Environmental Handbook

-Documentation on monitoring and evaluating environmental impacts-

German Federal Ministry for Economic Cooperation and Development Bundesministerium fr wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)

Wide-ranging and indepth specialized knowledge is needed in order to professionally evaluate the environmental relevance of a project or individual technical plans in the scope of cooperation activities, for example plans for locating industrial sites. The sixty environmental briefs in Volumes I and II provide an overview of potential environmental impacts and known environmental protection measures, they are a working aid when preparing and reviewing a project's environmental aspects and can be used during the planning phase, and also for the final evaluation. The areas covered : cross-sectoral planning, infrastructure, agriculture, mining and energy, trade and industry, are pertinent to all cooperation activities and planning work. Volume III gives an overview of the many environmental parameters and standards applicable in different countries, and facilitates the evaluation of individual environmental impacts. The handbook has been compiled in close cooperation with the Deutsche Gesellschaft fr Technische Zusammenarbeit (GTZ) and the Kreditanstalt fr Wiederaufbau (KfW).

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This Environmental Handbook is a revised version of the 1987 publication "Materialien zur Erfassung und Bewertung von Umweltwirkungen in Vorhaben der wirtschaftlichen Zusammenarbeit" (documentation on monitoring and evaluating the environmental impacts of economic cooperation projects). It takes particular account of new technical developments in the environmental protection sector and the experience gained during use of the original publication. The handbook is intended to provide those engaged in examining the environmental relevance of specific sectors or activities with assistance in identifying and evaluating potential environmental impacts.

Depending on the nature of a project, investigation of its environmental impacts may entail varying degrees of complexity. Where complicated issues are involved it will be essential to bring in experts to elaborate the necessary basis for decision-making. In other cases it will be sufficient to consult a suitable standard work, particularly where less problematic projects are concerned, in order to obtain initial guidance (guidelines) during the project development phase and to provide awareness-enhancing background information for persons whose involvement in the project does not pertain to this particular field. Volumes I and II of the Environmental Handbook contain sixty environmental briefs, each of which covers the typical fields of activity in a specific sector and their potential impacts on the natural and social environment. The authors have endeavoured to compile them in such a way that additional aids are unnecessary to begin with; references to further literature are included. Each environmental brief is structured in the same way; only in the case of those relating to master (framework) planning was it essential to modify this structure in line with the nature of the field covered. In addition to outlining the scope of the sector and the related activities, each environmental brief sets out the potential environmental impacts of these activities, appropriate protective and monitoring measures, and known alternatives or means of preventing undesirable impacts. The notes on the analysis and evaluation of environmental impacts which are included in each of the environmental briefs are supplemented by Volume III, the Compendium of Environmental Standards, which gives an overview of common parameters having environmental relevance, their impacts and the standards laid down in various countries.

The intention was to set out the most important information on environmental relevance in a highly concentrated form and to provide decision-makers and experts with a rapid overview of individual sectors. The handbook was prepared in consultation with the environmental coordinators of the organisations engaged in realising German development cooperation activities, thereby making it possible to draw upon the experience of these organisations (Deutsche Gesellschaft fr Technische Zusammenarbeit GmbH [GTZ], Kreditanstalt fr Wiederaufbau [KfW], Federal Institute for Geosciences and Natural Resources [BGR], German Finance Company for Investments in Developing Countries [DEG], Federal Institute of Physics and Metrology [PTB]). The Umweltbundesamt (Federal Environmental Agency) in Berlin and the Deutsche Naturschutzring (German Nature Conservation Society) also contributed their opinions. GTZ Division 402 will be happy to receive any suggestions for improvements and additions to the handbook. The publisher hopes that the Environmental Handbook will provide all users with valuable assistance in environmentally sound project planning.

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Head of Division
Environment, Resource Protection and Forestry

Federal Ministry for Economic Cooperation and Development

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Guidelines for conducting a comprehensive study of a project's environmental aspects

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A. Necessity of an environmental study

Ascertainment and consideration of likely environmental impacts is an essential part of project planning[1]. The necessary scope of a study on environmental impacts and environmentally sound project design will depend on the extent of the anticipated environmental stresses, the sensitivity of the environmental components requiring protection, the complexity of the project, the availability of information and the stage of appraisal. Particular attention must be focused on projects which typically involve major environmental risks, such as industrial plants producing significant emissions (e.g. refineries), infrastructure measures whose potential impacts are difficult to assess (e.g. construction of new cross-country roads/effects resulting from accessibility) and projects involving extensive interference with the balance of nature (e.g. mining, wood production, utilisation of water etc.). A detailed study will generally be required in such cases.

[1] The purpose of the study is to provide a basis for project planning and appraisal. The results may be presented in the form of a separate study or as part of a feasibility study.

