



Federal Ministry
of Education
and Research

Research for Sustainability

**Framework programme of the German Federal Ministry of
Education and Research (BMBF) for a sustainable, innovative society**



RESEARCH

Published by

Bundesministerium
für Bildung und Forschung/
Federal Ministry of Education and Science (BMBF)
Public Relations Division
11055 Berlin

Orders

In writing to the publisher
Postfach 30 02 35
53182 Bonn

or by

Phone: +49 (0) 1805 - 262 302
Fax: +49 (0) 1805 - 262 303
(0.12 Euro/min. from the German fixed network)

E-Mail: books@bmbf.bund.de
Internet: <http://www.bmbf.de>

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Division 721: Basic Policy Issues: Cultural Science, Sustainability, Environmental Law

Layout

ecosense – media & communication

Photo credits

ecosense – media & communication

Bonn, Berlin 2005 (Modified reprint 2006)

Printed on recycled paper

for further information

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The concept of sustainable development is becoming an increasingly important competitive factor in the industrial sector. The economic success and social

acceptance of new products and processes demand improved resource efficiency and the avoidance of environmental impacts whether it be in the field of health, agriculture, forestry, production, in the distribution and use of goods, in the transport sector or in the production and use of energy. It was not just by chance that Germany was world leader in exports of environmental protection goods in 2003 with an 18.8% share of the world market, followed by the United States with 18.4% and Japan with 10.1%. In 2004, Germany produced goods worth 55 billion euro to protect the environment and the climate. This represented 5.1% of overall industrial production. And in 2003, a total of 3.3% of Germany's overall R&D expenditure was in the field of environmental protection. This shows that German expenditure in this sector is well above the OECD and EU average. The global dimension of environmental planning, technical development and markets demands increased preparedness to accept global responsibility.

This is the aim of the Federal Government's current "High-Tech Strategy": By the year 2020, Germany is to become a country with the most renowned institutions of higher education and with the best trained young people; a country where the technologies of the future are developed and the spirit of invention guarantees health and safety. Progress in the field of know-how, the early evaluation of acquired knowledge and economic success are closely linked with the ethical aspects of protecting human life and with questions of consumer safety or the preservation of our natural environment.

The BMBF's "Research for Sustainability" framework programme provides a fundamental contribution to achieving these goals. It involves societal actors in project design and implementation from an early stage. The interlinking of technological progress with societal processes increases the acceptance of innovations and assists their introduction in education systems.

The framework programme focuses on the four fields of action of sustainability in trade and industry, sustainable concepts for regions, the sustainable use of resources and a strategy for societal action. It is designed as a "learning programme" under which projects and measures can constantly be adapted in line with new findings.

The success of the framework programme to date is reflected among other things by the fact that 70% of the partners involved in projects in the field of "key innovations" are commercial com-

panies. Two thirds of these are small and medium-sized enterprises. The programme's international approach is intended to strengthen synergies in the European and international research areas.

The fact that the programme's brochure has now had to be reprinted after such a short time is a further expression of the keen interest in "Research for Sustainability". I am confident that this interest will remain strong in future.

A handwritten signature in black ink, appearing to read "F. Meyer-Krahmer".

Professor Dr. Frieder Meyer-Krahmer
State Secretary at the BMBF

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A. Current situation



The environmental research supported by the Federal Ministry of Education and Research (BMBF) initially developed methods and techniques for recording and reducing pollution. The objective of the technologically oriented strategy was to provide for constant further development of the state of the art of environmental protection technology. The focus of research funding shifted from end-of-pipe technology to preventive and avoidance solutions and increasingly to causal research and environmental system research.

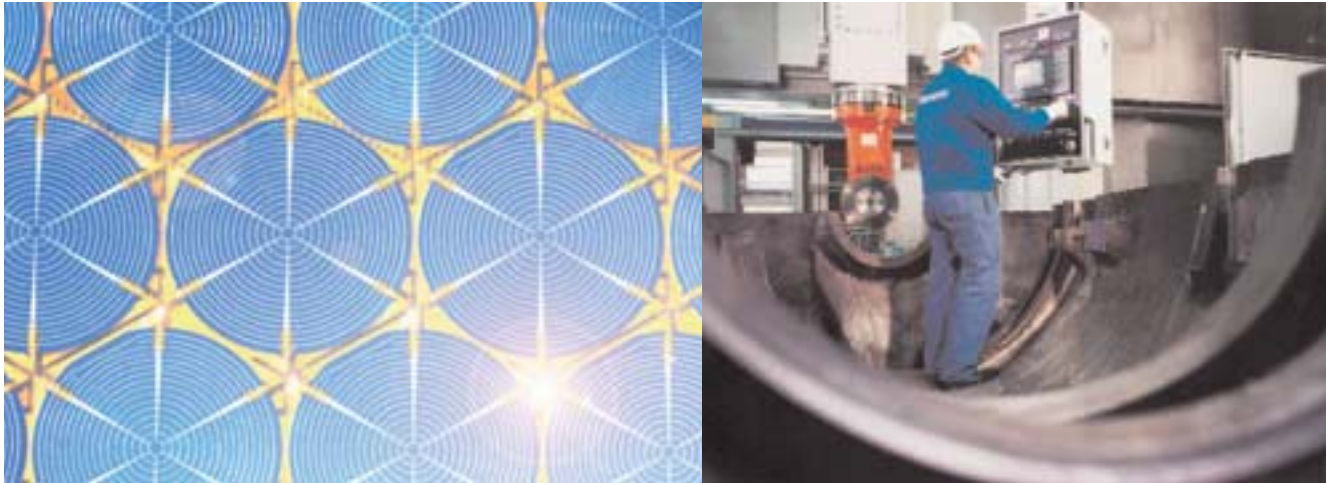
The action plan adopted within the framework of the 2002 world summit in Johannesburg, the European strategy for sustainable development of Göteborg and the national sustainability strategy have set ambitious goals for the realization of the guiding principle of sustainable development. Education and research are the core elements at all three levels. The objective of the BMBF is to promote sustainable economic systems and lifestyles in a comprehensible and scientifically sound manner and to gain the support of the society in this endeavour. The BMBF wants to meet the requirements of the target triangle (society, economy and nature) developed in Rio de Janeiro – with contributions to the long-term benefit of all subgoals, to the supporting conditional framework and to any necessary equalization between the subgoals. Here it places its focus on action-oriented opportunities and, wherever possible, on the measurable potential of sustainable processes and products.

The national sustainability strategy outlines a guiding principle with four concise goals and, at the same time, four touchstones: generational equity, quality of life, social harmony and international responsibility. The research approach selected by

the BMBF can provide specific research and implementation contributions to the majority of the goals of the sustainability strategy in one or more of the four fields of action indicated below: for specialized goals, such as enhancing energy and resource productivity, for climate protection, reduction of land use, preservation of local and global species diversity, improvement in the quality of environmental resources, including air quality; in connection with provision for the future and securing material prosperity, development of activating prospects for the elderly in society, integration of fellow citizens from abroad and intensively in connection with cross-sectional requirements, such as transfer and education for sustainability and promotion of the innovative capacity of the German economy.

Sustainability research with its system-based approach is typically set up on a crossfield, interdisciplinary and interdepartmental basis and is designed to support several fields of activity and policy. The BMBF will coordinate the goals and support guidelines of the announcements that implement this framework programme in project support with the respective ministries concerned – in particular the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU), the Federal Ministry for Consumer Protection, Food and Agriculture (BMVEL), the Federal Ministry for Transport, Building and Housing (BMVBW), the Federal Ministry for Health and Social Security (BMGS), the Federal Ministry for Family Affairs, Senior Citizens, Women and Youth (BMFSFJ) and the Federal Ministry for Economics and Labour (BMWA) – while going beyond the usual process of research coordination prior to the approval of individual projects.

B. Sustainability as an economic and innovation factor



The qualified engineer who develops thermal insulation techniques for old buildings, the management expert who works at a rating agency for environmentally oriented financial investments, the farmer who joins others to form a marketing association for organic vegetables – they all owe their jobs to the fact that sustainability is increasingly developing into a major economic factor. However, many of these employment effects are not recorded because sustainability as a cross-sectional approach is not a separate statistical category. By contrast, the domain encompassing the environmental protection industry and environmental technologies is well documented and is at the same time a heavyweight with respect to long-term support activities of the BMBF and a major innovation sector.

According to a current study of the Federal Environmental Agency of Germany, nearly 1.5 million people were employed in the environmental protection sector in 2002, i.e. 3.8% of all employed persons and thus more jobs than in mechanical engineering, automobile production or the food industry. While the trend for classical environmental protection investments, such as waste disposal and air pollution control, is declining somewhat, sectors like renewable energy and environmentally oriented services are making significant advances. Even if one takes into account the loss of poorly qualified jobs (such as end-of-pipe tasks eliminated due to integrated environmental protection), the **employment effect is positive**. Furthermore, innovative processes trigger a substantial **qualification boost**, which in turn stabilizes employment. According to the report entitled 'Studies on the German innovation system 2/2003 – innovation indicators for the environmental industry', Germany exported potential environmentally protective goods having a value of around 24 thousand million euros in the year 2000, approx. 5% of the exports of industrial goods. Germany (16%) is the second largest exporter in the environmental protection market, inbetween the USA (23.5%)

and Japan (12.5%); this is also in line with the report of the Bundestag Committee on Technology Assessment entitled 'Consequences of environmental and resource protection for education, training and employment' of 13 June 2002 (Bundestag Drucksache 14/9459, p. 12).

According to the quoted study on the innovation system, the vast majority of the production potential for environmentally protective goods (approx. 80%) is concentrated in **research and know-how intensive industrial sectors** – with an estimated national production figure of 41 thousand million euros in 2001. The dynamics of the environmental protection sector and its position, which should be expanded further as far as possible, are reflected in the patent statistics, in which Germany ranks internationally at the top of the list with respect to environmentally relevant patents according to concurring analyses of the German Patent Office (DPA), the International Statistical Institute (ISI) and the Institute for Economic Research (Ifo). In the last 10 years the number of relevant patent applications has quadrupled and currently German companies alone account for 50% of the applications related to environmental protection at the European Patent Office. The patent analysis of the quoted study, 'Innovation indicators for the environmental industry', confirms that the good world trade position is based to a decisive degree on technological advantages and is intensively ensured through patent protection, though other countries are increasingly involved in this field. The national competence thus pays off, but it must be further strengthened in a framework of ongoing innovation dynamics through targeted research.

C. Education and research – a motor for sustainability



Sustainable development is characterized by three basic principles, each of which by itself, and in particular integratively, is supported through the competence of science and research:

- the principle of generational responsibility, which is aimed at protecting the concerns of the following generations and requires reliable forecasts,
- the principle of integration so that system-wide social, economic and ecological goals can be linked, and
- the principle of participation, which is targeted at strengthening the personal responsibility of the relevant actors – industry / SMEs, research, social groups and individual citizens – in the development and implementation of sustainability strategies.

By expanding basic know-how, the BMBF wants to improve the preconditions for innovations, establish them in society and thus contribute to sustainable use. This means that both orientation and action-taking know-how are necessary: orientation know-how to identify non-sustainable developments and risks, and action-taking know-how to be able to make life and economic development viable. This also includes the knowledge of how to integrate the various target dimensions of sustainability into the problem-solving strategies. Sustainability requires looking beyond one's own field, group, region and generation and being able to set up models, make forecasts, carry out simulation, abstraction and documentation, i.e. systematic research. An approach via science and research as a rational strategy can avoid errors in implementation, accelerate social integration and make

use of cross-field and intersectoral know-how for this purpose. A dual benefit results from the involvement of the small and medium-sized enterprises (SMEs) that are strongly represented in the field of environmental technology: the concrete application of sustainable processes is implemented and assessed at an early stage, and the research capacities of SMEs are strategically strengthened through impulses from the cooperating scientific community.

The German Bundestag has constantly underlined the strategic importance of education and research, such as in the motion for resolution "Research policy for shaping the industrial society in a sustainable manner" (BT 13/6855), which was adopted by mutual agreement, and in the recommended resolution and report of the Committee for Education, Research and Technology Assessment "Education for sustainable development" (BT 14/3319). The report of the Office for Technology Assessment at the German Bundestag on "Research and technology policy for sustainable development" (BT 14/571), the parliamentary question on education and research policy for sustainable development (BT 14/6022) as well as the reply of the German Federal Government (BT 14/6959) have accentuated and specified necessary contributions of education and research to sustainable development.

D. Outline of goals, focal points and the initial implementation phase



The BMBF has consistently developed sustainability support into a systemically oriented innovation strategy. Through interdisciplinary and transdisciplinary research the BMBF couples technological advances with organizational and social processes, fosters transfer into the education systems and thus creates optimal opportunities for the application of sustainable innovations. New structures and tools are necessary for this orientation of the framework programme (for details see section H.):

- the public meetings of the BMBF Sustainability Forum,
- specific indicators and milestones in the individual announcements below the framework programme that prepare the interfaces necessary for an evaluation,
- supporting process for implementation of all results and information relevant for action (work results from the framework programme, announcements and projects; data on actors and networking measures) in the education system, particularly in measures for vocational training.

The programme focuses the broad-based sustainability target on four fields that promise significant potential in strengthening the ecological, economic and social sustainability goals of the national sustainability strategy. The activities are aimed at

1. creating concepts for more sustainability in industry and business; they are to gear value chains and production systems to more sustainability through development and use of new technologies, processes, product and service strategies and at the same time secure the competitiveness of the German economy;
2. developing sustainable use concepts for regions, and at the same time shape the use of our living space such that our quality of life is improved and its natural, social and economic bases are stabilized on a long-term basis;
3. providing concepts for sustainable use of natural resources so as

to manage natural resources like water and biodiversity such that they are available on a long-term basis and disaster situations are avoided or can be managed;

4. developing strategies for social action geared to sustainability with the aim of meeting basic needs while minimizing the risks for the long-term stability of nature and society.

The initial implementation phase starts up in 2005. The grants designated for this purpose in the following are target figures according to the present situation. They are subject to further updating within the framework of budgeting and budget implementation. Here is an outline of the four fields of action (for details see section E):

Field of action 1: Concepts for sustainability in industry and business

Fields of need and corresponding value chains (see page 16)

The BMBF wants to identify sustainable ways of meeting the relevant needs of humanity. In this process the value chains that are primarily involved in satisfying needs are analyzed and the potential “levers” that enable innovation leaps towards sustainability are identified. The objective of research is to develop concepts that gear the structural transformation to sustainability. The starting point will be the field of needs related to nourishment with value chains in the food industry and agriculture as well as the field of needs related to communication with value chains in the electronics and the information and communication industry. During this process the BMBF can make use of the roadmap for sustainability in the information and communication industry.

On the basis of results from ongoing funding for the conditional framework for sustainable development, furthermore, specific recommendations for action must be developed in order to implement a shaping policy that also assess the lead-market potential of sustainability innovations.

Production systems close to resources (see page 18)

Access to resources will open up options for action at the top end of value chains and/or in fields of needs. High gains in sustainability can be expected especially in production sectors in which different sustainability demands come together, such as the multi-functional forestry / timber sector, with supplementary commitments to the preservation of biodiversity, climate protection and protection of drinking water resources. The BMBF has allocated 20 million euros for the announcement of government funding “Sustainable Forestry” of April 2004. This field of action additionally includes economically significant sectors in which large volumes of material are moved with a high consumption of resources (e.g. metallic and chemical raw materials), there is still a substantial sustainability potential at the national or international level and approaches can be utilized for a significant increase in resource productivity. Because of the strong economic growth in the newly industrialized countries and the technologies applied there, funding for sustainable extraction and for transport of raw materials promises exceptional potential for international cooperation.

Key technologies for system transformation (see page 18)

Cross-sectional technologies that can make a contribution to sustainability in many value chains are examined, e.g. new forms of surface coating, innovative methods of product planning or the use of new ‘bionic’ designs/processes modelled after nature. The objective is to develop far-reaching innovations and new technical concepts for achieving specific sustainability goals. Funds to an amount of 67 million euros are planned for key technologies for sustainability in the 2005-2008 period. A support process will be carried out for this approach so that the actual sustainability effects and related opportunities and risks of key technologies can be better assessed. A bionics competence network will be



financed as part of the support process with funds of 6 million euros from 2005-2007.

Successful business models in a sustainable market economy (see page 19)

Conditional framework and market context: Education and research are to identify effective basic governmental conditions for sustainable business models. So far there have been few incentives and opportunities for changing business models because of high transaction costs.

Internal and external business processes: Research projects are to work out feasible models for the further development of business models geared to sustainability, e.g. for changing the operative and strategic business processes, for development towards a sustainable entrepreneurship as well as suitable learning and communication strategies within value chains.

Product strategies: The research results will evaluate the success of new product strategies in mass markets and the management of the entire lifecycle (lifecycle management) and, at the same time, also include a product-based analysis and management of value chains according to the concept of Integrated Product Policy (IPP) of the European Commission. Integrated product management is planned here as the first support activity with an amount of 20 million euros in the period from 2005-2008. Furthermore, incentive systems in line with the market for economical and sustainable use of critical or scarce materials can be ascertained within the framework of the product strategies, e.g. the use of leasing for certain process chemicals.

Climate protection strategies (see page 20)

Reduction of emissions relevant to the climate in industry:

The objective of research funding is to develop intersectoral climate protection concepts that take into consideration all areas of sustainable development and include in particular the users, but not to optimize individual process steps. The activities are targeted at economic sectors and regional decision-makers of a cross-sectional nature, e.g. the energyintensive chemical industry and at the same time strategic manufacturers and suppliers of primary and intermediate products. As a result, concrete contributions to further reduction of greenhouse gas emissions are expected, including support for the strategic goal of the chemical industry to reduce emissions by 45-50% by 2012.

Many chemical products also play a major role, for example, in the rehabilitation of existing buildings, which shows a high energy-saving potential. Altogether approx. 50% of all buildings will have to be redeveloped in the next 20 years. If, for example, 13 million housing units were rehabilitated in accordance with the Energy Saving Act by 2010 (30% of all housing units), the emission of 13 million tons of CO₂ could be avoided. R & D contributions here must be based on new holistic and efficient concepts that promise an optimal cost-benefit balance while incorporating SMEs and regional decision-makers.

Adaptation strategies and risk management: Parallel to emission avoidance, strategies for better adaptation to the climate will be explored so as to minimize damage resulting from extreme weather conditions today and take precautions for tomorrow. During the last decade the number of large weather- and climate-related natural disasters (excluding earthquakes) more than doubled as compared to the 1960s. Adjusted for inflation, the economic damage increased over six-fold, the insured damage even increased by a factor of 13.5 (Münchener Rück 2004). Even if the observation period is not long enough to convey a truly representative picture, the trend up to now is disquieting.

Examples: In 2003 20,000 people in western Europe died from the consequences of the hot summer (WHO), the low level of the rivers, such as on the Rhine or Po, led to cooling water problems for power stations, inland shipping suffered great losses and in Portugal the largest forest fires in 20 years raged (economic damage in southern, central and eastern Europe amounted altogether to approx. US\$13 thousand million). In 2002 the flood disaster on the Elbe and Danube Rivers caused damage totalling 9.2 thousand million euros and claimed the lives of 15 persons. In 1999 hurricane Lothar caused 80 deaths and storm damage to an amount of 1 thousand million euros resulted in Baden-Württemberg alone.

