing of interests. To ensure integrated environmental protection, each environmental administration body should possess cross-media assessment competence and be able to organise adequate coordination of workflows extending beyond its own department. In particular, the conservation approach based on environmental quality objectives involves necessary requirements regarding environmental monitoring, evaluation and reporting (SRU 2007, Chapter 1.2). Furthermore, German constitutional law and European and international law require the environmental administration to display more openness and move towards increasing public participation in environmentally relevant administrative procedures.

641. It is difficult to operationalise the integration objectives of integrated environmental monitoring in existing routines, because environmental law is fragmented, conflicts of objectives are not transparent, and many substance-specific requirements exist in parallel (Table 10-1). This problem was identified at political level in the mid 1990s (Bundestag committee of inquiry into "Protection of Man and the Environment" – objectives and framework conditions for sustainable future-oriented development 1998) and continues to impede efficient enforcement and an effective policy on substances. Regulatory assessment methods, instruments and criteria for progress review have been developed on a problem-specific basis (Risikokommission 2003).

For this reason both environmental legislation and the assessment methods are dominated by an additive approach and requirements to balance interests. Giving precedence to a protection objective or a legal act is hardly enforceable, whether from a political or legal point of view. Neither is it possible to do without balancing interests in individual cases. On the other hand the European Commission is striving for a decidedly decentralised integration policy, by systematically raising the requirements for sectoral policies to take account of each other. Here, checks on implementation are largely the responsibility of the Member States, where they encounter the established monitoring routines. In view of the complex protection objectives this strategy of decentralised integration policy makes sense, but there is a danger of its "fizzling out" in "organised non-responsibility" rather than leading to efficient measures.

642. It is the intention of the European Commission that methodological discussions should no longer be separated by enforcement tasks or environmental media, but should in future be based primarily on impact properties (SCHER 2010; cf. para. 633). Thus the issue of integration and consistency of conservation objectives and requirements (e.g. application of pesticides and conservation of biodiversity as a protected asset) arises not only at legal level, but also in administrative enforcement. For pragmatic reasons alone, a progress review system should not be built up afresh, but should as far as possible be integrated in the existing monitoring programmes.

For example, all federal Länder are already using the data from the WFD for assessing most Habitats Directive fish species for the purpose of Habitats Directive monitoring. Monitoring of frequent Habitats Directive forest habitat types is covered by the Federal Forest Inventory. And the relationship between the occurrence of land identified by the HNV farmland indicator and the framework of agro-environmental measures is being examined by the Federal Office for Nature Conservation under an R+D project. Integrated enforcement should be tested from a content point of view. There is a need for research and action in this field and with regard to the integration of research findings in environmental monitoring routines.

Projects on ubiquitous pollutants are already being tested in coordination between administrative departments. For instance, the cooperation between BfN and UBA regarding nitrogen monitoring in relation to the habitat types of the Natura 2000 areas is being expanded further. By contrast, the moss monitoring system that made it possible to record atmospheric exposure of German Natura 2000 areas to heavy metals and nitrogen, was discontinued in 2009 (SCHRÖDER et al. 2010; KRATZ and SCHRÖDER 2009) and should, in the opinion of the SRU, be reactivated.

Chemicals monitoring, among other things, is correlated with other biological and economic data in the context of long-term soil monitoring by the Länder (TLL 2006) and the Federal Forest Inventory. The national forestry environmental monitoring system (Level I of ICP Forests (forest soil condition surveys, forest condition surveys), Level II of ICP Forests (intensive long-term monitoring)) could be taken as a model for agriculture and nature conservation as well with regard to its organisation as a cooperative federal and Länder monitoring system (BOLTE et al. 2008; 2007; SEIDLING et al. 2002; SPLETT and INTEMANN 1994).

10.4.3.2 Data sharing and use:

Stepping up the flow of information

643. It is basically an essential requirement for effective monitoring – especially where this links a number of individual programmes – that the flow of information be improved. To this end, more overarching databases should be established and data transfers facilitated. Agreements between the federal and Länder level are not sufficient here – it is essential to integrate the European level as well.