The following key environmental aspects must also be considered for other environmentally relevant projects:

- actual ecological situation in the project region or with respect to specific ecosystem
- existing stresses on the various ecosystems in the planned project location and their likely development if the project is not implemented (baseline state)
- description of the additional stresses imposed by the project and its alternatives
- estimation of future overall stresses
- interaction between ecological, economic, cultural and social effects
- impacts on women to be considered separately
- recommendations for environmentally sound options (alternative methods, emission-limiting requirements), including determination of suitable location
- overall evaluation

In order to lay down the framework and likely **focal areas of an environmental study**, the nature, reach and significance of the planned project's potential environmental impacts must be estimated with the aid of the usual documentation and relevant materials. The basis is provided by information about the project's design and context, the occurrence, dispersal and eventual whereabouts of pollutants, direct and indirect physical interference with ecosystems that affects natural cycling systems, and primary and anticipated secondary impacts on the socio-economic situation of the project region's population. Appropriate terms of reference for the study must then be elaborated on the basis of this information.

B. Basis for investigating environmental impacts

1. Initial information can be derived from the project documents. It must be ensured that these documents provide concrete details that can be drawn upon in assessing environmental aspects. This applies in particular to areas of significance both in technical and economic terms as well as from the ecological viewpoint. Foremost among these are the following:

- use of natural resources
- use of land
- transport situation
- (waste) disposal
- energy consumption
- socio-economic and cultural context
- impacts on upstream and downstream sectors

Where necessary, more detailed information is to be collected during elaboration of a feasibility study, making use of local knowledge where appropriate.

2. In order to determine who is to compile the study and with whose assistance, it is necessary to ascertain the existing scientific and technical expertise, the regulations applied and the extent to which statutory requirements and relevant findings are put into practice. If the structures for ensuring compliance with environmental requirements are considered effective, for example, the environmental study may be confined to particularly difficult and atypical problems.

C. Content and structure of the environmental study

The structure set out below is intended to help ensure that account is taken of all significant environmental impacts in the project region as well as upstream and downstream sectors. Experience has shown that serious environmental damage occurs in cases where follow-on problems were not spotted in advance; one way of preventing such a development is to lay down comprehensive terms of reference. The structure given should be regarded as the maximum scope for a study and is to be used in its complete form whenever complex environmental impacts (as described in A above) are anticipated.

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1. Definition of the area(s) affected

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1.1 Climate and weather

Macroclimate:	radiation, air temperature, atmo-spheric pressure, humidity, precipita-tion,

	evaporation, direction and speed of wind
Microclimate:	inversions, frequency of fog, local winds
Weather risks:	storms, sandstorms and dust storms, hail, torrential downpours, high water, flooding
Risk of natural disasters:	earthquakes, volcanic eruptions, typhoons etc.

1.2 Soil and groundwater

- Soil type
- Soil stability (landslip and erosion risks)
- Soil fertility
- Groundwater resources and their quality
- Groundwater formation and flow
- Geological structure, nature of rock, tectonics
- Groundwater recharge and flow

1.3 Hydrological cycle

- Information on the aquatic ecosystem

- Flowing waters with details of yearly flow and water quality, catchment areas

- Stagnant waters

- Coasts and seas

- Use of waters for fishing

- Obtaining drinking-water supplies

- Other uses

1.4 <u>Vegetation and land use</u>

- Existence of regional planning

- Agriculture: field use, livestock husbandry, irrigation, terracing (large-scale, with use of fertilisers, pesticides etc.)

- Forestry: commercial timber, fuelwood, natural forest, plantations

- Industrial areas

- Transport routes

- Other infrastructure

- Tourist areas/recreational areas

- Functions as a natural environment (particularly sensitive in ecological terms)

- Protected areas

1.5 <u>Flora and fauna with particular reference to their need for protection</u>

- Protected and endangered species (taking into account their position within the

ecosystem)
- Beneficial and non-beneficial species
- Fauna and flora as the basis of the food supply

1.6 Population and settlement

- Size of population, age structure, gender index
- Population density/pressure and carrying capacity
- Sources of income and gainful activity[2)]
- Nutrition, health status
- Level of education, illiteracy rate
- Fuel and water consumption, quantities of solid wastes and wastewater
- Ways of life on the basis of nature and form of land use
- Environmental awareness, attitude towards nature
- Structures for averting and coping with natural disasters
- Form of settlement in the vicinity of the possible project location

[2)] Study of gender-specific environmental relevance.

1.7 Components of the ecosystem meriting particular protection, miscellaneous

- Natural resources: groundwater, bodies of surface water (e.g. containing large fish stocks), soils (e.g. arable farming), woodlands, mineral resources, ecosystems meriting protection, endangered species (conventions on protection of species, international

protection regulations etc.), areas meriting protection for cultural reasons
- Cultural monuments, historical buildings
- Established settlement and social structures
- Settlement landscape and natural landscape

2. Existing stresses and stability/stress resistance of ecosystems

2.1 Atmospheric pollution

(Dust/fine dust including proportion of heavy metals, sulphur dioxide, nitrogen oxide, carbon monoxide, chlorine and fluorine compounds, organic and carcinogenic substances, radionuclides, pathogens, odours, greenhouse gases)