Overall it is estimated that weather and climate play a role for roughly 80% of the world economic activity (Deutsche Bank, 2003). In view of this background, an expert aided classification system must be developed to improve forecasting, record the climate and weather sensitivity of natural areas and civilization location factors and develop precautionary planning bases for regional management. Target groups include companies for which the climate/weather have a high economic relevance, research institutes as well as actors from administration and society. Specific contributions to a reduction in the vulnerability to extreme weather and climate change and exploitation of the resulting economic opportunities are expected. Climate protection strategies will be funded to an amount of 35 million euros in the 2005-2008 period.

Field of action 2: Sustainable use concepts for regions

Urban regions: Land management and urban mega-agglomerations (see page 22)

Land management: After the peak in the year 2000 129 ha of additional land were utilized for building and settlement purposes every day in Germany. According to the national sustainability strategy, an estimated figure of 30 ha/day is targeted by 2020 in order to secure social and ecological quality. The focal points of the support activities of the BMBF will be regional and national trend analyses for regional development and its assessment as well as exemplary model concepts for innovative land management for selected regions and types of area. Furthermore, the focus is on land recycling, the development of new yardsticks for evaluating soil quality and the need to protect selected areas as

well as dissemination of knowledge by developing new information and communication structures. A possible approach: Merely on the basis of the figures, full utilization of the currently approx. 200,000 ha of derelict land in cities could completely replace the present additional annual use of 130 ha of "greenfield areas" per day for four years. It appears realistic that the BMBF can help the municipalities to reduce the additional utilization of green areas by around 10-20% through targeted project funding. Research projects with a volume of 13 million euros are planned for land management and soil protection measures in the period from 2005-2008.



Urban mega-agglomerations: As of 1st February 2004 the BMBF started a new support measure that concentrates on the "mega-cities of tomorrow". The focus is on rapidly growing cities with populations of over 1 million that will cross the mega-city threshold in a few years. It is expected that half of humanity will already live in cities in the year 2007. This proportion will rise to around two thirds by 2030. The persistent trend towards urbanization represents one of the biggest problems for global sustainable development since flows of people, resources, goods and capital will intensify and interact with each other here to an extent unparalleled up to now. The objective of the funding measure is to develop proposed solutions and strategies for sustainable shaping of the mega-urban regions of the future and implement them in the form of pilot studies. The selection of the model cities will be completed by 2006. Initial design concepts are scheduled to be submitted by 2009 and tested in the following implementation phase. Support measures with a funding volume of 14 million euros are envisaged for the 2005-2008 period.

Rural regions: Sustainable agriculture and forestry (see page 24)

The research on sustainable development in rural and forestry regions focuses on integrative assessment and action concepts that combine landscape-oriented and macroeconomic approaches. The research focal points are :

- strategies and indicators for land use and rural development taking into account various scenarios regarding land productivity progress and changes in the consumption behaviour of the population;



- incentives that favour protective and economical land use;
- further development of environmental economic methods for the internalization of external costs and benefits as well as measures for improved communication and transparency, also in connection with the question of how sustainably operating enterprises can obtain fair prices for products;
- innovative farming methods, such as "precision agriculture", conservation-oriented soil cultivation and species-appropriate livestock farming;
- impact and structure of basic economic conditions, such as the reform of the Common Agricultural Policy of the EU.

Research on the related areas of sustainable agriculture and nourishment is to be funded to an amount of 30 million euros in the 2005-2008 period.

Sensitive regions (see page 24)

Sustainable development of the coastal zones: Integrated coastal zone management (ICZM) is the internationally recognized system approach, also supported at the EU level, for sustainable use of coastal regions. Within the framework of ICZM the

BMBF has identified the following research focal points for sustainable development of coastal zones:

- ecological and socioeconomic assessment of the impacts of economic / industrial activities as well as of the major forms of use of biotic and abiotic resources in the coastal regions;
- options for sustainable action derived from the above for alternative energy sources, ports / transportation, maritime industry, extraction of mineral resources, aquaculture / coastal fishing, settlement concepts / tourism / recreation and national defence;
- impacts of global change on coastal regions as economic zones and habitats and strategies for the future derived from these;
- bases for effective risk management (natural disasters, accidents at sea and in the coastal catchment area);
- development of scientifically founded regional planning procedures for the seaward-side areas of coastal regions.

The research will concentrate on working up integrated indicators and guidelines for action to initiate and maintain a process of sustainable use of coastal resources. Based on this, national and international ICZM strategies will be developed.

Marine aquaculture technology: Given the growing demand for fishing products and limited, in some cases declining catches, fish farming by means of aquaculture supports

- the development of shore-based aquaculture facilities that extensively rule out pollution of coastal waters, giving consideration to economic efficiency, and reduce landscape consumption by means of recycling technologies for treatment and reutilization of the water,
- scientific research on the biology of the products, particularly in the fields of fish farming, combating disease and nourishment, aimed at reducing the use of fish meal and fish oil, among other things.

The objective is to obtain know-how that provides plant technology which is adapted to the technical, climatic and infrastructural conditions in the target countries and can be implemented worldwide on the basis of reliable knowledge of the needs of certain marine organisms.

Dealing with desertification to secure subsistence: The problem of destruction of productive areas in dry regions, which is due to non-adapted use in most cases, can only be solved through closer cooperation between research and development. The funding measure on desertification research planned for 2006 will therefore focus on the implementation of research results in the regions affected. At the same time it will also address the fundamental problem of insufficient incentives to change behaviour. The main objective of these projects will be to prevent further loss of natural resources and regain regions for sustainable use. A German-Turkish joint project in Anatolia is planned as an initial pilot project. Funding of 17 million euros is budgeted for research support in the 2005-2008 period.

Field of action 3: Concepts for sustainable use of natural resources

Sustainable use of water as a resource (see page 27)

Planning tools for sustainable water resources management: The BMBF will support foresighted planning tools for sustainable water resources management that are based on simulation and evaluation of possible future development pathways and will be developed through interdisciplinary, transdisciplinary and internationally networked research. The goal is to develop new location-adapted technologies and processes designed for long-term use, including suitable management systems and sets of measures for improving water availability and quality. River catchment areas constitute a natural supply area for the distribution of water. Impacts of changes in the global water cycle can be managed on a sustainable basis only at this level. Against this background the BMBF launched a new funding focal point in mid-2000, i.e. GLOWA (Global Change of the Water Cycle), in which tools are developed for foresighted and sustainable management of large, and in most cases, transboundary river catchment areas. The support measures will result in planning tools for decision-makers in the regions examined that ensure satisfaction of increasing water needs while safeguarding the resource on a long-term basis.

Development of sustainable water technologies: Supplying the world population with drinking water is one of the greatest challenges of this century and significantly helps to reduce conflicts and migration. The BMBF makes a strategic contribution by means of environmentally sound drinking water and wastewater technologies that are adapted to the living and environmental conditions in newly industrialized and developing countries and by supporting educational programmes. This plays an effective role in achieving the core goal of the Johannesburg Summit, i.e. cutting the proportion of people without access to clean drinking water in half by 2015. Furthermore, the support helps to open up dynamically growing water supply and wastewater treatment markets worldwide. A German consortium, for example, will provide deliveries and services for the large-scale project "Wastewater disposal Teheran West/Northwest" amounting to 100 million euros after funding of a feasibility and planning study and intensive political funding by the BMBF. As a result of this German-Iranian research and technology cooperation, not only will sustainable solutions be realized for water supply and wastewater disposal for millions of Iranians, but also several thousand jobs will be secured and new ones created in Germany. Funds totalling 20 million euros are planned for the development of efficient water resources management and sustainable water technologies in the 2005-2008 period.

Flood management: In view of repeated flood disasters, the BMBF will support improved concepts for national flood management and make an applied contribution to the improvement of preventive flood protection in the area of technical flood protection. In addition, special educational programmes will be devel-

oped and risk communication to the society improved. Support funding of 10 million euros is earmarked for this purpose for the period from 2005-2007.

Sustainable use concepts for biological resources (see page 30)

Sustainable landscape development in peripheral regions: Social processes, such as "running regions dry" or the still unforeseeable impacts of the European agricultural policy in an enlarged EU, will increasingly influence the landscape in Germany, too. Peripheral, i.e. unused, regions will result. The new "wilderness" is a new challenge for landscape development. Pilot projects will develop and test strategies for sustainable landscape development which shape landscape structures and patterns in



such a way that the functional (ecological, economic and social) services feasible on the basis of the natural area, e.g. for agriculture and forestry, hunting and fishing, transport, trade and tourism, leisure and recreational activities and in particular for the protection of biodiversity, are preserved and/or restored on a long-term basis. The pilot regions will be selected in 2006. Alternative development pathways that follow a testing phase of several years are to be developed and evaluated only two years later. In 2010 initial success of sustainable landscape development should be visible in the model regions. Funds amounting to 6.5 million euros are earmarked for research projects aimed at preserving biodiversity and restructuring no longer usable cultivated land in the 2005-2008 period.

Sustainable use concepts for endangered regions: The research goal is to develop socially acceptable management systems geared to sustainability for biodiversity as a resource (protection despite use as well as protection through use). The management systems will be able to evaluate the biological, ecosystem-related

and relevant social influencing variables, such as the respective political and economic conditional framework, property situation and cultural background, and indicate the prospects of sustainable use. Outstanding international importance has been attached to preservation of biodiversity through the adoption of the UN Convention on Biodiversity of 1992. 10 years later a concrete agreement on achieving a significant reduction in the loss rate by 2010 was reached in Johannesburg. After ratification of this international environmental convention Germany, too, must guarantee protection of biodiversity on a binding basis according to international law. The key problem is the increasing use of land by people to cover their food and energy needs. Since mid-2000 the BMBF has been providing funding for application-oriented, interdisciplinary biodiversity research with the aim of developing strategies for preservation and sustainable use of the biosphere



within the framework of the BIOLOG funding initiative, which has been set up to run for nine years and has received considerable international attention. In the first phase a monitoring concept was developed and tested as a model for a worldwide observation network. At the end of the second support phase (2007) initial concepts aimed at enabling significant improvement in the protection of biodiversity will be presented for sustainable forms of land use in regions at risk.

Research concepts for examination and use of exploitable biological traits on a partnership basis: The potential use of biodiversity is currently left extensively unexploited. More intensive exploration of this potential use requires new scientific research approaches as well as the development of cooperative strategies and management structures. This allows ensuring a fair equalization of advantages in connection with the use of any results of economic interest between the partner countries involved within the framework of research projects on a partnership basis (benefit sharing – concepts according to CBD guidelines).

Economic assessment concepts for biodiversity; concepts for biodiversity monitoring: Every measure relevant for biodiversity, whether it be carried out on a sustainable or non-sustainable basis, consciously or unconsciously, implies an assessment of biodiversity. At the same time biodiversity is a non-renewable resource. Thus, the development of economic assessment models and methods is of great importance.

Whether a specific use was sustainable or not can only be decided retrospectively. The goal of the research, therefore, is to develop a scientifically founded, efficient monitoring concept for changes in biodiversity, as was also called for in Johannesburg in 2002.

Field of action 4: Social action geared to sustainability

Understanding the operating mechanisms of globalization; giving the world market a social and ecological direction (see page 32)

The sustainability research of the BMBF is aimed at going from an understanding of globalization to a search for solutions for a more sustainable shaping of globalization processes. Proposals for a global competitive, environmental and social policy will be made to point out how we can meet our growing responsibility in the world – be it in the framework of supranational institutions, such as the UN or WTO, binding conventions and rules based on international law, by virtue of our role as a national technological and political pioneer or by virtue of international action on the part of the various interest groups (governance).

The second goal is an improved understanding of cultural diversity and identity in the globalization process. By setting up a research platform that has not been available thus far in Germany, it will be possible to point out how the western, and in particular the European, identity develops in comparison to the cultural framework of other societies, how fencing-off and identity building take place in religion, science, art, media and family in the countries of the East and South, whether there are trends towards a new regionalism in Europe, how new common cultural ground reacts to old behaviour patterns, whether there is a common basis of the economic and political globalization elites and what role linguistic competence plays for identity building at the national level and for the ability to establish global cooperation.

Sociodemographic change (see page 34)

Integration as a challenge for society: A pronounced effect of the globalization process is the increasing number of citizens with a migration background in Germany. It also confronts the German society with the task of repeatedly re-establishing access, participation and a sense of belonging for all population groups in order to achieve integration. At the same time the economic and demographic development increasingly calls the effectiveness of the forms of integration applied via the labour market and

social state in the past decades in question. On the basis of research results regarding disintegration processes, the potential for social integration and concepts for its exploitation are the primary focus of the supported research. It involves the development of concepts for political actors and social institutions, but also for intermediary social actors, such as associations, municipalities and initiatives that contribute to avoiding fencing-off processes – no matter whether based on ethnic, cultural, education-related, regional or other socio-structural characteristics – and support inclusion. The projects are aimed at tapping existing social science knowledge in close connection with practice and processing it for solution concepts. Joint projects with a funding volume of 7 million euros are planned for this purpose.

Social security, solidarity and generational equity: In view of the ageing of society, the diversity of lifestyles that are increasingly characterized by childlessness as well as discontinuous career paths between education, training, hiring and unemployment, sustainability research draws up new concepts for a social state based on generational equity going beyond the fragmentation of competencies between departments and federal levels. Joint project partners from science, politics and practice question the way in which social security systems function and are financed, compare them with other countries without overlooking their structural problems and develop innovative tools and structures: simplicity and equity become the guiding criteria of viability here. Finance experts examine the question of the sustainability of public budgets at the various federal levels in terms of their amount and structure. Ecologically counterproductive subsidies as well as both intentional and unintentional effects of state revenue and expenditure systems on women and men, families and childless persons, migrants and other social groups are analyzed. The objective is to point out to political and administrative actors and the public how public finance policy could shape successful transitional processes geared to more generational equity in fiscal terms in view of interest groups with a short-term orientation. The measures include specific funding for economic sustainability research to an amount of 7 million euros in the 2005-2008 period, through which the international visibility of the German economic sciences will be strategically improved as well.

Ecological modernization of society (see page 36)

Control instruments for a sustainable environmental policy:

Sustainability research will subject political, legal and fiscal instruments for an ecological modernization of society to an interdisciplinary analysis and derive from that new control strategies while taking account of the fact that the state is not the sole normsetting actor, but competes with or functions as a subsidiary complement to enterprises, associations and civil society groups with their differing interests and capabilities of exerting influence.

Sustainable consumption patterns and infrastructures: Environmental research has focused too long on information and con-

trol and at the same time neglected the key motivating force of consumption behaviour: the stimulus of people themselves. With an eye to the sustainability strategy of the German Federal Government, the Sustainability Council called to mind in March 2004 that lifestyles and changes in values in society should be included in action concepts to a greater extent. Therefore, besides the everyday living conditions, socio-ecological research takes the material and emotional needs of various consumer groups as its starting point – and they do not involve doing without, but rather the satisfaction of needs, enjoyment and recognition. Based on the results of socio-ecological agricultural and food research, further areas of consumption will be examined systematically for innovative consumption strategies. Substantial sustainability reserves for private households can be found in housekeeping itself, in the entire area of leisure activity and long-term consumer goods. As part of another focal point, we examine the inherent potential of the technological and institutional transformation of the infrastructural systems of water, energy and information in terms of supply reliability, resource consumption and the influence of those supplied. Socio-ecological concepts are to receive funding of 33.6 million euros from 2005-2008.

Future scenarios and risk management strategies: Sustainability research is to develop strategies for handling ignorance and developments that are not absolutely predictable by means of methods of innovation and technology analysis. The focal points are remote and long-term risks of new materials and technologies or social developments (for example, malnutrition in industrialized countries). Parallel to this, legal, economic and ethical precautionary tools will be developed that enable innovation, but avoid unreasonably great ecological and social risks (e.g. systems based on liability law or obligations linked to ownership or use of goods), and at the same time take into account the reversibility of new technologies and the adaptability of technological solutions to changes in the social and natural environment.

E. Support goals in detail



E 1 Field of action 1: Concepts for sustainability in industry and business

Since the mid-1980s the focus of research support has increasingly shifted from downstream technologies to preventive measures through which pollution is avoided at the source. The objective here is to reduce the costs incurred by companies and the state due to cleaning up and reprocessing contamination. Since the mid-1990s product-related questions have also arisen in connection with sustainable consumption. All these efforts are described as integrated measures since they involve an integrative intervention in production processes and products. Research work targeted at the business and organizational processes of enterprises as well as research on basic conditions that foster the dissemination of environmental innovations play a growing role. Because of the increasing significance of climate protection, the German Federal Government has committed itself to far-reaching measures. The development of climate protection strategies for industry and business is a key factor in this context.

In spite of many efforts in recent decades, the current ways of meeting needs still have considerable negative social and ecological side effects.

Through the decision to set up a 10-year action programme for sustainable production and consumption the world community committed itself to this goal at the world summit for sustainability in Johannesburg.

In the search for solutions focus is placed on three key questions:

1. How can ecological scarcities be integrated into market-based pricing mechanisms and the governmental conditional framework more effectively than in the past?
2. How can systemic solutions be developed for value chains and value added networks with significantly greater decoupling from value creation and resource consumption?
3. How can suitable strategies and methods be developed for a viable and risk-conscious orientation of companies in this complex field in view of the increasing complexity and dynamics of global value chains?

The necessary system innovations become accepted in enterprises too slowly with respect to the sustainability goals set by the German Federal Government. Up to now both technology and management have been oriented too strongly to the structures that have evolved and to existing business models.

Particularly among SMEs the qualification requirements that are placed on management and employees and have grown in the course of globalization are met only to a limited extent. The measures necessary for sustainable company development (e.g. partnerships and formation of networks with other enterprises or research institutes, inclusion of stakeholders, future-oriented market analyses, targeted risk management, systematic selection of the appropriate technologies, including an evaluation of their potential) are deferred in many cases because of other priorities that are important for survival, but short-term in scope.

Further development of environmental research geared to sustainability research means – in addition to the ecological orientation (e.g. reduction of energy, material and emissions) and the economic efficiency analysis integrated with an eye to dissemination – taking into consideration the social dimension as well. The first tools in this context were developed in recent years under the heading of “Corporate Social Responsibility” (CSR). How can the desired system innovations now be initiated?

As far as specific value chains are concerned, possible approaches suggest themselves which either start from the goal (i.e. from the fields of need) or from the beginning of the value chains (i.e. from resources and raw materials), and there it is especially important to identify major “levers”. Innovations in key technologies as well as the sustainability orientation of corporate organization and management are more cross-section-oriented.

Based on these considerations, the BMBF funding measures will be implemented via the following four approaches:

- Fields of need and corresponding value chains because in the end they represent the goal of the value chain and sustainability potentials going far beyond the potential of individual sectors or stages in the value added process can be tapped through the

system-oriented approach;

- production systems close to resources because they are at the beginning of the value chain and substantial material flows are moved here;
- key technologies for system transformation that can exploit sustainability potential in many different value chains through their broad application as well as
- successful business models for sustainability that enable decision-makers in companies to exploit the sustainability potential available in their sphere of influence.

Decoupling value creation and resource consumption and giving consideration to sustainable product utilization strategies and consumption patterns are important goals of all approaches. Furthermore, the outstanding significance of climate protection makes a separate approach for climate protection strategies expedient.