To make it possible to avoid duplication of work, evaluate data and make data usable in measures, there is a need to improve the sharing and use of data within the public sector. The integrated data analysis necessary for this purpose requires the merging of data: both different types of data and data from different sources. This makes it necessary to specify concrete requirements for quality management in data acquisition, which are also a prerequisite for derived criteria for quality standards (KNETSCH 2011a). It is therefore necessary to draw up binding rules for organisation, methods and technology (Table 10-2).

Table 10-2

Necessary rules for integration-oriented data analysis

Organisational rules
<ul style="list-style-type: none"> – relate to reproducible and verifiable process stages in data acquisition and the clear responsibility of the data owner, – comprise information on validity, reliability and reproducibility of the data, – include documentation of unusual features in the context of the data item.
Methodological rules
<ul style="list-style-type: none"> – relate to the validity of sample planning and measuring network design, sampling, and processing of data for the purpose of the study, – comprise quality assurance management of the analyses, – include the methods used for statistical processing and evaluation of the data.
Technical rules
<ul style="list-style-type: none"> – relate to technical transmission of the data in accordance with specified organisational rules, – comprise compliance with technical standards and data formats, – include the interoperability of environmental data in a different context (semantic data record).
Source: KNETSCH 2011a, p. 7, modified

644. Furthermore, by providing access to data it would be possible to involve scientific circles and the interested public in data evaluation and the initiation of measures. For this reason there should basically be free access to data between public authorities, and also in relation to the public. If restrictions are imposed, e.g. as a result of confidentiality requirements or the need for clear assignment of responsibilities, they should take account of the importance of information for governmental and social decision processes (RICHTER 2003, p. 199 ff.).

645. One viable approach is offered by the INSPIRE Directive 2007/2/EC, with the aid of which a geodata infrastructure is to be created within the EU. The directive requires available data to be processed appropriately and made available via portals, which means it will acquire great importance for environmental monitoring as well. There are certain overlaps with the Environmental Information Directive 2003/4/EC, under which authorities are required to make environmental information available to the public. For this the applicants have to pay a fee – except where the registers or lists are public in any case; but they do not have to show that they have a legitimate interest. There is a need to continue thinking along these lines and to look for technical and legal ways and means of sharing information between public authorities, and also with the public.

646. With regard to information and data on substances, it is first necessary to bring together the substance-specific data as envisaged in the REACH Regulation and make it possible to use the data for chemicals management. Not only access to the data should be regulated, but also the conditions for using the data. While the authorities that perform the task of substance evaluation within the REACH Regulation have extensive rights of access to this database, monitoring authorities and sectoral management authorities (e.g. industrial permitting authorities) only have access to the REACH information portal (RIPE (Réseaux IP Européens): www.ripe.net) or have to rely on administrative assistance (HEIB 2011, p. 343; FÜHR 2011, p. 246). This impedes speedy access to the database and its effective use for chemicals management. All existing substance data should be entered in a European database, and the authorities concerned should be provided with the necessary access (SCHMOLKE 2011, p. 548). Some preliminary work on this has already been done, e.g. merging of databases with information on chemicals in the freely accessible portal “Substance databases of the Federal Republic of Germany” (www.stoffdaten-deutschland.de). This application permits access to national substance databases.

10.4.3.4 First steps in organisational implementation

647. From an organisational point of view, environmental monitoring should be structured as a growing network, transparent and available to the public (Internet availability). At present there is no long-standing technical, documentary and operational form of organisation for an integration-oriented overview of environmental monitoring information, whether existing

or in the process of creation. The preconditions do however exist (BANDHOLTZ 2004). There are large quantities of data, but their disclosure is significantly impeded by uncertainties about the legal situation and the necessary quality stages (op. cit., p. 127). In addition to the environmental monitoring programmes, an “integration layer” should ensure that data generated under legislation on substances can be linked (BANDHOLTZ 2004): for example the use of REACH data to identify the substances to be monitored. Internet availability is a matter of course today and also makes the data available to the public.