E 1.1 Fields of need and corresponding value chains

The central starting point here is the identification and pursuance of new paths to satisfy the needs of humanity. First the value chains involved in the satisfaction of needs are analyzed. Within the value chains the potential “levers” that indicate innovation leaps towards sustainability are identified. According to the value chain or need, these “levers” may be found either in the production processes, the products or the conditional framework. What is important here is that not the individual process, but the entire system represents the starting point of research planning, even though specific processes may be the subject of research in concrete research projects. The closer link to social science research (see section on “Social action geared to sustainability”), which provides an insight into the future development of fields of need, is an indispensable component here.

In many cases more sustainability means substantial changes to existing structures. In view of this background, fields of need with high problem pressure and the resulting structural transformation have an exceptionally high sustainability potential.

The goal of research funding here is to develop and offer concepts aimed at steering the ongoing structural transformation towards sustainability. Especially the field of need related to nourishment with value chains in the food industry and agriculture as well as the field of need related to communication with value chains in the electronics industry and the information and communication sector are initially earmarked for funding. The latter is based, among other things, on the roadmap for sustainability in information and communication technology. In a dialogue with science and industry the BMBF will examine which other fields of need promise exceptional potential for sustainability research – e.g. sustainable living in view of a declining population in Germany – and continuously further develop its funding strategy accordingly.

Sustainability in the information and communication technology sector

On 11 May 2000 the German Bundestag approved the motion of the government parliamentary parties "Strategy for sustainable information technology". To implement the resolution, the German Federal Government commis-



sioned the NIK project (“Information and Communication Technology and Sustainability”) at the German Aerospace Center (DLR) via the BMBF. The mission of NIK is to link development geared to an information society to the challenges of sustainable management. The goal of the project is to develop a roadmap in a dialogue between industry and politics. This roadmap will point out development pathways for technological, economic and social developments for sustainable and environmentally compatible design and use of information and communication technologies. The roadmap for sustainable information and communication technology goes beyond existing activities by offering a comprehensive orientation framework that is specified in concrete terms in individual fields of action. Through the roadmap for sustainable information and communication technology a contribution is made to coordinating medium- and long-term developments in the information and communication technology sector with the demands from politics and society at an early stage.

The currently prepared roadmaps encompass a time horizon up to around 2010. They examine the following issues:

- recycling of video display units,
- environmental design of mobile communication of the 3rd generation as well as
- public procurement of information and communication technology.

Within the framework of the contract the above mentioned roadmaps will be specified in concrete terms and refined by the social actors. Furthermore, extension of the roadmapping to other information and communication technology issues relevant to sustainability is conceivable.

Mobility

Ensuring mobility is a key task for the future and for the economic success of our country. With growing individualization and increasing affluence the mobility of people and goods has also risen sharply. Whenever family, home, work and leisure time are no longer concentrated in the same geographic area, a change of place several times a day will become a matter of course. However, this development has its drawbacks: the regular morning congestion in rush hour traffic, risks of accidents, noise stress, environmental damage. Over 20% of the CO₂ emissions are accounted for by road traffic. The EU eastern enlargement will augment transit traffic through Germany. In addition, the enormous growth in worldwide economic relations and trade flows increase the traffic volume. 95% of the international transport volume is handled via sea.

Gearing mobility and transport both to the economic and in particular to ecological and social concerns is thus one of the priorities of the sustainability strategy of the German Federal Government. The focus here is on two goals:

- preservation of a high degree of mobility along with a reduction in the transport intensity of industry and society at the same time;
- efficient and environmentally compatible management of the continued traffic growth expected, i.e. reducing traffic-related pollution for the environment and nature as well as for health and quality of life.

Mobility

To get closer to achieving these goals, the German Federal Government started the research programme “Mobility and Transport” as well as “Shipping and Marine Technology for the 21st Century” in the year 2000. The emphasis here is on four funding focal points:

1. Innovations in motor vehicle production and shipbuilding are still the key factors for reducing climate gases, diminishing noise emissions and improving safety. Major



contributions to more sustainable vehicle concepts are expected from alternative, fuel-saving power units and new lightweight designs. A special focal point, “Quiet traffic”, seeks to combat traffic noise at the source. Traffic safety on the road is improved primarily by means of forward-looking driver assistance systems.

2. Another priority is given to research and development projects for efficient, sustainable traffic management. Detours or congestion cause entirely unnecessary environmental stress. Remedial action will be taken based on new telematics systems and strategies for traffic control.
3. An especially important focal point of support encompasses projects aimed at strengthening rail and ship traffic as alternatives to road transport. This includes the development of new customer-oriented local public transport systems as well as, for example, improving goods tracking systems in freight transport. The overriding goal is to provide sustainable relief to roads by increasingly shifting cargo shipments to the rail network.
4. In addition to carrier-specific improvements, it is equally important to optimize the transfer between carriers, i.e. intermodal interface management. Attractive options for changing over to other modes of private transport supported by appropriate information systems or time- and cost-saving transshipment options in the case of freight transport are a key factor for increasing permeability in the transport system and thus substantially improve its overall efficiency and capacity.

Even though passenger transport on the one hand and commercial traffic on the other do not follow the same laws, these fields of action apply, nevertheless, to both sectors. A sustainability strategy for transport must look at the overall system, specific improvements alone are not enough to cope with future challenges.

E 1.2 Production systems close to resources

Industry is the largest CO₂-emitting sector after the energy and transport sector. Whereas a significant decline in industrial CO₂ emissions was recorded in the 1990s, this trend has slowed down considerably in the meantime. This is detrimental to future generations. There is a substantial need for action in this context with regard to the remaining fossil energy resources and the natural bases of life, such as climate and biodiversity.

Sustainability potential in terms of resource protection can be expected, on the one hand, in areas where large amounts of materials are moved with a large consumption of energy or resources in economically important sectors and, on the other hand, in areas where sensitive resources like biodiversity or drinking water can be affected. Relevant innovation potential also results from broad use of renewable resources; examples include biogenic fuels and lubricants, bio-plastics and botanical active substances.

Since value chains become more and more complex as the stage in the value added process increases, the causal relationship between resource consumption and production is most clearly identifiable by choosing a raw materials-based approach. However, the resulting fields of research must take all stages of the value added process into consideration in order to open up options for action at the upper end of value chains and/or in fields of need and in this way also identify options for political influence and obtain reliable assessments regarding effectiveness.

Due to the strong economic growth in the newly industrialized countries and the technologies utilized there, international cooperation can exploit an extraordinarily high degree of potential in connection with this approach.

Substantial sustainability potential is seen primarily in the following funding areas planned:

- production sectors in which sustainability demands of different areas come together (e.g. multifunctional forestry / timber industry, in which aspects like the preservation of biodiversity, climate protection or the protection of drinking water resources have to be given consideration, in addition to the extraction of raw materials).
- economically important sectors in which large amounts of materials are moved with a high consumption of resources (e.g. metallic and chemical raw materials) and where there is still a considerable sustainability potential at the national or international level.

E 1.3 Key technologies for system transformation

The two approaches treated thus far are developed starting from the resources as the beginning of the value chains and from the fields of need as the goal of the value chains. Another major area of sustainability potential results from a cross-value-chain application of new technological developments (key technologies).

The reference here is to typical cross-sectional technologies that can make a contribution to sustainability in nearly every value chain. Such contributions may not possess the greatest sustainability potential in individual chains examined, but they unfold a substantial effect thanks to their broad application. This could be a new form of surface coating, for example, or – at the very beginning of a chain – an innovative method of product planning. Another example could be the use of new materials, such as renewable resources, in a completely new context.

The potential of new technologies with respect to sustainability is difficult to assess. The most recent innovations, such as bionic implementation of the lotus effect for diverse surfaces, show

Sustainable bioproduction

Biotechnology is considered to be one of the classical key technologies. Biotechnological production processes offer advantages over conventional chemical processes: they usually work under mild reaction conditions – in an aqueous environment at room temperature – with extensive avoidance of by-products and waste products. Biotechnological methods can therefore make a major contribution to sustainable development and a change in course towards “Sustainable management” in industrial production. The primary objective of the BMBF funding focal point “Sustainable bioproduction” started in 2000 is to get small and medium-sized enterprises (SMEs) to take part in the technological innovations in biotechnology and put processes and products into practice in interdisciplinary joint projects with university and extra-university research institutes.



that fields for technical innovations with sustainability potential can be planned or foreseen only to a limited extent. For this reason there should be additional support options going beyond the areas already supported (see box “Sustainable bioproduction”).

Key technologies should not be regarded simply as a further development of available technologies in this context. Rather, far-reaching innovations and new technical concepts are to be developed and implemented to achieve specific sustainability goals. A supporting process is carried out for this approach in order to be able to assess the actual sustainability effects and related opportunities and risks of key technologies better.

E 1.4 Successful business models in a sustainable market economy

Companies use diverse business models to be able to operate successfully in the market. The classical business model is that of industrial mass production. Even though this model is constantly declining in importance in its pure form in practice, many enterprises today are still based on its basic idea and focus primarily on economies of scale. The conditional framework that determines economic activity to a decisive degree is also optimized with an eye to this aspect. It is therefore extremely important for an industrial location like Germany to develop successful business models so as to be able to link economic success to environmental and social demands in a conflict-free manner. The following thematic points are of key significance in this context.

Conditional framework and market context

Approaches and opportunities for companies to change their current business models exist only to a very limited extent. The related transaction costs are generally too high. Education and research can identify an effective governmental conditional framework geared to sustainability.

Internal and external business processes

Companies can further develop their business models with the focus on sustainability, such as by changing the operative and strategic business processes, through an orientation to sustainable entrepreneurship as well as via suitable learning and communication strategies within value chains.

Product strategies

The European Commission views product-related analysis and management of value chains as the focal points of the concept of Integrated Product Policy. The central issues in this area relate to new product strategies in mass markets and control of the entire lifecycle (lifecycle management). Research support is provided complementary to the ongoing BMBF activities (see boxes “Research for the production of tomorrow” and “Sustainable job and corporate development”). The provision and dissemination of existing know-how in addition to the development of new know-how are the focus of the implementation of this issue in educational and research programmes.

Framework concept: “Research for the production of tomorrow”

In the BMBF measures for production research in the field of “New technologies” sustainability with its economic, ecological and social goals is an inseparable element of all supported projects. At the same time the guiding principle of management in cycles for environmental and resource protection is met directly in many projects. Entire product lifecycles are examined and research work for closing cycles, intensifying use or prolonging lifetime is supported on an exemplary basis for varyingly complex products in different sectors. Since the product idea and product development as well as the structuring of production methods and processes are networked to the corresponding services and product use, holistic approaches are pursued. For example: On the basis of the results of the project “Modular system for lifecycle management of complex technical consumer goods” supported by the BMBF, a company decided to enter a new field of business in addition to producing new compressors: professional and efficient production of rebuilt compressors using reconditioned parts and components. Because of the excessive costs for repairs, these technologically sophisticated devices were scrapped after failure by many customers up to now. However, a general analysis verified that the overall costs are lower in the case of several compressor lifecycles. After the company introduced newly developed solutions for improved dismantling capability, quality-oriented reconditioning, staff training and marketing, it now increasingly produces rebuilt compressors. The results show that successful and sustainable management can complement each other in a meaningful fashion. Approaches for working up solutions are expected from research, e.g. for documentation of the operating and maintenance conditions of complex technical equipment during the service life, for incorporation of new use concepts, such as leasing or operator models, into the development of sustainable products or for communicating information relevant to sustainability from one partner to another, e.g. from the designer to the repair and maintenance specialist. Such and similar sustainability-oriented questions are dealt with in idea competitions in connection with the BMBF framework concept “Research for the production of tomorrow”.

Sustainable labour and corporate development in the framework concept “Innovative work structuring – the future of work”

The framework concept looks at sustainability in the context of work and company organization as well as in connection with expanding and securing employment. The primary focus here is on identifying innovation impediments and developing clear guiding principles for the sustainable use of human and natural resources in a company context. Furthermore, methods and tools are to be developed and business management competence built up to implement the guiding principles in practical action. A trend report was drawn up on different approaches of sustainable work systems (SWS) within the framework of an assessment of successful changes in work structuring and company organization. Besides handling the material side of production in such a way as to protect resources, SWS are characterized in particular by the fact that they restore (protect) and at the same time further develop human labour in the process of its expenditure. Aspects of (social) sustainability were also included in an idea competition for viable work research. In a joint project (sustainability of work and rationalization), for example, modern forms of labour utilization are analyzed within this context to determine the extent to which they network, preserve or extend human and social resources or which opportunities exist here for sustainable innovation of work. In addition, within the framework of the programme “Innovative work structuring – the future of work” measures in different fields of action are supported focusing on the idea of prevention in connection with the preservation of the employability of individuals, for example by means of

- new approaches to the quality of work through prevention in occupational safety and health protection,
- human-oriented structuring of work in e-business and virtual enterprises as well as
- the development of factors for building up and expanding innovation-promoting corporate cultures and environments.



E 1.5 Climate protection strategies

At the international level Germany is a pioneer in the field of climate protection and has specified a large number of different measures in its National Climate Protection Programme (October 2000). This results in further reduction of emissions of so-called greenhouse gases. The complexity of all possible sets of measures in order to reduce emissions or avoid them entirely, on the one hand, as well as to enable adaptation to climate changes, on the other hand, means that a long-term strategic approach is necessary. The goals pursued in this field of research, therefore, cannot be achieved by means of individual approaches among those mentioned above.

Emission-reducing measures have been carried out for several years and the trend of greenhouse gas emissions in Germany displays initial success in the decoupling from economic growth. However, considerable further efforts are required to avoid a negative anthropogenic influence on the climate system in the long term and, on the other hand, to actively shape effective adaptation to climate changes (“Research for climate protection and protection from climate impacts”).

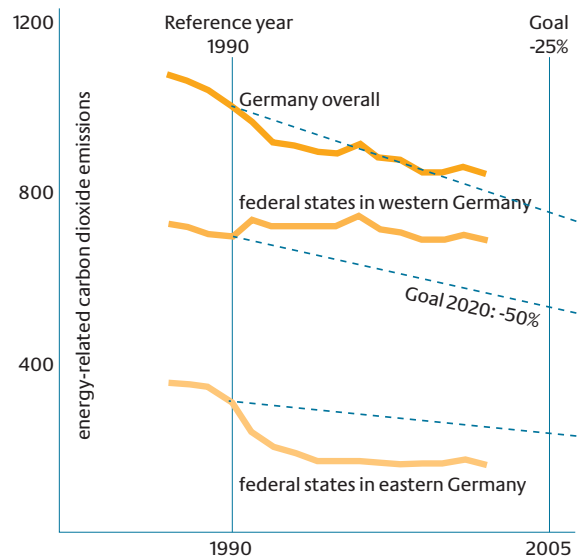


Fig. 1: Development of energy-related carbon dioxide emissions and goals for 2005 (-25%) and 2020 (-50%) in relation to reference year 1990

Reduction of climate-relevant emissions in industry

Pilot projects are to be carried out with the participation of companies in energy-intensive industrial sectors and at the same time innovative incentive structures for saving energy and reducing emissions will be examined in comparison to conventional tools, such as regulatory law or self-commitments. New technological approaches will be subjected to a concomitant innovation and technology analysis in order to be able to compare the climate protection measures in terms of their efficiency, costs and impact. This also applies to processes for the capture and storage of CO₂ from fossil fuels. Besides CO₂, the endeavours are also targeted at all other gases relevant to the climate that are specified in the Kyoto Protocol.

Adaptation strategies and risk management

The impacts of the so-called meteorological extremes, which may occur to an increasing degree during a climate change, demonstrate worldwide the great vulnerability of economic and social structures. In some cases they involve considerable economic

losses. In response to this, improved tools for forecasting extreme events ("environmental forecast") and strategies for managing and avoiding damage will be developed. Since the impacts of climate changes vary greatly at the regional level, specific adaptation measures must be developed in each case. In this way a major contribution can be made to stabilizing vital systems on a global scale.

Minimization of damage in commercial enterprises necessitates a new kind of integrated risk management that is able to prevent as well as overcome damage in accordance with a strategic approach with the aim of checking the risks arising from weather extremes or at least making them predictable. This means suitable measures have to be developed to improve the risk position of a company without at the same time impairing its market opportunities. Initial approaches to such research – currently without priority focus on industry – exist within the framework of climate impact research (see box "KRIM").



Joint project Climate Change and Preventive Risk and Coastal Protection Management on the German North Sea Coast (KRIM)

The KRIM joint project examines on a comprehensive and interdisciplinary basis the consequences of climate change with regard to an accelerated rise in the sea level and a significant increase in individual extreme events (storm tides) for the natural and social structures in northern German coastal regions within the framework of the German climate research programme **DEKLIM**. Their impacts are studied (on the basis of climate scenarios at eight representative, differently structured coastal sections in the Weser-Jade region) within the project. The studies will include various possible adaptation measures as the basis for modern coastal protection management. Furthermore, the aspects of individual and societal perception and communication of the possible consequences of a rise in the sea level and of the increasing probability of dike failure will be investigated. An analysis of the conflict potential inherent in coastal protection, the decision-making structures as well as appropriate solutions round off the KRIM project. The focus of the status and impact analyses is placed on the aspect of risk and its change, monitoring and management. In addition, a decision support system will be built up for coastal protection management based on the compiled findings. This system is aimed at enabling a simulation of diverse impacts of climate change on the coastal protection systems and the social consequences and risks. During the project period it will act as an instrument for integrating the interdisciplinary group of researchers and after completion of the work as a tool for decision-makers and for a public debate on how to handle the consequences of a climate change. Assessments and rec-

ommendations for preventive handling of the consequences of global climate change in the coastal regions of the German North Sea are to be derived on this basis in summary form.





E 2 Field of action 2: Sustainable use concepts for regions

Development of a sustainable economic management and lifestyle must be oriented to a more integrative analysis of the economic, ecological and social processes in natural areas and economic zones. At the same time one must not only take the complex interrelationships in a region into account, but also the interactions with neighbouring areas, such as in the case of trans-boundary rivers. Furthermore, greater attention has to be given to the interfaces between economic and natural areas (e.g. city/country) since very different living conditions are accompanied by increasing resource consumption and exchange here. Sustainable use concepts for regions not only require new approaches based on economic and social science, but also integrated models which permit the mapping of different regional development scenarios and their evaluation by means of sustainability indicators.

A step in this direction was taken through support provided since the beginning of 2002 for report systems for sustainable development in eastern German municipalities and regions. Information systems are developed in close cooperation between local partners in research and practice (such as Employment Office, Chamber of Industry and Commerce, associations of enterprises). These systems are used to compile and link data and background information on economic and social developments in the region/municipality. The objective is to incorporate the reciprocal dependencies and reinforcement of developments increasingly into regional decisionmaking processes through networked processing of the information.

Thus far sustainability goals have been primarily looked at with an eye to ecological improvement while there have been only initial attempts at inputting economic aspects into research with respect to implementation of research results. At the same time the impacts and influences of the actors affected in the sur-

rounding sphere have been increasingly identified, but not introduced as an inherent element of the R & D approach.

This more markedly transdisciplinary approach is increasingly applied in the new programme. This means the equally important incorporation of socioeconomic questions into natural science research will gain increasing significance in future. Research questions will be geared to a greater degree to the demands of affected actors and methodological interfaces will be developed to link natural science approaches to those based on social and economic sciences. At the same time the examination of global, regional and local questions will involve a greater inter-linkage of the latter. The models developed in the last 5 years offer a good prerequisite for this.

The BMBF's research funding in this context is targeted at different types of land use of regions or areas:

- urban regions used intensively by people: the central issue at the national level is land recycling and at the international level the development of mega-urban regions;
- rural regions that are characterized particularly by agriculture and forestry;
- sensitive regions with the focus placed on coastal areas.

E 2.1 Urban regions: Land management and urban mega-agglomerations

The BMBF measures will encompass a national focal point involving land management and an international focal point regarding the issue of mega-urban regions.

Land management

Land utilization numbers among the 21 indicators selected by the German Federal Government in 2002 as success criteria for sustainable development in Germany. In order to secure social and ecological quality of living space in Germany, a land utilization

target of 30 ha/day is to be achieved by the year 2020, starting from a maximum figure of 129 ha/day in 2000. Special importance is attached to reducing land utilization by decoupling land consumption from economic growth. The starting points for land management are reduction in use of new areas, land use oriented to reuse as well as new use of derelict land (land recycling). Among other things, reduction of land consumption through greater use of the underground area for traffic and economic applications will also be examined in this context. The focal points for future activities are:

- regional and national trend analyses of regional development and its assessment,
- development of exemplary model concepts of innovative land management for selected regions and types of area,
- recycling and revitalization of derelict areas that were previously used and are contaminated in part (land recycling),
- further development of the tools for sustainable land management, taking into consideration the legal, social, economic and institutional conditional framework,
- development of new yardsticks for evaluating soil quality and the need for protection of selected areas as well as
- dissemination of knowledge by developing new information and communication structures.

Urban mega-agglomerations

The United Nations estimates that today's world population of approx. 6.3 thousand million people will grow to 8.9 thousand million in the year 2050. This growth is accompanied by a redistribution from rural regions to the cities. Whereas only 38% of all people were urban dwellers in 1975, two thirds of the world's population will probably have settled in cities by 2050. Of those, more than 80% live in developing countries, as a result of which urban mega-agglomerations, consisting of interconnected medium-sized and large cities growing together in some cases, will come into being in many places around the globe.

This process, which is also described as an urban turning point, constitutes a major challenge for global sustainable development. The possible negative impacts of progressive urbanization are common knowledge. However, progressive urbanization need not necessarily conflict with the goal of sustainable development; it also opens up ways of implementing the guiding principle of sustainable development provided that the opportunities offered by the spatial concentration of the population are exploited consistently. The purpose of research is to work out visions and models for sustainable shaping of the urban landscapes of the future and test them on the basis of examples in selected cases together with research institutes in the selected countries and regions and in close coordination with the institutions responsible for urban development at the local level. The goal is to arrive at integrated overall solutions that take into account the different dimensions of sustainable development in an appropriate manner, going beyond the solution of specific problems like air pollution control or health care.



KORA – A module for the issue of “Land management”

Sustainable land use is only conceivable on a long-term basis

if areas previously used for industry, trade, settlement and transport are reutilized. However, a problem arises if the soil and subsoil are heavily contaminated due to years of use of harmful substances. Cleaning up the contaminated areas of former industrial sites is in some cases a very involved and, above all, expensive matter. A fundamental question that arises here is how extensive the remediation measures have to be and what contribution natural processes, such as microbiological degradation and chemical-physical bonding, can make.

The joint research project “Controlled natural retention and degradation of harmful substances in the remediation of contaminated groundwater and soil (KORA)” is therefore aimed at exploring the self-cleaning potential of nature for

diverse types of contaminants and contamination. A major goal of the KORA joint project is to elaborate recommendations for action that constitute a reliable basis for decision-makers in making decisions on the use of natural self-cleaning processes later on. The joint research project was designed right from the beginning in such a way that questions concerning the legal conditional framework, environmental-economic assessment and decision-making support are also examined in addition to the natural science investigations. Major impulses from practice are ensured through integration of a steering committee. The latter is composed of renowned experts from federal and state ministries, state working groups, enforcement agencies and associations. Consequently, key decision-makers for later utilization and implementation of the results are integrated into the work of the joint research project right from the beginning. In summary: The KORA joint project is a fundamental preparatory module for the issue of “Land management” in which the basic principles are developed for economically and ecologically compatible land rehabilitation.

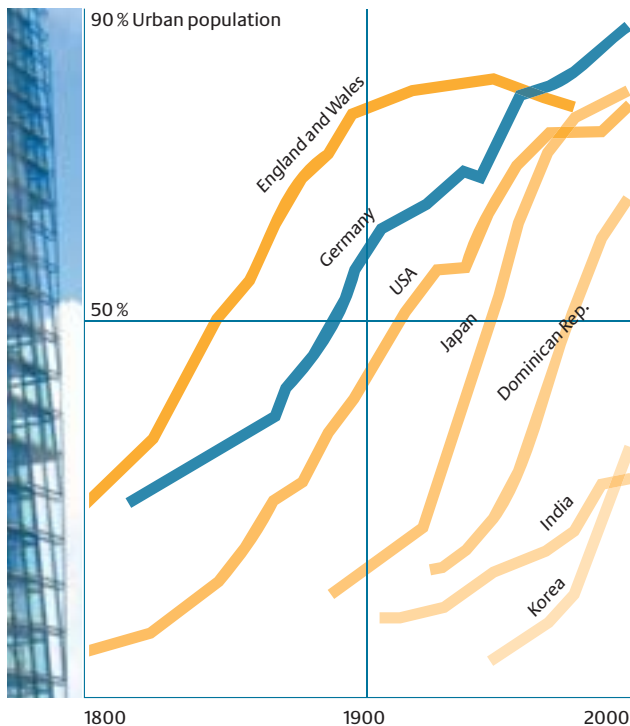


Fig. 2: Development of urban population as a percentage of the total population in different regions of the world

E 2.2 Rural regions: Sustainable agriculture and forestry

Since they account for approx. 80% of the land use in Germany, agriculture and forestry are of outstanding importance for sustainable development of rural regions and cultivated land. Besides their production function (raw materials) and their function as an economic area (marketing, jobs), they perform a wide variety of services (e.g. protective functions, resources) that do have a direct effect on the national economy and are therefore inadequately rewarded.

In view of the rapid transformation of the social policy framework as well as international commitments (e.g. Common Agricultural Policy, reduction in land assistance, EU accession of former eastern bloc states, international commitments with regard to virtually natural forest management, climate framework convention, globalization of agricultural and timber markets), the rural region must be viewed as an overall system with its various functions – as living space and as an economic, recreational and natural area – for the purpose of sustainable development. Another major focal point here is an overall assessment of the nitrogen surplus, which was specified as a gauge of sustainability within the framework of the national sustainability strategy. To give greater weight to the justified concerns of consumers with regard to undesired environmental effects of the respective land use, it is important to take into account “external costs” in government policy.

A combined and joint examination of the two fields of research, agriculture and forestry, is an essential requirement for

developing integrated concepts for sustainable land use. In addition to the aspects of the value added clusters of agriculture and forestry-timber production chain (Field of action 1, Production systems close to resources, see E 1.2 above), it is necessary to link the two fields with research issues in the areas of nourishment, water and soil protection, biodiversity, development of agglomerations and infrastructure in rural regions so as to provide for a holistic analysis of agricultural and forestry land use systems.

Future research on sustainable development in agricultural and forestry regions is aimed at supporting the implementation of sustainability at all levels of action and working up solutions for conflicting goals. Thus, the research will focus on integrative evaluation and action concepts that combine landscape-oriented and macroeconomic approaches. Furthermore, the objective is to further develop methods, processes and tools that represent the necessary modules for implementation and broad application of integrative development concepts. The research focal points are:

- strategies and indicators for controlling land use and rural development while giving consideration to multifunctionality as well as with regard to various scenarios for land productivity progress and changes in the consumption behaviour of the population;
- impact and structure of the economic conditional framework (e.g. reform of the Common Agricultural Policy of the EU) with regard to land utilization and incentive structure in favour of protective and economical land use (see also section E 2.1);
- further development of environmental-economic methods for the internalization of external costs and benefits as well as measures for improved communication and transparency also in connection with the question of how sustainably managed farms can obtain fair prices for products;
- further development of innovative farming methods, such as “precision agriculture”, conservation-oriented soil cultivation and species-appropriate livestock farming.

E 2.3 Sensitive regions

Sustainable development of the coastal zones

The European Environment Agency (EEA) determined in 1999 that coastal regions Europe-wide were subjected to substantial use demands and in danger of losing their ecological and economic functions in the near future.

In accordance with the principle of sustainability, the coastal regions must be viewed integratively as habitats, economic zones, natural areas and cultivated landscapes. Only on this basis will it be possible in the future to describe the interactions between economic development and resource consumption, on the one hand, and the ecological state of the coastal regions and the socioeconomic conditions, on the other hand, and enable sustainable coastal development. At the same time the impacts of global change have to be taken into consideration.

An internationally recognized system approach for sustainable use of the coastal regions that starts from this basis is inte-

Ways of achieving environmentally compatible agriculture

The properties and quality of soil used for agricultural purposes vary even within small areas, in some cases within a few metres. In common farming practice today these location-based characteristics are extensively ignored. Farmers coordinate soil cultivation, sowing and fertilization to an average location quality. As a consequence, areas with high fertility are overfertilized or existing yield potential is not exploited. An ecologically and economically optimized use of fertilizers and plant protection agents thus requires innovative management systems for location-specific crop farming (precision agriculture). In the "preagro" joint project, in which 17 partners from enterprises, universities and associations take part nationwide, sensors are developed for flexible cultivation, universally applicable management rules for precision agriculture are derived and economic cost-benefit analyses are conducted. Such methods as remote sensing, coupling of Geographic Information Systems (GIS) with satellite-aided locating and navigation systems, simulation models as well as pedological, geological and ecological investigation methods are applied. Transferability and applicability of the new management systems are to be achieved by including four representative farms, three private contractors as well as a farm machinery cooperative. Sustainable land use requires that conflicting economic



and ecological goals be avoided or resolved by mutual agreement. News ways of cooperative action were tested in the "GRANO" joint project in pilot regions in northeastern Germany. The focus was on the development and application of a transdisciplinary approach that gets farmers, environmentalists, traders and regional

planners to sit at the same table. The selection of the pilot regions (rural districts of Uckermark, Barnim and Elbe-Elster) in the federal state of Brandenburg, in which sustainable farming is to be implemented on an exemplary basis, took place according to a list of criteria that had been drawn up jointly by the project partners in order to set up a comprehensible procedure. Besides transferability of the results, special consideration was given to the interest and readiness to cooperate of the actors. The focus was on testing different participative procedures as well as establishment of a system for defining and evaluating ecological services, regional marketing for agriculture and tourism in addition to recording interactions, synergies and networking structures of regional initiatives.

grated coastal zone management (ICZM). In contrast to the predominantly sectoral-based coastal research conducted thus far, integrative, multidisciplinary research concepts that take into account the increasing complexity and intensity of use demands on coastal resources as well as ecological and socioeconomic developments are necessary in the future.

Based on these considerations, the BMBF has identified the following focal points for sustainable development of coastal zones:

- Ecological and socioeconomic evaluation of the impacts of economic/industrial activities as well as the major forms of use of biotic and abiotic resources in coastal regions – derivation of sustainable options for action (for alternative sources of energy; ports/transport; maritime industry; extraction of mineral resources; aquaculture/coastal fishing; settlement concepts / tourism / recreation; national defence)
- Impacts of global change on the coast as an economic zone and habitat and future strategies based on this
- Basic principles for effective risk management (natural disasters, accidents at sea and in the coastal catchment area)
- Development of economically justified regional planning procedures for seawardside areas of coastal regions.

Marine aquaculture technology

The fish catches from traditional deepsea and inland fishing can scarcely be increased. However, a growing demand can be satisfied by expanding aquaculture. In addition to fishing as a source of food, catching of ornamental fish and other sea organisms for display aquariums must be viewed increasingly critically. Farming of ornamental fish, which has hardly been carried out up to now, as well as increasing food production in aquacultures could offer a solution here. The current techniques of aquaculture have reached their ecological limits. Mangrove forests have been cleared for fish-farming ponds, both the remains of feedstuffs and the faeces of the animals overfertilize the sea, diseases are transmitted to animals living in the wild, medicine residues make the fish inedible and uncontrollable parasitic infestation more and more frequently leads to an abandonment of the entire farm. However, besides the ecological damage, which is difficult to rectify, the economic losses due to declining markets at home and abroad are even more drastic for the population living, mostly in barely developed countries.



Photo: Modern closed cycle aquaculture system

Funding focal point: 'Marine aquaculture technology'

Through its funding focal point 'Marine aquaculture technology' the BMBF supports

- the development of shore-based aquaculture facilities that extensively rule out pollution of the coastal waters by **applying closed cycle technology** for treatment and reutilization of water and reduce landscape consumption while giving consideration to economic efficiency as well as
- scientific research on the **biology of the products**, particularly in the areas of fish farming, combating diseases and nutrition, to reduce the use of fish meal and fish oil, among other things.

The objective is to obtain know-how for making facility technology available which is adapted to the technical, climatic and infrastructural conditions in the target countries and can be applied worldwide on the basis of reliable knowledge of the needs of certain marine organisms.

The funding measure will primarily be carried out in an inter-

national context. Cooperation with the partner countries will be based on three pillars:

- research and development projects in the form of 2 + 2 projects,
- initial and further training programmes for junior research and engineering staff within the framework of the R & D projects as well as
- initial and further training of specialized staff.

Indonesia, Vietnam and Jordan have already indicated several fields as examples. Extension of the cooperation to additional partner countries is targeted.

Photo: Research vessel "Polarstern"; E. Häberle



Dealing with desertification to secure subsistence

Desertification is the gradual destruction of productive areas in arid regions combined with anthropogenic activities for extracting natural resources. Currently over a thousand million people in more than 110 countries and 40% of the land surface are affected by the social, economic and ecological effects of desertification. The governments of the countries concerned are faced by the challenge of securing food for the constantly growing population while at the same time retaining their natural resources.

The key question for future research tasks will therefore be how people can maintain (prevention, conservation) and/or regain (rehabilitation, restoration) the quality of life in degraded arid regions by implementing sustainable management concepts. Future research in this field must also examine the question of how a sustainability policy can already be initiated today through the identification of regions endangered by desertification and by means of what incentives implementation of preventive measures can be achieved. The development of efficient irrigation systems adapted to the respective conditions, such as soil characteristics and agricultural form of use, can also make a major contribution.



E 3 Field of action 3: Concepts for sustainable use of natural resources

The question of the use of resources has characterized the environmental debate to a decisive degree since back in the 1970s. The finite availability of raw materials, such as oil and coal, was the central resource issue in the industrialized countries at that time. Through the UNCED conference in Rio de Janeiro in 1992 and the summit for sustainable development in Johannesburg in 2002 other resources of key importance also for developing and newly industrialized countries increasingly became the focus of attention: water and biodiversity. Since then these issues have become a subject of discussion on the national and international political agenda to an increasing extent. In recent years research has generated a great deal of new knowledge in this regard. Nevertheless, many questions regarding the sustainable use of these two important resources have yet to be clarified. Therefore, they are a focal point of the BMBF resource-based research approaches.

E 3.1 Sustainable use of water as a resource

Water is the key substance of the living world. It is a prerequisite for all human development and the largest material flow in our culture. Both the securing of food – up to 1,500 m³ of water per person and year are necessary for this alone – and any industrial production depend on the availability of water. As the world population grows, a rise in global water needs of 40% is expected in the coming decades.

Inadequate wastewater treatment and a lack of water protection lead to high economic costs in developing and newly industrialized countries due to illness in the population and thus exacerbate poverty. Every day 6,000 children die from the consequences of poor water quality and hygiene. Every second sickbed is occupied by a patient who suffers from an avoidable water-borne disease. In view of these global problems, the availability of water was emphasized explicitly as a requirement for sustainable

development at the conference of Rio de Janeiro in 1992. The significance of this issue was also confirmed at the millennium summit of the United Nations in September 2000. In the final declaration all heads of state and government committed themselves to cutting the proportion of people without access to safe drinking water in half by 2015. In Johannesburg in 2002 this demand was renewed and extended to include the need for hygienically adequate sanitary disposal.

The future measures of the BMBF therefore encompass extremely internationally geared focal points, particularly for the development of integrated, foresighted planning tools and sustainable water technologies. The issue of flood management will constitute a focal point both at the national level and in European cooperation.

Planning tools for sustainable water resources management

Increased use of groundwater resources for drinking water supply, among other things, is taking place worldwide. At the same time these resources are jeopardized by dropping groundwater levels and mounting contamination in many places.

Therefore, there is a growing need for foresighted planning tools based on simulation and evaluation of possible future development pathways (scenarios). Reliable scenario analyses are not possible at present, not even in the highly developed industrial countries. The development of these planning tools requires a high degree of interdisciplinary, transdisciplinary and internationally networked research since not only natural science aspects have to be taken into account, but also the changing legal, political and other basic social conditions. Such tools will play a decisive role in providing for more effective and reliable planning of adaptation measures. This is of particular importance for the development of new location-adapted technologies and processes (including management systems, lists of measures) with a long-term effect, i.e. geared to sustainability, for improving water availability and quality.

Water research in semi-arid regions based on the example of the Near East

Pro capita water availability in the Near East is among the lowest worldwide. At the same time water needs are constantly rising as a result of population growth and economic development. The surface water and groundwater resources are frequently cross-border and therefore hold a high conflict potential. For this reason sustainable management and use of the resources require cooperation between all bordering countries. Against this background the BMBF funds exemplary projects in the catchment area of the Jordan River in which German, Israeli, Jordanian and Palestinian scientists and research institutes cooperate. In the project **“Water Resources Evaluation for a Sustainable Development in the Jordan Rift Basin”** the major mechanisms for the formation of new groundwater, groundwater salification processes as well as the storage, retention and runoff characteristics of the aquifers are investigated in hydrogeological studies. On this basis, prognostic conclusions can be drawn on improved

groundwater management by means of numeric groundwater models. In the **GLOWA Jordan River Project** the sensitivity of the water and land resources are quantified in relation to global processes of change in the Jordan River catchment area in a case study applicable to other arid and semi-arid river catchment areas within the framework of the funding focal point **“Global change of the water cycle”**. At the same time global ecosystem interrelationships and the socioeconomic conditional framework are taken into account to an equal degree.

Of no less importance than the scientific results is the political effect of the projects. Scientific cooperation in tackling common future tasks can forge links and contribute to the peace process.



The support measures are designed to provide decision-makers in the regions under study with planning tools so that increasing water needs can be met in such a way that the resource is secured and safeguarded on a long-term basis.

Development of sustainable water technologies

In solving the urgent problems of water supply, there is a worldwide trend towards a central water supply with uniform water quality for all uses. However, it is necessary to fundamentally review the existing structures, retain regional resources in the region and achieve acceptance for differentiated water qualities for different uses. Furthermore, solutions must be worked out that enable sustainable use without drastic impairment of the quality of life. Thus, new strategies have to be developed that indicate alternatives to the philosophy of a central water supply and wastewater treatment. Innovative decentralized supply and disposal systems must be adaptable to different settlement structures and other requirements without any loss in functionality and safety. Application of German experience in other countries requires both knowledge of the conditions there and the ability to adapt processes and systems that have proven effective here in Germany to the often extremely different circumstances abroad.

However, thought must also be given to completely new, unconventional methods of water extraction in arid and semiarid regions. The drastic scarcity of water resources forecast here opens up a promising field for extremely innovative, but also risk-entailing research and development that can make a currently incalculable contribution to global sustainability. Examples of unconventional water extraction sources are the use of air moisture over land or of water vapour over the sea surface, tapping of underground rivers as well as systematic use of rainfalls with a high seasonal fluctuation.