There is also a need for GIS-based spatial allocation. Examples exist at three levels of spatial specification. At the land use level, the CORINE data can be used. For area-specific information, especially on agricultural land, it would be logical to use InVeKos (integrated administration and control system, introduced in the implementation of the Common Agricultural Policy), an electronic system that is already available to the agricultural sector for internal documentation and evaluation of the European Agricultural Fund for Rural Development (EAFRD) at authority level. The German Pollutant Release and Transfer Register (PRTR) works accurately at the level of individual addresses (UBA 2011).

648. There is a need to investigate whether key substantive and organisational aspects of integrated monitoring can be made subject to standardised nationwide regulations after the revision of the federal nature conservation legislation with the aid of Section 6 of the Federal Nature Conservation Act “Environmental Monitoring” (cf. Section 10.4.4). The necessary cooperation between authorities and ministries should be specified in concrete form and safeguarded by administrative agreements.

10.4.4 Laying down uniform nationwide monitoring standards

649. To ensure comparability of the data collected and ease of adaptation to European requirements, it is necessary to lay down uniform nationwide monitoring standards. This should be done under existing nature conservation law, which according to Section 1 subsection 1 of the Federal Nature Conservation Act aims at safeguarding not only biodiversity in the long term, but also the performance and functional capacity of the natural regime as a whole, and therefore pursues a comprehensive approach.

The reform of the federal system reallocated competencies in the field of environmental legislation. The intention was to put the federal government in a position to completely regulate the field of nature conservation and to ensure uniform transposition and implementation of EU legislation (Deutscher Bundestag 2006, p. 7 ff.). Accordingly, the framework legislative competence was relinquished. In the field of nature conservation and landscape maintenance the federal government now possesses – as for other fields of

environmental law – concurrent legislative powers (Article 74 paragraph 1 no. 29 Basic Law ; Article 72 paragraph 1 Basic Law). Although the federal Länder can basically make divergent rules, rules that cannot be diverged from include not only the law of species conservation and marine protection, but also above all the fundamental principles of nature conservation (Article 72 paragraph 3 no. 2 Basic Law). The literature contains much discussion of how they are to be interpreted, but the Federal Constitutional Court (BVerfG) has not yet made any pronouncement on this topic. It is generally assumed that environmental monitoring belongs to the general principles of nature conservation, since it is only on this basis that a nationwide concept can be implemented (HENDRISCHKE 2007, p. 456; SCHULZE-FIELITZ 2007, p. 257; FISCHER-HÜFTLE 2007, p. 83; DEGENHART 2010, p. 429). Such a concept not only presupposes monitoring programmes in the individual Länder, but also requires a certain measure of comparability. It is thus in the joint interests of both the federal government and the Länder to agree on certain minimum requirements and structures and to set them down in writing. In the revision of the Federal Nature Conservation Act the legislature itself also worked on the basis that environmental monitoring was a general principle and referred to it as such in the Act. Accordingly, it is possible to embody in nature conservation law uniform nationwide monitoring standards from which the Länder cannot diverge.

It is doubtful whether this also covers chemicals monitoring. According to the narrative to the Act, the change in wording from monitoring of the “natural regime” (Section 12 Federal Nature Conservation Act, old version) to monitoring of “nature and landscape” (Section 6 Federal Nature Conservation Act) is intended to make a corresponding restriction in the subject of the monitoring (Deutscher Bundestag 2009). It is questionable whether this is intended as a departure from monitoring in the form of the extensively defined “natural regime” (KOCH and KROHN 2008, p. 31 f.). Some authors assume that no restriction has been made here (SCHUMACHER/SCHUMACHER in: SCHUMACHER/FISCHER-HÜFTLE 2010, Section 6 marginal note 9). At least chemicals monitoring continues to be encompassed by the monitoring of nature and landscape, since Section 6 subsection 2 of the Federal Nature Conservation Act requires that monitoring covers not only changes in the status of nature and landscape, but also their causes. As a result, it is possible to lay down valid nationwide standards for monitoring – including chemicals monitoring – on the basis of nature conservation law.