The reutilization of wastewater is discussed and demanded in many arid and semi-arid countries as an urgently required contribution to solving the problems. Special attention here must be given to the possible impacts on human health. Treated wastewater can be used in particular for irrigation, industrial purposes or groundwater replenishment. To realize a concept for recycling purified wastewater, it is necessary to draw up quality criteria for each type of use, provide for the respective legal and institutional requirements and create acceptance. This requires to an increasing extent transdisciplinary solutions in which socioeconomic issues in addition to the natural science and engineering aspects play a decisive role.

To maintain the high standards of German supply and disposal technology and of quality control, innovation options for improved treatment, process and transport techniques must also be examined. In view of the fact that more than 2/3 of the drinking water in Germany comes from treated groundwater, the interrelationships in the groundwater ecosystem must also be understood better.

Multiple use of the water and thus effective resource protection could be achieved through an intelligent combination of different economic sectors at industrial estates. Entirely new supply and disposal concepts are conceivable here by including energy and waste. In spite of initial efforts, this demanding field of research is still in its infancy since only parts of it have been investigated fundamentally.

As a rule, wastewater not only contains harmful substances, but also potentially reusable materials that can be recovered in accordance with sustainable development. A typical example of this is the extraction of phosphate from domestic wastewater since the natural phosphorus reserves will already be depleted in a few decades.

Flood management

The flood events in Europe in summer 2002 and the enormous damage that they caused to private and public property as well as to the environment have made it plain that improved flood management is a direct contribution to sustainability. In a 5-point programme adopted by the German Federal Government in September 2002 the cornerstones of a joint flood protection programme were outlined by the federal and state governments calling for improved water retention through integrated management concepts as well as decentralized measures, new regional planning concepts for avoiding potential damage and improved warning systems.

In the field of operational flood management an early warning system optimized through further development of the technical capabilities and adapted to the local conditions plays a decisive role. Because of the complexity of the interrelationships, major advances for effective flood management within the framework of integrated water and land management in river catchment areas can only be achieved by means of interdisciplinary, integrative and transboundary research approaches.

Further developments in technical flood protection represent an indispensable element of the required management concepts. This field in particular is characterized by a high innovation potential. A major role in this context is played by innovative methods for building dikes. In addition, immediate measures for safeguarding dikes and enhancing long-term stability, mobile protective facilities as well as reliable technologies for foreseeing vulnerable dike sections are important as well. New developments are also necessary in technical measuring devices, in structural precaution measures as well as to safeguard the supply and disposal infrastructure.

In the realization of the funding measures it will be ensured that implementation of the innovative solutions will be inputted into the structuring of the funding measures through the involvement of the regional and local decision-makers at the local level.

Decentralized water supply and disposal systems

Through the funding focal point “Decentralized water supply and disposal systems” new processes and combinations of processes are developed to reduce drinking water needs while at the same time decoupling material and water flows. This enables recovery and reutilization of the components and better energy yield. Further sub-aspects of this programme include the use of grey water and rainwater, anaerobic wastewater treatment (e.g. through membrane or virtually natural processes), separation, vacuum and compost toilets, biogas generation, waste separation / incineration, generation of compost and fertilizers, economic, sociocultural and legal aspects. R & D projects of a demonstration nature are carried out in Germany as well as in some newly industrialized and developing countries. For example, the water and material flows as well as the agricultural needs for fertilizers and humus are determined in the Mekong Delta, based on the actual state of the soil and aquifers. On this basis, a suitable wastewater concept is developed that is aimed at gaining a high degree of acceptance by virtue of the direct recycling opportunities at the local level and is economically feasible. Extensive ecological closed cycle waste management will be introduced within the framework of extension of the Valley View University in Ghana. This includes modification of the administration building with water-saving toilets, construction of a new teachers’ building with compost and/or water-saving toilets and grey water use, storage of rainwater in a cistern, recycling of biowastes, compost, urine, etc. in the university’s agricultural activities and/or for biogas generation. Further projects involve ecological closed cycle waste management at a holiday facility (Turkey), energy and nutrient recovery in existing facilities (Latin America) as well as closed system waste management in new housing estates (Germany).





Development of environmentally friendly barges

The results of the water ecology research indicate that further expansion of waterways must often be viewed critically for ecological reasons. On the other hand, inland shipping has good prospects of playing a central and – due to the relief provided for road traffic – also a sustainable role in coping with the traffic volume that has risen rapidly as a result of the EU eastern enlargement. However, this means it must be made more competitive, i.e. faster, safer, more environmentally friendly and more efficient. For this reason the development of faster barges, which can be operated in an environmentally sound and energy-saving manner by virtue of the lightweight construction and optimized propulsion units, even under conditions of a low water level and varying width of the waterways, is supported within the framework of the BMBF programme “Shipping and marine technology for the 21st century”.

E 3.2 Sustainable use concepts for biological resources

Species diversity is of enormous significance for the Earth’s ecosystem, a significance that extends from small-scale maintenance of nutrient cycles to stabilization of the world climate. At the same time humanity depends on the use of these biological resources. As a consequence, conflicting goals emerge for the solution of which no strategies based on sustainable development currently exist. The decline in biodiversity caused by human activities leads at all its levels (genetic variability, number of species, biotic communities) to irreversible losses that can only be avoided through precautionary measures. The goal of achiev-



ing a significant reduction in the loss rate of biodiversity by 2010 despite continued mounting of the use pressure on natural ecosystems was reaffirmed in Johannesburg in 2002. The purpose of the research is to develop strategies for the protection and sustainable use of biological resources as quickly as possible. The ecosystem approach described in the UN convention, which envisages integrated management of land, water and biological resources, plays a key role in this connection. International research programmes like Diversitas will be taken into account in the selection of research focal points. The objective of the research is to put this approach into practice. The focus here is on the following four research topics:

Sustainable landscape development in peripheral regions

Social processes, such as “running regions dry” or the still unforeseeable impacts of the European agricultural policy in an enlarged EU, will increasingly influence the landscape in Germany, too. Peripheral, i.e. unused, regions will result. The new

“wilderness” is a new challenge for landscape development. Pilot projects will develop and test strategies for sustainable landscape development which shape landscape structures and patterns in such a way that the functional (ecological, economic and social) services feasible on the basis of the natural area, e.g. for agriculture and forestry, hunting and fishing, transport, trade and tourism, leisure and recreational activities and in particular for the protection of biodiversity, are preserved and/or restored on a long-term basis. The pilot regions will be selected in 2006. Only two years later alternative development pathways that follow a testing phase of several years are to be developed and evaluated. In 2010 initial success of sustainable landscape development should be visible in the model regions.



Sustainable use concepts for endangered regions

The goal of the research is to develop socially acceptable management systems geared to sustainability for biodiversity as a resource (protection despite use as well as protection through use). The management systems are designed to evaluate the biological, ecosystem-related and relevant social influencing variables, such as the respective political and economic conditional framework, property situation and cultural background, and indicate the prospects of sustainable use. Outstanding international importance has been attached to the preservation of biodiversity through the adoption of the UN Convention on Biodiversity of 1992. 10 years later a concrete agreement on achieving a significant reduction in the loss rate by 2010 was reached in Johannesburg. After ratification of this international environmental convention Germany, too, must guarantee protection of biodiversity on a binding basis according to international law. The key problem is the increasing use of land by people to cover their food and energy needs. Since mid-2000 the BMBF has been providing funding for application-oriented, interdisciplinary bio-

diversity research with the aim of developing strategies for preservation and sustainable use of the biosphere within the framework of the BIOLOG funding initiative, which has been set up to run for nine years and has received considerable international attention. In the first phase a monitoring concept was developed and tested as a model for a worldwide observation network. At the end of the second funding phase (2007) initial concepts for sustainable forms of land use in endangered regions will be presented.

Research concepts for examination and use of exploitable biological traits on a partnership basis

The potential use of biodiversity is currently left extensively unexploited. More intensive exploration of this potential use requires new scientific research approaches as well as the development of cooperative strategies and management structures. This makes it possible to ensure a fair equalization of advantages in connection with the use of any results of economic interest between the partner countries involved within the framework of research projects on a partnership basis (benefit sharing – concepts according to CBD guidelines).

Economic assessment concepts for biodiversity; concepts for biodiversity monitoring

Every measure relevant for biodiversity, whether it be carried out on a sustainable or non-sustainable basis, consciously or unconsciously, implies an assessment of biodiversity. At the same time biodiversity is a non-renewable resource. Thus, the development of economic assessment models and methods is of great importance. Whether a specific use was sustainable or not can only be decided retrospectively. The goal of the research, therefore, is to develop a scientifically founded, efficient monitoring concept for changes in biodiversity, as was also called for in Johannesburg in 2002.



E 4 Field of action 4: Social action geared to sustainability

Social action is the result of conscious and unconscious decisions of individual and collective actors. It is based on convictions and values of people in households, societies and clubs, enterprises, associations and administration. Rules and institutions that are essentially generated by the state, the market, the media and social structures influence these practices. Individuals thus live in a framework of conflict between recognized opportunities for action and experienced limitations on action as well as between leisure time and practical constraints.

Limitations on action can facilitate social coordination. However, they can also block social development. This applies in particular when the conditional framework changes and rules and institutions are no longer adapted to this change. Free use of the world fish stocks, for example, which was ecologically harmless for thousands of years, is no longer sustainable when industrialized fishing fleets can overfish the oceans.

Sustainability research examines and evaluates existing social institutions and rules for their ability to contribute to sustainability. Functioning processes and control instruments should at the same time be secured and preserved. The response to wrong developments should be new action concepts. It is important here to combine measures that have a short-term effect with a long-term reform courses in a meaningful fashion.

In view of globalization a national strategy can only be successful if it is embedded in an international context. World trade and geopolitics have an enormous influence on national and local activities and determine the pressure and scope of action of the actors involved. At the same time there is a growing global responsibility on the part of governments, enterprises and social groups. The starting point of the BMBF's research support encompasses three social challenges that currently influence the public debate to a decisive degree:

- globalization,
- sociodemographic change and
- ecological restructuring of society.

From the point of view of sustainability funding focal points having priority will be formulated for these three issues in the following. Both natural science and social science research contributions are necessary at the interface between nature and society. Furthermore, in the future the economic sciences are to be mobilized for sustainable development to a greater extent than before. However, solutions for real social problems also require that consideration be given to non-scientific knowledge, complex actor structures and unequal power balances. For this reason transdisciplinary integration and communication elements will be tested and supported in socio-ecological research projects as integral elements.

This means a change in the research landscape is necessary. Outstanding importance is attached to non-governmental environmental research institutes with basic funding because of their experience in transdisciplinary socio-ecological research. The BMBF reinforces their innovation and radiation strength (infrastructure support) and promotes interdisciplinary and transdisciplinary training for junior research staff at university and extra-university research institutions. Questions of gender will be given special consideration both with respect to the staffing of the research networks and with regard to the research content because they can open up additional knowledge for the benefit of everyone.

E 4.1 Understanding the operating mechanisms of globalization; giving the world market a social and ecological direction

Industry and technologies, environment, politics and culture can no longer be defined at and restricted to the national level. For example, flooded areas and desertification reinforce migration movements from the countryside to mega-cities or to neighbouring states all the way to Europe and the USA. South East Asian stock market crashes also reach European finance and labour markets. Diseases like AIDS and SARS affect countries around the globe. The world has become smaller.

Giving the world market a social and ecological direction

The causes, operating mechanisms and consequences of globalization trigger euphoric future visions as well as diffuse fears. On the one hand, it is claimed that liberalized free trade benefits industrial, newly industrialized and developing countries to an equal extent along the lines of “comparative cost advantages”. On the other hand, more and more voices in practice and theory warn of economic globalization losers in North and South. How should a world trade regime be structured so that the largest number of people possible can take part in the welfare increases hoped for? Or do we need, for example, a curbing of global finance, commodity and service flows by means of rationing or taxes?

The observed decoupling of economic-technological action from socio-political efforts calls the effectiveness of national or even European environmental, social and economic policy into question. An institutional competition reflected in a deregulation race, on the one hand, and in significant cuts in corporate and capital gains taxes, on the other hand, has now set in. It is open here whether national economies with standardized location factors will survive in the globalized competition in the end or those countries that develop an inimitable profile by means of differentiation and innovation.

Similar to the product markets, optimists expect a more efficient environmental and social policy through an international institutional competition between disciplined national governments. Critics of a deregulated globalization, by contrast, fear a downward environmental and social policy spiral in which both national and international scope for redistribution and sustainability will be considerably restricted.

The pressure on the social security systems in the industrialized countries as well as the worldwide increase in migration movements and transport services illustrate the social and ecological drawbacks of the increasing economic and technological interlinkage. Do ecological or social standards represent modern forms of protectionism or can they cushion the side effects of globalization to the extent that they can be enforced worldwide in the first place? How do social and ecological standards respond to the simultaneous demand for a unilateral opening of the EU market for products of the developing countries?

Sustainability research links an understanding of globalization to the search for solutions for a more sustainable shaping of globalization processes. Action-oriented research has to point out how this responsibility can be assumed through supranational institutions, conventions and rules that are binding based on international law, a national pioneer role and competition between the various interest groups (see box “Global Governance”).

Global Governance

Worldwide social and environmental problems have become so virulent that we cannot wait for the formation of a global government to solve these problems. Perhaps this is a good thing. After all, numerous researchers hope for much faster and more effective improvements from a competition of ideas, institutions and decentralized action concepts between diverse governmental and non-governmental actors (governance) than through centralized and sluggish coordination processes. If a supranational level of authority is lacking, often only minimal compromises can be achieved, as many international agreements have demonstrated (Kyoto; Johannesburg). In addition, economically weaker countries, which may represent a much larger population, usually participate underproportionally in the decision-making process. For this reason decentralized approaches, in which, for example, individual nation states develop and implement solutions or input them in larger international contexts, appear promising. Nationally tested concepts of ecological taxation, for instance, and the promotion of renewable energy sources are taken up and further developed by other countries. Besides state pioneers, non-governmental organizations are gaining importance. Globally operating companies, powerful environmental organizations and sociopolitical interest groups influence social debates. The UN, too, increasingly includes non-governmental actors in its decision-making processes. Others, however, warn of a “governance euphoria”. They ask in particular about the democratic legitimation of non-elected interest groups and about the organizability of different interests. Very specific particular interests with few powerful beneficiaries, for example, can be much more easily combined than large groups, especially if individual commitment generates positive external effects and merely promises a small individual advantage. Freeloader behaviour may be the result. In the past it was also shown that the lack of a higher level of authority regularly led to a lower degree of redistribution. The potential and limits of governance processes are an integral part of several socioecological research projects. In the case of climate protection, for example, a study is conducted on how the various regulative levels (local, regional, national, global) and activities of different actors mesh with each other, reinforce each other or block one another. On this basis, recommendations are made to political actors for designing more sustainable institutions and regulation networks and learning processes for more successful governance are initiated among the actors.

Cultural diversity and identity in the globalization process

Globalization is not only a process that changes economic relations and social relationships worldwide. In fact, it affects at the same time the basic cultural principles of coexistence. Increasing intercultural contact as well as the development of stable democratic structures require in-depth skills in self-observation and in the observation of others. They are the basis for intercultural competence and mobility.

How does the western, in particular the European identity develop in comparison to the cultural framework of other societies? How do fencing-off and identity building take place in religion, science, art, media and family in the countries of the East and South? How does new common cultural ground react to old behaviour patterns? Is there a common basis of the economic and political globalization elites? What role does linguistic competence play for identity building at the national level and for the ability to establish global cooperation? In this context sustainability research looks at the cultural implications of globalization processes. Through its funding strategy the BMBF aims at setting up a research platform on this issue geared to action know-how for the first time in Germany.

E 4.2 Sociodemographic change

Low birth rates with increasing life expectancy, altered roles between the genders, increasing diversity of lifestyles and employment biographies – these findings characterize the sociodemographic change. Germany’s present population of around 82 million will in all likelihood drop to about 67 million by 2050.

Two issues are focused on directly here:

1. How do we ensure social integration in view of the changes in the population structure based on global and demographic processes of change? How do we preserve public spirit and solidarity in view of the diversity of life plans if the classical placement mechanisms of inherited status and work become relative in their significance? The key terms “de-limitation of work” (*“Entgrenzung der Arbeit”*) and “patchwork employment biography” characterize a social development in which traditional life concepts are supplemented by new orientation patterns.
2. How do we deal with the relationship between the generations and the contract between the generations? This refers to the agreement which is based on social norms and values, is laid down only in part in legal provisions and according to which the middle generation provides for support of both the children and the no longer gainfully employed elderly members of society. The demographic change and the enormous prolongation of the average lifetime must not be viewed in this context only as a problem, but should also be seen as an opportunity for design and gain.

Integration as a challenge for society

Against the background of global pressure for change, which generates problems in connection with access, participation and a sense of belonging, people increasingly associate the current sociodemographic development with infringements of their recognition and fears of exclusion. Fields of conflict linked to these disintegration fears and experiences include the labour market development and jeopardized securing of a livelihood, political internationalization and restricted scope of participation for the individual, the convergence of foreign religions and cultures, discontinuous biographies and new family structures.

Therefore, social integration concepts are needed that take into account the existing differences, without neglecting the endogenous cultural change within the receiving society itself.

Social integration is not only a demand placed on citizens with a migration background or merely a problem of disadvantaged groups in society. It is also a challenge for the “majority society” to deal with these social groups in a serious manner. Schools with their broad cross-section of majority and minority groups offer an outstanding opportunity to initiate a discussion and learning process, particularly among young people. They must be put in a position to handle this integration task.

The shapeability of lifecourses in our society appears to have increased, but so has the shaping pressure, and yet young people especially do not know exactly what opportunities and options they have and for which of them they should decide. Educational institutions can support them with regard to orientation. However, society must also critically examine the question of where young people get their recognition if they are overtaxed by the school and extra-school achievement society or subjectively have the impression of “not being able to keep up”.

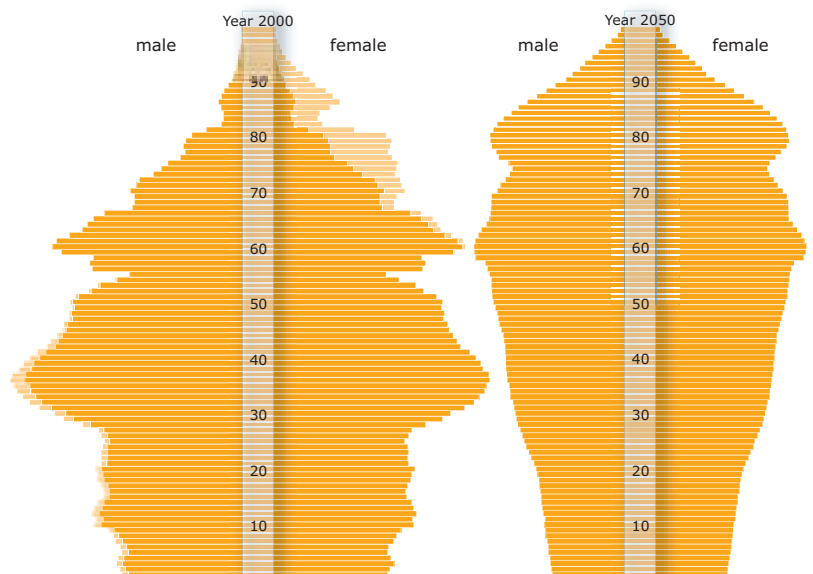


Fig. 3: Demographic change 2000 - 2050
Source: German Federal Bureau of Statistics

Gender questions in sustainability research

Just a few years ago different perceptions of environmental problems by women and men as well as their unequal feeling of concern was hardly taken note of in environmental research. And yet socially ascribed and experienced gender roles play a major role here as soon as the relations between nature and society are examined on a socially and culturally differentiated basis. The focus is on tapping additional knowledge and action options for the benefit of everyone. The BMBF's socioecological research support pursues a double strategy in this connection: Research questions are formulated on a **gender-sensitive** basis right from the beginning. For example, projects on sustainable eating habits also involve, as a matter of course, the question of how men and women do their shopping and how they typically structure their everyday form of nutrition – as a single person or in a collective household – and analyze the impacts of alternative sustainability concepts on the gender roles (**gender impact assessment**). If significant, further social differentiation characteristics, such as age or origin, are also examined in the projects.

Anyone who wishes to develop successful sustainability concepts has to include the relevant actors in the research process. Therefore, women and men must be equally involved on the practical side (gender mainstreaming). Support for junior research staff in the field of socio-ecological research within and outside the university goes one step further. Over half of the researchers involved are women. In this way gender topics are also conveyed better via persons on a long-term basis.

The development of diverse new lifestyles and social diversity means more freedom for the individual, but also holds the risk of atomization of family structures, less public spirit and more individual insecurity. Sustainability research must also point out integrating action options in this context.

Social security, solidarity and generational equity

Sociodemographic change has considerable impacts on the social security insurance schemes for pension, unemployment, illness and care. On the one hand, the ratio between those paying into the system and recipients of benefits, which is foreseeably falling off numerically, poses basic questions of distribution between the generations and calls the financing methods applied up to now into question. On the other hand, the so-called normal employment arrangement, based on a married, male, full-time wage or salary earner with several children, is on the decline. For more and more people phases of training, unemployment, self-employment or solely family work interrupt periods of dependent employment. The share of temporarily employed persons, mini-jobs and part-time workers is rising. The social security insurance schemes are inadequately prepared for these discontinuous courses of gainful employment.

The question arises as to how viable the funding of the social security systems through gainful employment is. With a decreasing labour share of total output the economic performance of citizens can be deduced less and less from the payslip. Sustainability research compares the existing social security system to so-called citizen's insurance schemes or tax-financed systems of other countries and develops reform options for the social state that are financially and socially viable on a longterm basis. Such research must be set up on an interdisciplinary basis, including the relevant social actors.

How sustainable are the government budgets at the various federal levels in terms of their amount and structure? When we refer to sustainable fiscal policy, this means two things:

First of all, the government revenue and spending policy must be equally committed to the three pillars of sustainability: environment, industry and social aspects. Current discussions on such issues as the ecological or social policy harmfulness of individual subsidy cases or gender budgeting are taken up here.

Secondly, the principle of equity for all generations requires that the present generation not run up excessive debts at the expense of future generations. Public debt and hidden pension burdens may jeopardize this principle. Even now they restrict the room for manoeuvre significantly. In a generation balance, however, the private transfers between the generations (inheritance of assets) must also be taken into account.

Sustainability research determines how generational equity and sustainability can be integrated into the public fiscal policy. The objective is to point out to political, administrative and social actors the amount and structure that government revenues and expenditures must have so they can be regarded as sustainable and how transitional processes can be geared more to fiscal sustainability. The research policy goals include reinforcing empirical research at universities and extra-university research institutions, integration of non-scientific know-how as well as an improved international visibility of the German economic sciences.

E 4.3 Ecological modernization of society

Research for social action geared to sustainability is aimed at generating problemsolving know-how and making actors – politicians, enterprises, consumers, associations, local government, citizens – more capable of taking action. It will create the knowledge base required for joint action with the actors and thus at the same time making a contribution to methodological and theoretical reinforcement of interdisciplinary and transdisciplinary research approaches.

Control instruments for a sustainable environmental policy

The social turning towards an environmentally sound use of natural resources on a longterm basis has brought about great success in many sectors, as indicated by the purity of the air, the cleanness of rivers and the declining depositions of contaminants and nutrients in the soil. After years of readiness to provide resources for a functioning environment, questions about the efficiency of the funds and tools deployed and their social repercussions are getting louder. How do the targeted ecological goals compare to social and economic goals? What opportunities present themselves for environmental policy in stagnating or shrinking national economies, in times of globalization and radical change in the labour market?

Sustainability research subjects political, legal and fiscal instruments for ecological restructuring of society to an interdisciplinary analysis and develops them further. Sustainability research works out new control strategies against the back-

ground that the state is not the sole norm-setting actor, but acts in competition with or as a subsidiary complement to enterprises, associations and civil society groups with their differing interests and options for exerting influence.

Sustainable consumption patterns and infrastructure

The postulate of sustainability is counteracted when the utilization of natural resources and environmental pollution increase as a whole in spite of a rising number of environmentally friendly products. After all, achieved advances like more economical engines are frequently compensated for by increasing consumption demands (longer distances, automobiles with more powerful engines and heavier vehicles). Technical progress for the reduction of pollution competes with new needs and further-reaching demands, such as fundamentally being able to obtain any marketable product anywhere and at any time.

Within the framework of socio-ecological research integrated solution strategies are developed for sustainable consumption patterns in specific areas of need. They are based on efficiency and sufficiency considerations. At the same time the initial focus is on the field of need related to nourishment (see box “Nourishment as a key to sustainable consumption”). On the basis of experience gained there, action concepts will be elaborated for further fields of need. As far as consumers are concerned, they complement the action concepts that are to be worked out in the 1st field of action (see section E 1.1) from the perspective of companies involved in the value chain.

Another focal point concerns the infrastructures of water, energy and information supply, which represent the long-term

Nourishment as a key to sustainable consumption

The discussions regarding BSE, swine fever and avian influenza have replaced the previous agricultural policy debate over groundwater contamination. Both issues display links to non-sustainability in agriculture. Through the agricultural change initiated by the German Federal Government and the reform of the Europe agricultural policy agriculture has been given a new conditional framework for a change towards sustainable development that has to be completed through action on the part of the relevant actors. Based on an analysis of the decisive factors for the readiness of the agricultural sector to change over to ecological farming, the researchers first of all identify together with the actors opportunities for corporate behaviour and cooperation along the stages of the value chain.

Secondly, the focus is on integrating sustainable nourishment strategies into the everyday routine of consumption. Social development in recent decades is characterized by smaller households, the members of which cook less frequently and instead eat outside their home, as well as the success of convenience food. Since 2002 the BMBF has been supporting socio-ecological research projects that link social and communication science perspectives to business man-

agement, technical and nutritional ecology points of view and develop integrated strategies for a change in nourishment, agriculture and consumption. At the same time the question is asked how preferences form and what legitimation the state has for influencing consumers. After all, consumers have substantial power – and responsibility – to decouple the satisfaction of needs from resource consumption.

Nourishment is more than just a rational or physiological process. It is, at the same time, a sensorial experience, an expression of one's personal lifestyle and a cultural rite. In this context the BMBF funds an action-analyzing project in which these “soft factors” of nourishment are investigated. The economists and psychologists involved contradict views from the traditional environmental debate that consumers only have to be informed and enlightened rationally so they change their behaviour. Together with “slow food e.V.” and other organizations that have committed themselves to slower, more enjoyable nourishment, the researchers hold “nourishment events” for this purpose at which they test different methods of communication and interaction with various target groups and evaluate them scientifically.

conditional framework for individual consumption behaviour. Current trends in privatization and decentralization of the supply of energy, water and information must then be examined with an eye to the potential and risks inherent there in terms of supply security, resource consumption and the influence of the recipients on the supply side.

At the same time the operational uncertainty of organizational, social and above all technological innovations requires development of legal, economic and ethical precautionary instruments that, on the one hand, do not nip every innovation in the bud but, on the other, also avoid unreasonably large economic and social risks.



Future scenarios and strategies for risk management

In the last 30 years the environmental situation in Germany has changed significantly. The sky over the Ruhr is blue again, the water quality of the Rhine is good enough that it is safe for people to swim in it again; many products are recycled. Thus, research must not restrict itself to questions that are already the focus of public debate, but also has to act like a scout in tracking down insidious environmental risks and putting them on the political agenda. In awareness of the general uncertainty about the future in a complex and dynamic world sustainability research is called upon to elaborate strategies for handling ignorance and developments that cannot be forecast precisely.

The research focus here is directed in particular at the opportunities and risks held by key technologies and management in networked systems. Accelerated innovation cycles lead to changes in the private and professional everyday routines of each individual, extending all the way to a reorientation of entire sectors of social action. At the same time this process opens up opportunities and time windows to initiate a change towards sustainability. Methods of innovation and technology analysis can create opportunities for sustainability and competitiveness wherever they find promising alternatives for high-risk developments. Sustainability research starts with these approaches and takes them further, for example by giving consideration to social and political structures and asking what constellations of interest and alliances of actors are promising for efforts to carry through sustainable developments with good prospects instead of risky ones.

Regulations based on liability law, for example, or obligations tied to ownership or use of goods are possible tools in this context. At the technology level certain characteristics appear to be key factors for more sustainable innovations, such as the reversibility of new technologies in the event of risks that are not identified until later or, for example, the adaptability of technological solutions to changes in the social and natural environment.

F. Incorporating sustainability into society



F 1 Communication and dissemination

The complex abundance of research work leads to sustainability only if its results reach the target groups in business and industry, initial and further training and are implemented there. The paramount goal of the BMBF is therefore to bring the results of sustainability research to a broader group of users.

This framework programme aims to initiate new communication and cooperation processes and strengthen the orientation of the supported projects to application and practice by means of the following:

- Integration of partners in practice and potential users into the individual research projects to ensure a strong application orientation and intensify the exchange between science and practice
- Incentives and measures enabling researchers to communicate their work and results effectively and in a way suitable for the target groups, including further training programmes, such as communication and press training courses, and support of effective publicity campaigns at research institutions like open days
- Initiation of generally organized support processes that include interest groups and potential users, communicate research results to practice and get them to be discussed while at the same time providing the opportunity to evaluate research projects from the point of view of the users and adapt them to the latter's needs
- Setting up a BMBF Sustainability Forum that meets regularly and at which the current support announcements are presented to a broad group of interested parties, results are made known and future focal points and further developments of the programme are discussed
- Further development and updating of the Website "Research for Sustainability – www.fona.de", which makes the results of sustainability research available to a wide public, presents actors and reports on current topics and events.

A specific mix of promising dissemination measures will be compiled for the respective focal points. The respective strategy analyzes the potential target groups, such as industry, science, politics and administration, and is oriented to the concrete research goals.

Transfer to industry

In sustainability-related joint projects the BMBF already supports attractive issues, which are usually very application-related, in a close dialogue between industry and research. This strategy will be further extended. In addition, measures optimized for the specific funding focal points are planned in order to support and accelerate transfer of research results to application.

A special challenge is posed by the incorporation of further groups of enterprises, particularly in view of the substantial involvement of the small and medium-sized enterprises (SME). The latter frequently cannot be reached directly, but only indirectly via chambers, associations or special consulting firms or services and the educational system. The results of sustainability research must be provided to the scientific community and industry as well as to the vocational training and further training system to implement transfer via heads. Sustainable processes establish themselves in everyday practice precisely through these

measures (for the envisaged measures in the education sector see section F 2).

Transfer to policy

The Johannesburg action programme demands more scientific know-how for political decision-making processes. According to experience from international processes and bodies, such as the Intergovernmental Panel on Climate Change (IPCC), this necessitates a learning process on both sides and must overcome communication and transfer problems in particular.

As a disseminator and initiator of policy-integrating measures, the BMBF has to provide for the dissemination of research results in different political departments. Thus far this has been done by means of individual forums, rounds of discussion, bilateral agreements and interdepartmental projects initiated by the BMBF. These approaches will be further expanded in the future and, among other things, combined in the BMBF Sustainability Forum that meets regularly.

Target group broad public/civil society

The public is showing increasing interest in research issues and demanding proof that publicly funded measures in education and research benefit social desires. For this reason we want to initiate independent measures in cooperation with partners in the media in order to communicate results of sustainability research to the broad public as well.

To improve dissemination and acceptance of sustainability research, it is also important to establish a dialogue with non-governmental organizations (NGOs) so current knowledge and new problem-solving paths can be incorporated into their daily work. Here again the regular meetings of the BMBF Sustainability Forum offer a suitable instrument for this purpose.

F 2 Education for sustainability

The UN environment summit in Johannesburg called upon the UN General Assembly to proclaim the period from 2005 to 2014 as the decade of Education for Sustainable Development in order to integrate sustainability into the educational systems of the nations at all levels. Supporting education for sustainable development is also a central goal of the German Federal Government. It wants to make education for sustainable development a self-evident task in **all areas of education**.

Networked and foresighted thinking, the ability to participate and show solidarity, interdisciplinary work, skills regarding intercultural understanding and the ability to cooperate are essential qualifications enabling active support of sustainable development in local initiatives in accordance with AGENDA 21.

Imparting specialized as well as personal competencies is the common goal of all areas of education. This goal can only be achieved if the various actors work together as partners: federal, state and local government, industry, culture, science and universities.

Thus, reference is also made to the special relationship

between research in the individual fields of action and education: the framework programme contributes to the generation of new knowledge, and at the same time emphasizes the necessity to pass on this knowledge such that it serves as an orientation for action on the part of the individual. Approaches in this context have already been developed and implemented in a number of ongoing research programmes. For the future focal points within the framework programme "Research for Sustainability" appropriate measures are to be elaborated with the aim of contributing to innovative further development of education for sustainable development in accordance with the goals of the German Federal Government.

General education

To ensure action in accordance with AGENDA 21, education for sustainable development must already be incorporated into schools providing general education. The new BLK (Bund-Länder Commission for Educational Planning and Research Promotion) programme "Transfer 21", for which funding of 12.5 million euros is earmarked, offers a suitable platform for this purpose.



Tried and tested models are available from the BLK programme "21", which was concluded in 2004 after a five-year term. Around 200 pilot schools in 15 federal states (*Länder*) took part in this project of joint educational planning of the federal government and the *Länder*. The basic concept of the programme was implemented via three basic modules: "Interdisciplinary know-how", "Participative learning" and "Innovative structures".

- "Interdisciplinary know-how" is linked to the necessity of "networked thinking" and the development of appropriate problem-solving competencies.
- "Participative learning" takes up the central demand of AGENDA 21, i.e. the participation of all social groups in the process of sustainable development.
- The principle of "Innovative structures" is related to current fields of school reform, such as school programme development, image building and making schools more open.

The BLK programme "21" provides convincing answers: how classroom instruction on sustainability topics can be structured, what forms of participation and opportunities for cooperation with the school environment are available and in general what education can do for sustainable development. Teaching concepts on an

interdisciplinary basis illustrate the connection between ecological, economic and social aspects and specific issues: pupil enterprises make sustainable management experienceable. The many forms of cooperation between schools, local government and companies within the framework of sustainable regional development are excellent examples of methods of making schools more open towards practical subject matter.

In 2004 the BLK decided on further-reaching measures to transfer these results to as many schools as possible. In four years 4,500 schools are to be incorporated into this process, i.e. 10% of the schools providing general education. Special weight is given here to expanding and qualifying support systems, inclusion of primary and all-day schools and integration of teacher training. The corresponding programme "Transfer 21" commences on 1st August 2004. The BMBF assumes half of the total costs. The transfer programme is at the same time a joint contribution by the federal government and the *Länder* to the decade of "Education for Sustainable Development" proclaimed by the UN.

An "Education for Sustainable Development" Internet portal will effectively network the various actors involved in the efforts aimed at education for sustainable development. Supplementary initiatives contribute to the professionalization of the teachers, improve cooperation between the actors at the local level, help to set up international cooperation and generally to intensify and support the incorporation of education for sustainable development into the general education system.

Vocational training

Vocational training has a strategically important purpose in the broad implementation of the guiding principle of sustainable development that requires specific competencies – e.g. the ability to apply know-how and skills in a targeted and problem-solving fashion in connection with increasingly complex tasks. The restructured action-oriented training regulations and framework curricula oriented to the field of learning are to make these competencies accessible. The key point here is the growing independence and personal responsibility of the learners.

Vocational training in the context of research and development attempts to keep the inevitable delay between the emergence of new company-related competence needs and the imparting of such competence in school instruction as short as possible. The incorporation of vocational training aspects into the framework programme can build on numerous BMBF activities. Basic guidelines for the required occupation-specific and general competencies have been identified at 20 actor conferences. The BMBF conference "Vocational training for sustainable development" (Osnabrück, March 2003) has made a major contribution to the specification of the action framework for future activities of vocational training for sustainable development.

In the next step the approaches will be supplemented by examples and pointed out to those involved in the companies in each case, especially the SMEs, as alternative action, and then tested while the prospects of a corporate strategy geared to sustainability are illustrated with the help of directly applicable

tools. Parallel to this, forms of action will be developed that enable and encourage the individual as an employee and consumer to make use of scope for sustainable behaviour and thus, for example, sustainable management as well and, if applicable, actively open up such scope. Furthermore, the actors involved in updating the training regulations, in particular the Federal Institute for Vocational Training, will be systematically informed about the results of sustainability research attained through this framework programme.

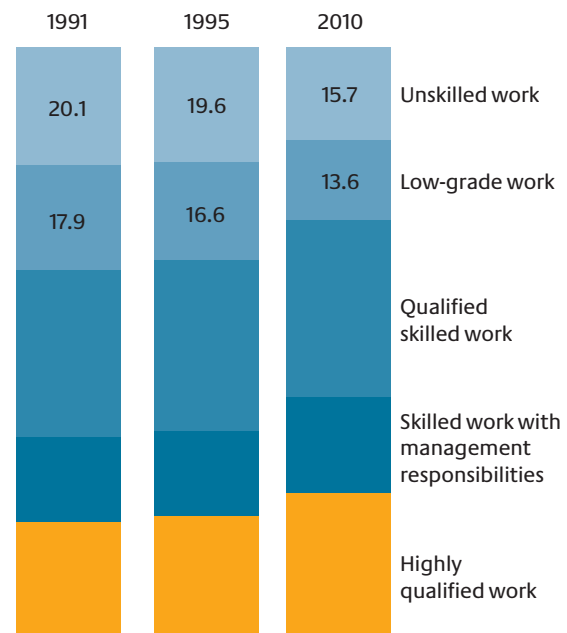


Fig. 4: Gainfully employed persons (excluding trainees) according to level of work in Germany (in %). Source: Schlösser et al. (1999)

University education

Institutions of higher education possess specific sustainability knowledge in the technical disciplines, in the humanities as well as in the natural and social sciences. Their functions include creating a better understanding for ecological, economic and social problems and also discussing ethical questions in society. Because of their function as a model for other important social actors and their role as a disseminator in research and teaching, universities can make a strategic contribution to fostering sustainable development at various levels: creation of knowledge (especially through scientific research), imparting knowledge through university instruction, dissemination of knowledge through information and communication technologies and utilization of knowledge by means of innovative technologies.