10.4.5 Financing an integrated monitoring system

650. Especially with regard to substance monitoring, there are various starting points for involving the chemical industry in its financing. These, however, are limited as regards not only the substances monitored, but also their impacts. Establishing and maintaining an integrated monitoring programme makes it necessary to provide additional financial resources, and especially

personnel. Although this initially gives rise to additional costs, these can be saved elsewhere – if the availability of extra information permits better targeted measures (European Commission 2012). The “polluter pays” principle in environmental law basically makes it possible to charge the costs of prevention, disposal and compensation of environmental pollution to those who caused them (for the “polluter pays” principle, cf. KLOEPFER 2004, p. 189 ff.). The financing of integrated environmental monitoring should also be fundamentally based on the polluter pays principle.

If the aim is to design a wide-ranging overall concept that seeks to identify the impacts on biodiversity, the “polluter pays” principle reaches its limits where the data collected by the monitoring programme cannot be traced back to environmental pollution by clearly identifiable polluters. In that case the costs would have to be financed via the state budget – and hence by the federal and Länder authorities – in accordance with the principle of burden sharing. This does not, however, rule out the possibility of allocating the cost of acquiring specific data in accordance with the “polluter pays” principle.

651. Especially with regard to substance monitoring, there are various starting points for involving the chemical industry in its financing.

Starting points within the REACH Regulation:

- The ECHA is financed partly through registration fees. If monitoring is added to the list of ECHA’s tasks, the fees could be used for monitoring as well. This approach runs into various problems, however. First of all, the fees are incurred on a one-off basis on registration or updating. As only newly produced chemicals will have to be registered from 2018 onwards, the ECHA is in any case headed for a funding shortfall. Admittedly there are hopes that sufficient funds will then be generated in the form of authorisation fees. However, in view of the small number of substances expected to require authorisation by then, there are great doubts as to whether this will be successful. The ECHA and its tasks will then have to be financed by increasing resources from the EU budget in any case.
- In the context of substance evaluation, the evaluation authorities can demand additional data. Here – as in the existing substances programme – the authorities could lay down a monitoring requirement. One problem here, however, is that the monitoring only applies to outstanding questions in the evaluation of individual substances.
- When an authorisation is granted, the conditions include monitoring of the authorised substances during the authorisation period or even beyond it. The problem here is that the monitoring only applies to the authorised uses or substances. It is difficult to initiate a nationwide integrated monitoring system.

Other starting points:

- One possibility is to enact a Monitoring Ordinance under which financial obligations could be imposed on the chemical industry. However, where the monitoring programmes also relate to substances that are no longer made or used, the starting point for financial participation is dubious. In particular, retrospective financial obligations on the manufacturers must presumably be ruled out.
- It is possible to levy a chemical charge in the sense of a special levy which addresses the chemical industry's financial responsibility. This revenue would not go into the general state budget, but would be used for financing the task of chemicals monitoring (regarding special levies, cf. KIRCHHOFF 2007, marginal note 69 ff.). Here too, however, it is doubtful whether the monitoring of substances that are no longer made or used could be financed via this charge.

652. In other fields too it is basically possible to charge the costs of monitoring to polluters or even entrust them with the task itself (e.g. agro-genetic engineering). Nevertheless, comprehensive biodiversity monitoring will have to be financed by the state. But monitoring is also in the interests of the state in that the latter can use the results to discharge its reporting obligations to the European Union or to evaluate the measures it has taken.

10.5 Summary and Recommendations

Importance of monitoring for environmental policy

653. Nature and environment form the basis for sustainable development. Information about their status is a prerequisite for conservation measures. The concept of strong sustainability calls for long-term conservation and sparing use of the natural basis of life. The three principal tasks of environmental monitoring – analysing environmental status, identifying and assessing risks at an early stage, and reviewing the progress of environmental and nature conservation measures and sustainability policy objectives – are therefore a fundamental basis for decisions in politics and administration. Solutions must be backed up by concrete data for concrete decisions.