As interfaces between research, education and innovation, universities play a key role for an economy and society oriented to the guiding principle of sustainability. Sustainable development places new demands on the strategic development of

universities which require a holistic approach. The focal points here are:

- individual work programmes at the respective universities that are accompanied and supported by a body of experts (e.g. development of modules or courses of study by means of which universities can better respond to local and regional requirements and can contribute to the implementation of appropriate strategies, virtual seminars),
- creation of cross-university partnerships (network of approx. 20 universities) as well as
- comprehensive monitoring of the contributions of German universities for sustainable development to improve social transparency.

Junior researcher funding programmes

The principle of sustainability also results in responsibility for the working world of future generations. A common feature of many



new employment opportunities is that specialized know-how alone is not enough. What is called for is comprehensive competence for taking action that encompasses system understanding as well as the ability to cooperate on an interdisciplinary and transdisciplinary basis.

Special importance is attached in this context to targeted support of the new generation of researchers at schools and universities. It is planned to integrate **special junior researcher funding programmes** into the respective funding focal points of the framework programme “Research for Sustainability”, which have an international orientation as far as possible.

Junior researcher funding is closely connected to the quality of research and the establishment of international relations. PhD programmes are an important basis of research. The new generation of researchers must be given the opportunity here to see their own research achievements in the context of the scientific community and to evaluate them critically. Both (international) conferences and publications as well as research projects can

make a major contribution in this connection. Not only the “classical” exchange countries, such as the USA, Great Britain and France, are of significance here. Contacts and stays in transition and developing countries increase one’s awareness of their particular problems and put young researchers in a position to develop needs-based problem-solving competencies at an early stage. At the same time stays of young researchers and students from these countries in Germany are to be supported to a greater degree. In this way, too, the BMBF meets an important demand of the Johannesburg summit.

Furthermore, networked courses of study and interdisciplinary junior academic groups at universities will be further funded and awards conferred for outstanding research work.

General further education

An integrative understanding of education for sustainable development that goes beyond the areas of conservation and environmental protection is also important for the field of “General further education”. The objective is to initiate innovative developments in general further education to foster an awareness of the necessity for changes in behaviour geared to “sustainability” through targeted project support. This includes:

- “Living well in the ONE WORLD”: Full-time and part-time adult educators as disseminators are to be motivated and qualified to integrate topics of sustainable and viable development into their “normal” educational work, supplement the programme development of their educational institutions with such topics and initiate and support One World project groups.
- Activation and qualification of experience-oriented places of learning (leisure and adventure worlds): The project is to propose and support amusement parks, museums, science centres and similar institutions and to activate and optimize the educational potential of the institutions. To arrive at target-oriented learning from the current randomness of the diverse topic, content and learning structures of the institutions, a cooperation network of institutions will be developed and one or more focal points defined for which the institutions design leisure-oriented learning programmes. Each institution can make an input in this context according to its specific profile and capacity.
- Motivation and qualification of older adults for citizens’ commitment: The goal is to develop and test a concept for winning over, motivating and qualifying elderly persons who are or were already involved in activities in connection with trade unions, staff representative councils, works councils or in other areas for volunteer retirement work. The concept entails addressing and winning over participants, developing further training modules and setting up four project locations.

Junior researcher funding programme

Supporting the new generation of researchers is of great importance for sustainable development in the field of environmental research and research for sustainable development. In addition to general support through grants to universities and extrauniversity research work, which is usually carried out in the form of doctoral theses, all areas of support have special junior researcher funding programmes. International junior researcher funding activities play a special role in this context.



According to a specific recommendation for action from the "Action concept: Sustainable and competitive German water resources management", the BMBF set up the scholarship programme "International Postgraduate Studies in Water Technologies (ipswat)" for winter semester 2001/2002. Firstly, the programme serves the purpose of further internationalization of the German university landscape and, secondly, targeted support of the international "Knowledge transfer via heads" as a funding measure to solve global water problems. Within the framework of ipswat the BMBF grants master's degree and PhD scholarships to German and foreign junior researchers who have outstanding qualifications and complete internationally oriented postgraduate studies related to the field of water at German universities. Through the realignment of BMBF

funding to Global Change – here: in the areas of Climate, Atmosphere, Water and Biodiversity with the programmes DEKLIM, AFO2000, GLOWA; BIOLOG – not only were specialized concepts based on interdisciplinary networking and giving consideration to socioeconomic questions implemented, but also targeted junior researcher funding measures were included for the first time. The motive for incorporating this new funding measure into the programmes arose in particular from the necessity to integrate young researchers into the interdisciplinary cooperation between different scientific disciplines in the area of global change research on their own responsibility at an early stage and thus make a long-term contribution to further development of this complex research field.

Implementation is carried out in different ways. Whereas in GLOWA the junior researcher groups (3 junior researcher groups for each GLOWA network on average) are integrated very closely into the joint project work schedules as regards content right from the beginning, the AFO junior researcher groups (5 junior researcher groups altogether) were thematically involved only in the programme framework. Their design is targeted primarily at implementing scientific ideas with personal responsibility and gaining experience in the management of one's own team. In DEKLIM the AFO model was used and also supplemented by an additional approach. Junior researchers from different institutions worked together in so-called network groups on a joint project such that a

free choice of topics from the programme focal points was possible. With regard to content, the 8 DEKLIM junior researcher groups were then integrated into the four thematic areas of the overall programme.

For the area of funding embracing Integrated Environmental Protection / Sustainable Management an international scholarship programme was set up that is implemented by DAAD (German Academic Exchange Service). In various Asian and South American countries funding is provided to researchers who want to do their doctorates in Germany or their home country on questions of integrated environmental protection in the fields of agriculture / agricultural technology, food technology, leather production and textile processing as well as forestry and wood processing. German researchers are given the opportunity in this programme to conduct research in the above mentioned countries for up to three months. The medium-term objective of the programme is to initiate cooperation in the area of research for sustainable management through international capacity building. Junior researcher funding in the field of oceanographic and polar research as well as the geosciences is carried out to a considerable extent via HGF (Helmholtz Association of National Research) centres. For example, in the AWI Foundation and in GFZ (GeoForschungsZentrum Potsdam) over 200 annex positions have been created for junior researchers and postgraduate students. Furthermore, a scholarship programme for foreign researchers has been implemented by DAAD and is supported through total BMBF funding of 1.5 million euros. Another key funding strategy in this field encompasses secondary training programmes within the framework of scientific-technical cooperation. At present junior researchers in Russia, China, Brazil, Indonesia and the Near East are funded in this connection.

The funding of junior researcher groups in the field of socio-ecological research was announced in 2001. 10 groups were selected for funding. The special feature of the groups is, for one thing, their composition. A requirement for funding is interdisciplinary cooperation in the group that crosses the boundary between natural sciences and social and economic sciences. Secondly, the groups are affiliated both to a university and at the same time to an extra-university institute to improve knowledge transfer and permeability between these two scientific sectors. The selected groups deal with issues that concern, for example, the change in agriculture, sustainable power management, regional value added potential by virtue of sustainable products or sustainable mobility styles. Since researchers who work along the boundary between natural and social sciences often have several degrees or are also involved in activities outside science, these special paths were explicitly taken into account in the specification of the permissible age limit of the junior researcher group leaders.

G. International strategy



Increasing globalization and the rapid development of world-wide knowledge necessitate a more intensive interlinkage between national and international policies and developments. Economic, social and political processes can be viewed less and less from a purely national level, but must be put in an international context.

The sustainability debate has been international in nature right from the beginning and inevitably requires a global point of view with internationally based activities and solution concepts. Accordingly, problem-solving approaches can be started at the national level, but must not end there. Education and research are key elements of international cooperation since they play a major role in building up problem-solving and action-taking competence.

G 1 Political commitments at international level

The international community had already professed its advocacy of the guiding principle of sustainable development at the United Nations Conference on Environment and Development in Rio de Janeiro in 1992 and drew up its global action programme for the 21st century in the form of Agenda 21. The signatory states were called upon to develop a strategy aimed at an economically efficient, socially just and ecologically compatible development.

The World Summit on Sustainable Development in Johannesburg in September 2002 served as an assessment of the previous activities and reinforcement of the concept of sustainability. In Johannesburg the German Federal Government together with the other participating states adopted a plan of implementation as well as the Johannesburg Declaration on Sustainable Development. In the field of research and education the plan of implementation envisages, among other things:

- intensifying research cooperation between developing and industrialized countries
- strengthening cooperation between natural and social sciences and between politics and science,
- incorporating the issue of Sustainable Development at all levels into the educational system as well as

Agreement	Year
General	
UN: Rio Declaration on Environment and Development	1992
UN: Agenda 21	1992
UN: Johannesburg Declaration of the UN World Summit on Sustainable Development	2002
EU: Sustainability Strategy	2001
Resource-specific	
UN: United Nations Framework Convention on Climate Change	1992
UN: United Nations Convention on Biological Diversity	1992
UN: United Nations Convention to Combat Desertification	1996
Education	
WTO: The General Agreement on Trade in Services (GATS) and Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS)	1995
UN: World Decade of Education for Sustainable Development	2005-14
UNESCO: World Declaration on Higher Education for the 21st Century	1998
UNESCO: Declaration on Science and the Use of Scientific Knowledge	1999
UN: HABITAT (United Nations Human Settlements Programme)	1978
UN: Action programme on millennium goal of poverty reduction by 2015	2000

Table 1: Selection of international agreements on sustainability with contribution of the German Federal Government

- improving the access of students, researchers and engineers from developing countries to universities and research institutes in industrialized countries.

Prior to the World Summit the German Federal Government laid down its **national sustainability strategy** and thus declared its readiness to contribute to the implementation of the internationally agreed goals (see section A above). In the framework of the close cooperation within the EU the national sustainability strategy is incorporated into **the European sustainability strategy** that was elaborated in a joint coordination process and adopted at the European Summit in Göteborg in 2001. The European strategy displays a slant of its own through its alignment to EU-specific requirements and tools. It integrates the goals of the 6th Environment Action Programme and extends the Lisbon Strategy for sustainable growth, employment and greater social cohesion by adding an ecological component.

The European sustainability strategy builds on the identification of 7 problems that may seriously or irreversibly jeopardize the welfare of the European society. They are:

- global warming,
- food security,
- poverty,
- increase in percentage of old people in society,
- resource consumption (decline in biodiversity, increasing waste volume, loss of soil),
- traffic overload and
- regional imbalances.

The strategy for coping with the above problems embraces a package of proposals and recommendations, a package of important goals and specific measures as well as steps to implement and review achieved progress.

G 2 Goals

Major BMBF goals targeted by the framework programme “Research for Sustainability” at the international level include:

- Active co-shaping of international conditional framework, programmes and initiatives in favour of the principle of sustainability, in particular by means of
 - a dialogue with decision-makers in partner regions to set up strategic alliances,
 - strengthening multilateral cooperation,
 - supporting sustainability networks as public private partnerships between the government administrations of the EU countries and globally operating industry,
 - supporting the scientific and economic community in initiating international partnerships as well as exploiting international support opportunities
- Exploiting new export and transfer opportunities in research (e.g. sustainable technologies) and education (e.g. action programmes)
- Supporting foreign policy commitments and special agreements in the sustainability sector to which the German Federal Government has committed itself within the framework of its international responsibility (see Table 1)
- Making use of worldwide sources of knowledge to enhance the innovation capacity of German research and industry
- Marketing for German education and research, which hold a top international position thanks to the traditionally high importance of environmental protection with respect to sustainability.

G 3 Implementation

In all fields of action of the present framework programme there are very different starting points, but also clear necessities in terms of international cooperation. The tools used for this purpose include, in particular, bilateral scientific-technical cooperation (among other things, with the network of speakers from the scientific community and the International Bureau), cooperation within the framework of the EU as well as involvement in the programmes and commissions of the respective multilateral organizations. The specific structure will be defined individually according to the field of action and funding focal point.

G 3.1 Bilateral cooperation

Currently Germany maintains scientific-technical relations to over 50 countries worldwide. The partners are both institutions of higher education as well as extrauniversity research institutes and companies. Besides cooperation with industrialized countries, the BMBF supports cooperation with major newly industrialized and advanced developing countries and thus makes a contribution to worldwide economic and social development in the education and research sector.

Sustainable water systems for Central Asia

The region of Central Asia has recently gained increasing importance for the policy of the German Federal Government by virtue of the German involvement in the international security force in Afghanistan (ISAF). In particular Germany supports cooperation within the region, helps in solving social and ecological problems and is actively committed to stability and democratic development. The BMBF supports this policy through cooperation projects in the field of water research and technology. Water scarcity, brought about or reinforced by nonsustainable management, is a major development handicap for the entire region. The phenomenon of progressive desertification around the dried-up Aral Sea is known all over the world. At the same time, however, the per capita water consumption in some countries ranks at the top of the list worldwide due to intensive irrigation agriculture and extremely high losses resulting from dilapidated lines. The situation is aggravated by the increasing pollution of the groundwater as a consequence of inadequate wastewater treatment.

Iran is a pioneer in the modernization of water supply and disposal systems. Major impulses for the neighbouring countries, especially Afghanistan, can be expected from there. For this reason the BMBF supports the cooperation of science and industry with Iran, such as in connection with technologically improved methods of wastewater treatment, minimization of line losses and removal of nitrates from drinking water. This German-Iranian cooperation not only supports improvement of the living conditions in the region, but has also already contributed to the awarding of major contracts to German industry. In Uzbekistan the BMBF supports the development of land and water use concepts aimed at indicating ecologically and economically sustainable alternatives to cotton farming based on intensive irrigation. In close cooperation with the German Federal Ministry for Economic Cooperation and Development (BMZ) the research results will be implemented as a model scheme and contribute to a reorientation of the agricultural policy in Uzbekistan and in the neighbouring countries on a long-term basis. A key element of the project is therefore the scientific education and training of young Uzbeks and support for constructing a local university.

A project at Lake Van, located in the region where the borders of Turkey, Iraq and Iran meet in eastern Turkey, will examine whether separation of the inflowing freshwater from the salty seawater and thus creation of a large new drinking water reservoir is feasible. A common feature of this and other projects is that the results are transferable within the region and possibly to other arid areas and that, in addition to the bilateral research cooperation, capacity building constitutes a key element.

In recent years a number of bilateral projects geared to sustainability have been supported by the BMBF. They include activities concerning land use, climate, water, consumption and global governance. The framework programme "Research for Sustainability" is based on the experience gained there as well as on the existing networks and is aimed at putting isolated activities into an overall context to a greater degree, giving them a strategic orientation and focusing on key guiding principles of sustainability.

The International Bureau (IB) at DLR performs an important function in the implementation process. Thanks to established contacts to the actors in the bilateral and multilateral cooperation and specific knowledge of the relevant countries, the activities can not only be effectively put in an overall context on the German side, but can also be coordinated to the situations and challenges in the respective partner countries and regions.

G 3.2 European cooperation

The overriding goals of cooperation in the European research and education region are exchange and cooperation complementing national efforts and thus enhancement of the international competitiveness of German research.

Germany's and Europe's competitiveness on the world market will profit from an orientation of research and economic activities to sustainability. The integration of national potential and the **utilization of synergies** at European level play a key role in tackling future scientific and social challenges.

The European Research Framework Programme is one of the most important instruments for realizing of the European research area and supporting innovation. The EU Commission makes use of the incentive for targeted technical change to implement the EU sustainability strategy.

The Sixth Framework Programme, which runs until 2006, is designed to structure efficiently research and technological development in the EU Member States, the associated applicant countries and the other associated countries and boost sustainable development through measures with a multiplier effect. The EG framework programme encompasses the specific programmes "Integration and Strengthening of the European Research Area", "Structuring the European Research Area" as well as the programme for the Joint Research Centre and has a volume of approx. 16 thousand million euros. Further funding will come from the contributions of the new Member States and associated states.

The first specific programme focuses on 8 priority issues, of which the following in particular are related to the BMBF framework programme "Research for Sustainability":

- Priority 3: "Nanotechnologies and nano-sciences, "intelligent" materials, new production processes"
Goal: Capacities for building up and making practical use of research in the field of the structure of supra-molecules and macro-molecules as well as their application in the chemical and health sectors.

- Priority 5: “Food quality and security“
Goal: Scientific and technological basis for the production and distribution of safe, healthy and varied food.
- Priority 6: “Sustainable development, global change and ecosystems” (including research in the field of energy and transport)
Goal: Implementation of sustainable development by combining environmental policy, economic and social goals giving consideration to renewable sources of energy, transport and sustainable use of land and sea resources in Europe.
- Priority 7: “Citizens and state in the knowledge society”
Goal: Mobilization of the European research capacities in the economic sciences as well as political and social sciences to build the knowledge society.
- Priority 8: “Support measures and planning in anticipation of future research and technology needs”
Goal: Formulation and implementation of joint strategies going beyond the framework of thematic priorities, e.g. in the area of sustainable development, particularly to support the political goals of the EU in the environment and energy sector.

Furthermore, the following measures, which constitute an integral part of the first specific programme, are of special significance for the BMBF framework programme “Research for Sustainability”:

- Horizontal research programmes with the involvement of small and medium-sized enterprises
Goal: Support of European SMEs in traditional or innovative sectors in strengthening their technological capacity and as competent actors at European and international level; involvement of the SMEs in the 7 thematic priorities to an amount of 15% of the total funds.
- Special measures to support international cooperation (INCO)
Goal: Providing support for international research cooperation with the developing countries, the Mediterranean countries, including the western Balkan states, Russia and the New Independent States (NIS). For developing countries the focus is on ‘Protective use of the natural resources’ with the topics of ‘Management of ecosystems’ and ‘Different needs in coastal regions’. For the Mediterranean countries emphasis is placed on the topics of ‘Integrated water management’, ‘Environmental risks’ and ‘Renewable energies’. For the western Balkan states ‘Elimination of war damage’ in the environmental sector is the focal point. Attention in Russia and the new independent states focuses on the topic of ‘Managing environmental risks in connection with the changes brought about by humanity’.

The commitment and evaluation results of German researchers must be emphasized here. In 2002, for example, a total of 176 project applications were submitted in priority 6.3 “Global changes and ecosystems” (excluding energy and transport), of those 126 applications were with German participation. Around a fifth of the funds available in priority 6.3 were allocated to German research partners.

The BMBF programme Research for Sustainability will focus on future developments, in particular on strategic coordination at national and European level. To prepare for the Seventh EU Research Framework Programme, we have to ensure continuity and long-term synergy between national and European research work, but also take up and implement new initiatives, such as the new action plan for environmental technologies in the European Union 1 (ETAP). ETAP will have a significant influence on the Seventh Framework Programme planned for 2006-2010.

The strategy for linking national support to European measures must be kept in mind. Through preliminary national research activities the ground can be prepared for taking up questions of European dimensions and making our actors competitive. Innovative research topics can be networked and further developed based on national funding in the European research area. Scientific competencies and regional knowhow can be created and backed up through national funding.

The 4 fields of action of the BMBF framework programme “Research for Sustainability” are coordinated with the various priorities in the Sixth Research Framework Programme as well as with the targets of the European sustainability strategy and key international issues (see matrix in the annex). On this basis they are, furthermore, logical in terms of the forthcoming coordination and implementation of the currently assessable contents of the Seventh Framework Programme. The following list makes no claim to be a comprehensive and unalterable strategic concept, but rather points out the synergy potential of the various focal points on the basis of examples:

■ **BMBF field of action 1: Concepts for sustainability in industry and business**

Decoupling economic growth from resource consumption is not only a key aspect of the European sustainability strategy (see section G 1) and in the WSSD (World Summit on Sustainable Development) Programme for Sustainable Production and Consumption of Johannesburg, but also in priority 3 “Sustainable Management” of the Sixth Framework Programme. Further development of nanotechnologies and biotechnologies is another major factor for European and interdisciplinary cooperation; this should be researched and supported in field of action 1 of this framework programme as well under the term “key technologies”. Other examples include the product-based analysis and control of value chains, which is incorporated into the concept of Integrated Product Policy (IPP) by the European Commission, and further technological development in the area of sustainable forestry and agriculture, which is covered in the Sixth Framework Programme by priority 5 and 6. New problem-solving strategies and technological innovations will also be developed to enhance resource productivity. Field of action 1 goes one step further and also looks

¹ Communication from the Commission to the Council and the European Parliament, Stimulating Technologies for Sustainable Development: An Environmental Technologies Action Plan for the European Union, ETAP, 28 January 2004, COM(2004) 38

at the internal and external business processes for sustainability research.

- BMBF field of action 2: Sustainable use concepts for regions**
 Strategies for sustainable land use, further development of innovative management methods or the impacts of the reform of the Common Agricultural Policy of the EU are issues that are found both in field of action 2 and in the Sixth Framework Programme (priority 6.3 and 6.8). Especially the issue of “sensitive regions” in field of action 2 opens itself to international cooperation. As in the Sixth Framework Programme, the focus here is on European cooperation for integrated coastal zone management or how to handle desertification. The focal points of this framework programme, such as marine aquaculture technology and urban mega-agglomerations, have a markedly international orientation – in the year 2050 approx. 80% of urban dwellers will live in developing countries – and are thus especially suited for research cooperation at the European level. They are designed as a complementary measure to the Sixth Framework Programme. Knowledge-oriented climate research has attained a high degree of maturity with targeted national support and is primarily suitable for interdisciplinary work, also in cooperation between the EU and third countries.

- BMBF field of action 3: Concepts for sustainable use of natural resources**

Sustainable use of water as a natural resource is a central topic of field of action 3 that increasingly focuses on the adaptation of nationally supported technologies and know-how to other climatic zones and thus takes up European initiatives (EU Water Initiative, ETAP², 6. RP, priority 6.3.). Concrete contributions are made to protection and management of biodiversity and a national contribution is made to the implementation of the international conventions on biodiversity through the focal point ‘Use concepts for biological resources’.

- BMBF field of action 4: Social action geared to sustainability**

Field of action 4 works up action-oriented solutions to make economic, social and cultural globalization processes more sustainable. This is thematically linked to the research subjects of priority 7 “Citizens and state in the knowledge society” (interrelationships between globalization and convergence pressure) of the Sixth Framework Programme, particularly with respect to research approaches for successful strategies for a liberalized world market, for environmentally and socially compatible globalization and for cultural diversity and identity. Integrated strategies for finding solutions aimed at

² Communication from the Commission to the Council and the European Parliament, Stimulating Technologies for Sustainable Development: An Environmental Technologies Action Plan for the European Union, ETAP, 28 January 2004, COM(2004) 38

Field	bilateral		multilateral	Type of cooperation
	EU			
Food, agriculture and forestry	■		■	Focus on China, Brazil, Scandinavia and eastern Europe, among others
		■		6th Framework Programme, ERA Net, COST activities in cooperation with the new EU Member States to an increasing degree
			■	Cooperation system FAO and the respective international research institutions, such as EFFI
Biodiversity management	■		■	Projects in high-risk hot-spot regions of Africa and Latin America (e.g. BIOLOG, Mata Atlantica)
			■	DIVERSITAS, GBIF
Water management and technologies	■		■	Worldwide cooperation to solve water supply and disposal problems (e.g. Russia) with focus on arid and semi-arid regions, e.g. in Central Asia, Near East as well as Northern Africa
		■		6th Framework Programme; cooperation between upstream and downstream countries in Europe, action plan for western Balkan region
			■	Cooperation with GWSP, HELP
Integrated coastal zone management	■			Indonesia, Brazil, among others
		■		6. RP, INCO III
Sustainable land revitalization			■	IGBP Programme
	■			Cooperation with USA (US EPA), Russia
Sustainable management	■			Focus on innovative environmental technologies in India, China and Russia
		■		6th Framework Programme, ERA Net activities, EUREKA in cooperation with the new EU Member States to an increasing degree
			■	Cooperation with UNEP (Lifecycle Initiative), UNIDO (Cleaner Production Programme), UNESCO, ICSU

Table 2: Focal points of international cooperation

sustainable consumption patterns in selected areas of need correspond to the goals in the WSSD programme on sustainability production and consumption as well as with elements from priority 5 "Food quality and security" and priority 3 (especially: new production processes). The research work is extended at the European level in connection with the search for new forms of evaluation and distribution of work or the question of how generational equity and sustainability can be integrated into public fiscal policy. The field of 'Environment and health' should be pursued more intensively at European level in the future; exceptionally good synergy potential results here with regard to transboundary problems.

A sector-specific strategy must take into account the degree of maturity of the respective research issue and the structure and cooperation of the national actors in science, industry and politics. The type of networking and precise strategy concerning how future national funding will respond to the European projects in terms of its thematic focus and make use of them or bring out new points will be specified in the announcements on the respective fields of action of the framework programme 'Research for Sustainability'.

In addition to this thematic networking, the accession of the ten new Member States, which took place in May 2004, will pose new challenges at European level and require special analysis. The European Commission already created a new advisory body in May 2003, i.e. the "Round Table: A Sustainable Project for Europe". The objective of the latter is to stipulate political priorities for the development of the future Europe and at the same time meet the growing requirements for an ecological viability of economic activities to a greater degree. According to estimates, acceptance of the environmental standards alone will involve costs of 50 to 80 thousand million euros.³ The enlarged Europe has to be oriented to the concerns of the new Member States, also in terms of the content of its research efforts.

National contacts for co-structuring and implementing the support measures of the EU are the network of the National Contact Point (NCP) as well as the specialized coordinators at the project management agencies concerned. Their job is to inform interested parties from the scientific community and from enterprises about the EU's research programmes and provide support for applications in the preparatory phase. The focus here is not only on specialized funding, but also on the arrangement of contacts and providing advice on overriding issues regarding the research framework programme.

G 3.3 Multilateral cooperation

The importance of multilateral cooperation in support of sustainability principles was reaffirmed in the Political Declaration of the Johannesburg World Summit. Bilateral partnerships are a major

step. In future, however, more and more multilateral cooperation will have to follow. Key elements in this context are:

- content-related development and co-shaping of new initiatives (e.g. action plan of the G8 countries for science and technology for sustainable development, G8 Summit Evian 2003, UN Decade on Education for Sustainable Development 2005-2015)
- implementation of multilateral initiatives at the national level (e.g. Climate Framework Convention),
- support and participation in multilateral organizations (e.g. OECD, UN) and relevant specialized institutions.

Substantial strengthening of these BMBF activities is targeted within the scope of the present framework programme. In particular emphasis will also be placed on a closer interlinkage of bilateral and multilateral initiatives in education and research. Bilateral projects will be geared to multilateral goals to a more pronounced degree and vice versa multilateral programmes and organizations will be used more intensively to initiate and implement bilateral projects. Some of the future focal points are shown in Table 2 and are based in part on existing cooperation. Further international activities are in the planning stage.

Further instruments of European cooperation:

EUREKA is a political initiative that offers a framework for transboundary cooperation in the market-related sector. EUREKA projects are geared to the introduction of new products, processes and services. Right from the beginning EUREKA, to which more than 30 countries and the European Commission belong today, has been committed to the concept of environmental protection, especially solving environmental problems and developing suitable, industrial applicable environmental protection technologies. In recent years, therefore, most projects are devoted to the environmental sector.



COST (Cooperation in the field of Scientific and Technological Research), a programme of intergovernmental cooperation, supports international cooperation in the applied research sector between industry, universities and extra-university research institutes. In 17 areas of focus, including the environment, there are currently more than 180 ongoing COST projects. Learning for sustainability through projects and measures connected with the SOKRATES and LEONARDO DA VINCI programmes are supported within the framework of European educational cooperation. In addition to creating an awareness of the significance of sustainable action, the focus here is primarily on initial and further training programmes for the use of environmental technologies.

³ Communication from the Commission to the Council and the European Parliament, ETAP, January 2004, page 5

H. Implementation of the programme



As a rule, a framework programme for project funding is implemented through public announcement of support focal points. The best project proposals are identified and subsequently supported in a competition-oriented procedure according to previously defined criteria appropriate for the respective field (section H 1).

Furthermore, a concomitant programme evaluation (section H 2), a coordinating programme management (section H 3) as well as an intelligent interlinkage for institutional support (section H 4) are necessary.

H 1 Announcements and application procedure

The framework programme is the basis for future BMBF funding measures in the field of sustainable development. Special announcements of funding specify the content of the fields of action and funding focal points indicated in section E. These announcements of funding are published on a broad basis, in the Federal Gazette, on the BMBF homepage and on the internet platform www.fona.de.

The project management agencies commissioned by the BMBF for the framework programme “Research for Sustainability” professionally advise the applicants on the programme goals and possible forms of funding. The contact addresses can be found in the respective announcements of funding and on www.fona.de.

The announcements on the funding focal points provide detailed information on the application procedure. As a rule, the applicants initially draw up a project outline within the framework defined in the announcements. The outline is evaluated with the involvement of an external body of experts. In the case of a positive evaluation, the applicant is requested to submit a detailed, possibly modified formal application. This formal application is used as the basis for the decision on funding after a review of aspects related to the specific field and of administrative aspects.

Assessment of the applications represents a key point of funding. Particularly the evaluation of interdisciplinary and transdisciplinary applications requires further development of the assessment procedures. The experience gained in various areas of funding in recent years will be utilized to ensure the most transparent and efficient assessment possible. The participation of international experts is envisaged for the selection of experts. Gender aspects will be taken into account.

H 2 Programme evaluation – ‘Learning programme’

The BMBF pursues new paths through the framework programme. Sustainability cannot be definitively defined as a typical cross-sectional issue or as a guide for action – sustainability has no specified limits and additional potential lies precisely between the scientific and economic fields and actors. Initiatives and measures must therefore be constantly adapted to new findings. To supply effective contributions for sustainable development, the framework programme “Research for Sustainability” is designed as a learning programme. The experience gained as well as the work and evaluation results obtained will be inputted immediately into further development of BMBF activities and thus necessarily usher in a new course. The evaluation concept is also directed at the publications of the funding focal points and through supporting evaluation guarantees fine tuning even while the framework programme is implemented.

Sector-specific indicators are developed to evaluate the funding focal points. These indicators are specified in the announcements. The results of prior audits and ex-post evaluations are taken into consideration in the new announcements. The concomitant evaluation includes the following key points: achievement of goals / monitoring of effects / economic efficiency monitoring. The crucial criteria for the achievement of goals will be:

- implementation in practical applications, market success, labour market effects
- transdisciplinarity achieved and continuing networking
- scientific excellence
- verified dissemination of the results in the specific educational systems.

H 3 Programme management

The BMBF coordinates overall development of the programme. The project management agencies commissioned by the BMBF assume the broad-based functions of planning, implementation and handling of the fields of action and funding focal points described in sections D and E. This will ensure professional and continuous management. The recommendations of the concomitant evaluation are inputted directly into the development of the programme and the focal points.

To improve networking and communication between the projects and ensure rapid transfer of results into practice (see section F above), suitable in-programme and cross-programme parallel measures will be carried out in cooperation with the project management agencies.

H 4 Links to institutional support

Extra-university research makes a fundamental contribution to sustainability research. Structural measures will further improve its effectiveness at a high level. The goals are optimization of the division of labour, specification of focal points and networking as well as a more pronounced competitive orientation. As a result, more sustainability-geared innovation is to be provided for on a practice-oriented basis.

A crucial prerequisite is to link the framework programme activities to programme-oriented research at the HGF centres, particularly to two programme areas, i.e. ‘Earth and environment’ and ‘Energy and key technologies’. According to its mission, the HGF will be able to input infrastructural services and more long-term and/or broad-based studies and volumes of information, such as data for lifecycle analysis of products and product components. The framework programme must additionally support cooperation between universities and extra-university research institutions in order to combine competencies in a labour-saving manner. New internationally visible Centres of Excellence can play a useful role in this context. The framework programme is aimed at exploiting and systematically funding synergy potential.

Networking to institutional funding will be supported through regular contacts with the research organizations. Reports are to be made on the attained status once a year; success criteria include tackling sustainability problems based on a division of labour, networking actors at university and extra-university institutions on a long-term basis and an exchange of staff.

The Helmholtz research field "Earth and Environment"

The research field “Earth and Environment” of the large research institutions belonging to the Helmholtz association deals with questions of sustainability in various programmes:



Programme 1 "Geosystem: The transformation of the Earth system"

Programme 1 "Geosystem: The transformation of the Earth system" aims at an understanding and quantification of global processes in the solid Earth as well as of their interaction with the atmosphere and hydrosphere. Both are necessary to provide society with suitable strategies for

securing future life on a dynamic planet. The focus is on discovering and modelling relevant geoprocesses, monitoring the state and development trends of the Earth system, understanding and evaluating the impacts and risks of the geoprocesses for the human habitat and developing geotechnologies for use of the subsurface of the Earth. An extensive global monitoring infrastructure will be created and maintained through national and international cooperation for this purpose. This global monitoring system will encompass near-Earth satellites, flying exploration systems, a global network of permanent geophysical and geodetic stations, mobile instrument arrangements and integrated analytical and experimental facilities. The programme is involved in developing solutions for great challenges, such as “Earth dynamics and risks”, “Climate variability and climate change” or “Water”.

Programme 2 "Atmosphere and climate": The atmosphere determines the environmental conditions of the Earth to a great extent. The focus of programme 2 is on a study of the atmosphere and its changes, giving consideration to the complete interactions within the atmosphere and the exchange processes with adjoining subsystems, such as the biosphere. The impacts of human activities on the chemical composition of the atmosphere and thus also on the climate are examined. Research is conducted on dynamic, chemical and microphysical processes as well as related feedback mechanisms so as to improve the predictability of global and regional climate changes. Large-scale international experiments are planned. New types of satellite data (ENVISAT) will be utilized for the various scientific projects. Programme 2 will make a considerable contribution to the great challenges of “Climate variability and climate change” and “Water” as well as a somewhat smaller contribution to “Earth dynamics and risks”.

Programme 3 "Ocean, coastal and polar systems" conducts research on the physical, biological and geoscientific basis of global ocean systems, including the coastal regions and with special weight on the polar regions. Processes and interactions taking place in these systems

play a paramount role for the world climate and thus for environmental changes. For this reason the current changes in key regions and the responsible processes and global changes that are documented in special archives are of enormous interest. The most important goal is to develop a model system capable of making forecasts that also takes into account the interactions between the cryosphere, the oceans as well as the marine biosphere and geochemosphere and quantifies the impacts of these systems on the climate, the energy and material flow as well as biodiversity on different spatial and time scales. On the basis of this model system the second goal entails developing scenarios for control and sustainable use of the marine environment, particularly of the coastal zones.

Programme 4 "Biogeosystems: Dynamics, adaptation and regulation". This programme concentrates on the dynamics, interaction and adaptation of important subsystems within the biogeosystems to human activities and environmental changes. Agricultural systems along with their subsystems comprising soil, water, plants and air are primarily examined, but also useful plants within forestry and agricultural forestry systems and their interactions with the environment. The programme will study how sensitively these primary components react to environmental and anthropogenic changes. The intensities, concepts and methods determined form a reliable basis for correction and regulation of negative and nonsustainable development in biogeosystems. The key subjects of the research are preservation and monitoring of soil functions and of the functional biodiversity as well as of the genetic resources in soils and plants. In this way programme 4 will help to develop concepts and strategies for the protection, restoration and sustainable use of biogeosystems, including the natural bases, i.e. soil, water and plants.

Programme 5 "Sustainable use of landscapes". This programme looks at the influence of human activities on environmental resources in landscapes with the focus on a regional (landscape-based) analysis and interdisciplinary research, in which the natural and social sciences cooperate with each other. This problem-oriented programme mainly concentrates on two different, but often linked types of landscape in densely settled regions with a pronounced human influence, such as urban agglomerations, large contaminated areas or mining landscapes, on the one hand, and semi-natural landscapes with a particular, but not exclusive focus on arid and semi-arid environments, on the other hand. The questions examined include biodiversity and ecological stability, protection of the water resources – from water availability and water management all the way to technologies for the remediation of large contaminated waterbodies – consequences of climate change for land use as well as socioeconomic and legal problems.

In Programme 6 "Sustainable development and technology" innovative technological development and research concentrate on the great challenges, such as "sustainable use of resources" and "social policy dimension of global change". Technological innovations that enable sustainable use of resources, offer solutions for reducing emissions from material flows and enable regeneration of natural resources will make suitable contributions to sustainable development. These technologies will be developed with the help of an integrated approach that also entails technology assessment and socioeconomic research. In cooperation with other research fields and programmes of the Helmholtz association this approach will make it possible to advise the relevant political actors and society by offering integrated strategies for sustainable development.

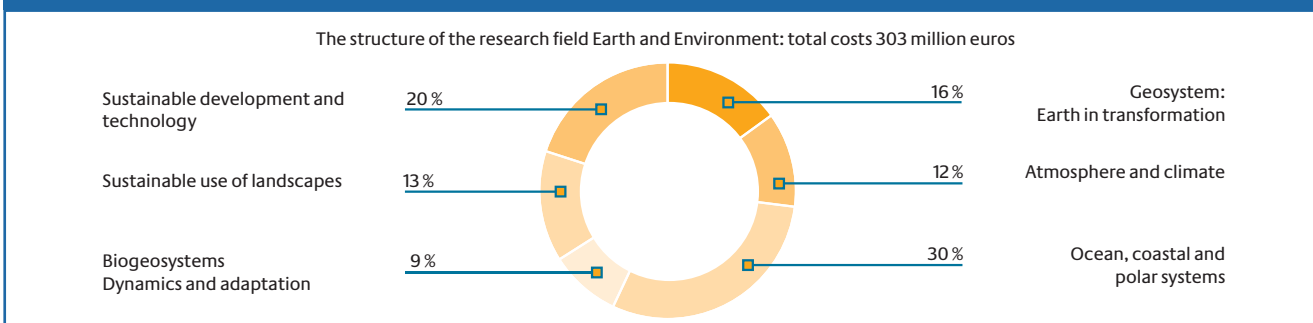


Fig. 5: The structure of the research field Earth and Environment

I. fona – Research for Sustainability



fona – The initiative

Research for sustainability achieves a virtually incalculable wealth of valuable individual results. However, they can make a contribution to sustainability only if they are implemented in practice. This means it must be ensured that the respective target groups in industry and the training sector are reached. Therefore, the goals of the BMBF fona initiative are:

- broader use of the results of sustainability research through the combination and extensive depiction of information and research activities as well as
- setting up a network of actors through thematic linkage of actors with research subject matter.

www.fona.de opens up new means of communication and interaction for sustainability actors. The Internet platform offers information on contacts and contact data regarding project management agencies as well as all actors that are involved in research projects within the fona network or are active in the respective fields of research.

At the same time fona depends on the active involvement of the actors, who have the opportunity here of presenting their own activities in research, development and education for interested parties from society, industry and the field of training.

In addition, actors can also make use of the extensive range of services offered and obtain information on current publications, events, press releases and requests for proposals or themselves point out interesting event dates and links.



www.fona.de

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