Risk standards laid down by society, such as limit values in substance regulation or protection of the environment in the cultivation of genetically modified plants, must be verifiable. Compliance with these standards should therefore be verified by an integrated monitoring system. This is particularly important in view of the fact that the loss of extinct genetic sequences or even species is irreversible.

Because of the considerable time-lag between identification and elimination of the causes of biodiversity loss, there is a need to take early action in the interests of resource conservation and risk precautions. Against this background it is necessary to draw up an overall concept that can also show the status of biological diversity itself.

Fragmented monitoring as a problem

654. Basing monitoring programmes on media-oriented environmental legislation has resulted in sectoral surveys and measuring networks (monitoring of water, air, soil, surveys of species and structures). This applies to both national and European environmental monitoring programmes. The reason has been, and continues to be, verification of the effects of the individual legal provisions.

Environmental monitoring in Germany and Europe is therefore characterised by a large number of measuring networks, which are run separately on the basis of environmental media and administrative competencies. This frequently give rise to coordination problems across departmental and Länder or national boundaries and inconsistencies between the existing data. In particular, there is a lack of harmonised minimum requirements for checking progress towards the substance-specific individual objectives. And the situation regarding availability of the data or rights of access to the data is often unclear.

The aim must therefore be to network and if necessary harmonise these concepts, not only in terms of content, but also as regards their assessment facilities and public access. For pragmatic reasons alone, a progress review system should not be built up afresh, but should as far as possible be integrated in the existing monitoring programmes.

Registering the multifactorial pressures on biological diversity

655. Since the conservation and use of biological diversity have to be safeguarded on a sustainable basis, protected areas and normal countryside (farmland and forestry land, water bodies, settlements) need to be continuously monitored. The objectives of nature conservation apply to the entire land area. Even in "normal countryside" one finds protected species which react to the land use itself and to the substances used and/or the possible impacts of genetically modified organisms.

The status of biological diversity is influenced by multifactorial environmental pressures. As well as the impacts of land uses and changes in land use, there are three main environmental factors:

- substances from diffuse sources that cause chronic pressures;
- climate change, which results in shifts in the geographical range of species
- the impacts of genetically modified organisms on their environment.

In other words, these are chemical, physical and biological stress factors which individually and in combination cause complex impacts and systemic risks and cannot be controlled by measures confined to selected points. These multifactorial pressures on biodiversity are reflected by multiple competencies in the administration.

In future, cooperation and coordination between administrative departments should be strengthened and promoted.

Integrated monitoring

656. In order to identify, analyse and assess environmental changes and their causes, there is therefore a need not only for media-specific assessment of the status of the compartments soil, water and air and biological diversity, but also – and above all – for integrated environmental monitoring. In order to stop the tendency for pollutants to accumulate above a critical threshold, it is necessary to identify the environmental impacts of area-wide diffuse substance discharges and to assess the relevant exposure as a basis for scientific risk assessment (hazard + exposure) and decisions on risk management measures.

657. The environmental impacts of chemicals are increasingly being identified and evaluated using internationally harmonised methods. Consistency between enforcement tasks is also a major goal of the European Commission and its scientific bodies. The methodological discussions should no longer be separated by enforcement tasks or environmental media, but should in future be geared above all to impact properties. The result is the provision of action-oriented information on use and asset-specific guide values that can be compared with environmental data and thus permit systematic progress review. Germany will not be able to ignore this development. This means there is a need for timely design of and organisational preparations for the development of an integrated monitoring system.

658. Under the REACH Regulation there are valuable opportunities here for substance-specific information, but these are not being used. On the other hand the REACH Regulation itself is incomplete from the point of view of integrated monitoring. For example, an exposure estimate by the manufacturer is only required if the substances are hazardous within the meaning of the CLP Regulation or if they satisfy the criteria of a PBT or vPvB substance and are produced in quantities exceeding 10 t per annum. The exposure estimates are based on modelling and do not take any account of combined effects with other substances or additional loads due to other manufacturers. Their exposure paths in the environment are not always fully identified.

659. The more substance-specific risk information is available, the more urgent is the need for a concept for integrating the information in the relevant legislation. At present there is a lack of suitable methods and structures for this horizontal interchange of information. Without suitable technical and organisational requirements and measuring networks, it also remains impossible to verify the National Strategy on Biodiversity's objective of reducing area-wide diffuse substance discharges and their impacts on biological diversity. At the same time the sectoral legislation on chemicals regulation requires relevant data on possible impacts on biological end points.

Nationwide introduction of ecological area sampling

660. Full-coverage information on the status of biodiversity in the various land use types (at the three levels of biodiversity: ecosystems and habitats, species and communities, genomes and genes) is not possible at present. Integrated monitoring must therefore be combined with a nationwide ecological area sampling network, to permit the establishment of a statistically relevant relationship between the data to be collected in the field of biodiversity monitoring and the data collected on chemicals and/or the possible impacts of genetic engineering. Nationwide introduction of ecological area sampling can also reveal impacts of land use and climate change on biological diversity and make a contribution to reporting requirements under the Habitats Directive and the EAFRD Regulation. In parts, the basic ecological area sampling network already forms the nationwide basis for data collection for the indicator "species diversity and landscape quality" and for nationwide monitoring to underpin the HNV farmland indicator. The SRU therefore recommends expanding this partial network to effect the nationwide introduction of ecological area sampling as a basis for monitoring the conservation and use of biological diversity.

Institutionalising integrated monitoring

661. The steps involved in implementing an integrated environmental monitoring system will not be possible without institutionalisation. However, reorganising environmental monitoring would probably make it possible to save costs. The SRU therefore proposes an institutional link with the Federal Statistical Office. This would ensure that divergent data interests – e.g. from the point of view of nature conservation or environmental protection – were evident and coordinated from the outset. Another argument in favour of such a connection is that the Federal Statistical Office helped to develop the concept for ecological area sampling, and that it is already entrusted with the task of preparing the environmental economic accounts and publishing the indicator reports for the National Sustainability Strategy. An organisational link would also make sense here in view of the future acquisition of data on ecosystem services.

At official level, environmental administration bodies have to perform complex tasks in the field of planning, assessment and balancing of interests. To ensure integrated environmental protection, each environmental administration body should possess cross-media assessment competence and be able to organise adequate coordination of workflows extending beyond its own department.

Laying down uniform nationwide monitoring standards

662. To ensure comparability of the data collected and ease of adaptation to European requirements, it is necessary to lay down uniform nationwide monitoring standards. This should be done under existing nature

conservation law, which according to Section 1 subsection 1 of the Federal Nature Conservation Act aims at safeguarding not only biodiversity in the long term, but also the performance and functional capacity of the natural regime as a whole, and therefore pursues a comprehensive approach. In the field of nature conservation and landscape maintenance the federal government now has – as for other fields of environmental law – concurrent legislative powers. As a result, it is possible to lay down valid nationwide standards for monitoring – including chemicals monitoring – on the basis of nature conservation law.

Financing

663. The “polluter pays” principle in environmental law basically makes it possible to charge the costs of prevention, disposal and compensation of environmental pollution to those who caused them. The financing of integrated environmental monitoring should also be fundamentally based on the “polluter pays” principle. In

accordance with the “polluter pays” principle, any costs arising, especially for the monitoring of chemicals and genetic engineering, should be charged to industry, which is ultimately dependent on these data under recent environmental legislation. Where costs cannot be charged on the “polluter pays” principle, the costs would have to be funded from the state budget.

Public access to data

664. From an organisational point of view, environmental monitoring should be structured as a growing network, transparent and available to the public (Internet availability). Access to data should basically be unrestricted, and confidentiality should only be permitted in exceptional cases. By providing access to data it would be possible to involve scientific circles and the interested public in data evaluation and the initiation of measures. Furthermore, transparency in environmental policy raises its credibility.

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