2.2 Stresses and risks affecting soil and groundwater

- Pollution: content in respect of heavy metals, radionuclides and persistent organic compounds from pesticides, bactericides and fertilisers, pathogens
- Risks to soils caused by erosion, changes in pH value, denudation, nutrient leaching, compaction, salinisation, acidification, puddling
- Pollution of groundwater (as for soil)
- Adverse changes in groundwater recharge and groundwater level

2.3 Stresses and risks affecting surface waters

- Pollution(Oxygen content, inorganic substances such as salts and heavy metals, organic substances such as pesticides and bactericides, suspended solids, radionuclides, summation parameters for biochemical and chemical oxygen demand, turbidity, odour, taste, temperature, flow velocity, pH value, pathogens and waterborne diseases)
- Disturbances of the water balance(changes in flow, drawing-off of water, changes in annual characteristics, change in groundwater level)

2.4 Noise and vibration (indicating local habits)

2.5 Stresses and risks affecting the ecosystem as a whole

2.6 Stresses and risks affecting particular species (flora and fauna)

2.7 Special risks

- Epidemics
- Earthquakes, volcanic activity, landslides, earth subsidence
- Storms
- High water and flooding
- Torrential downpours and hail
- Insect pests (e.g. migratory and other locusts)

3. Description of stresses originating from the project

3.1 Description of processes and project activities with environmental relevance

- Products/economic goal
- Description of process, including information on transportation, storage and handling of toxic substances
- Raw materials and equipment used
- Residual (waste) materials, solid wastes and wastewater
- Energy requirements
- Possible malfunctions/operating problems and their consequences
- Planned occupational safety measures

3.2 Direct stresses and risks originating from the project

3.2.1 Atmospheric emissions (Individual aspects as in 2.1)

3.2.2 Introduction of substances into surface waters and groundwater (Individual aspects as in 2.2 and 2.3)

3.2.3 Introduction of substances into the soil (as a sink)

3.2.4 Waste materials, solid wastes and wastewater

- Quantity and nature of waste materials, solid wastes and wastewater produced
- Recycling in connection with the project
- Disposal facilities created specially for the project
- Guaranteed connection to proper disposal systems

(If special recycling or disposal facilities are necessary for industrial projects or large-scale settlement projects, these must undergo environmental impact assessment in connection with the project or separately.)

- Eventual destination of excavated material or mining waste

3.2.5 Noise and vibration

3.3 <u>Indirect impacts of the project</u>

3.3.1 Impacts resulting from extraction of mineral resources for use as materials in the planned project

3.3.2 Impacts of the project on use of groundwater and surface water and on drawing-off of water

3.3.3 Impacts resulting from the use of self-regenerating and non-self-regenerating resources

3.3.4 Impacts resulting from expansion and intensification of land use (including consequences of displacing previous users)

3.3.5 Impacts resulting from off-project disposal of solid wastes

3.3.6 Impacts of infrastructure measures

3.3.7 Impacts occurring during the construction phase

- Energy consumption and meeting of energy requirements
- Potential labour force
- Socio-economic impacts (new settlements, increased gender-specific workload etc.)

4. Assessment of future overall stresses and their impacts

4.1 Overall stresses affecting the individual subsystems and comparison with quantitative/qualitative standards

4.1.1 Atmospheric pollution (Individual aspects as above)

4.1.2 Stresses affecting surface waters and groundwater (Individual aspects as above)

4.1.3 Stresses resulting from recycling of residual (waste) materials and from disposal of solid wastes and wastewater

- in connection with the project (cf. 3.2.4)

- outside the project (cf. 3.2.4)

4.1.4 Stresses affecting the soil (Individual aspects as above)

4.1.5 Stresses caused by noise and vibration

4.1.6 Stresses affecting flora and fauna

4.1.7 Stresses affecting the entire ecosystem

4.2 Impacts of future environmental stresses on environmental components requiring protection

4.2.1 Health and well-being

- Health and safety of employees/users
- Direct adverse effects: immissions caused by air pollution, noise and vibration, pollutants in drinking water, pollutants in food, occurrence of pathogens fostered by presence of wastewater and solid wastes
- Indirect impacts: breaking-up of living environments through construction of traffic routes, destruction of settlement landscape by large buildings, resettlement necessitated by large-scale projects, disruption of traditional ways of life, possibility of uncontrolled new settlement

4.2.2 Microclimate

(Air temperature, duration of shade, evaporation rate, amount of precipitation, wind circulation, frequency of fog, formation of haze, risk of frost).

4.2.3 Soil and groundwater

(Salinisation, nutrient leaching, puddling, compaction, erosion, desertification, soil organisms).

4.2.4 Surface waters

(Eutrophication, degradation, canalisation, impounding to create stagnant waters, aquatic fauna and flora).

4.2.5 Vegetation and land use

(Exclusion of various forms of use, building over, sealing of open areas, monoculture, permitting of changes in land use).

4.2.6 Flora and fauna

(Eradication of endangered species [has a study of an international convention on species protection been carried out], breaking-up of living environments and migratory routes, changes in the spectrum of species).

4.2.7 Physical and cultural assets meriting protection

(Corrosion of structures, loss of historical buildings, impairment of suitability for recreational purposes [loss as a tourist destination], devaluation of residential areas, religious facilities).

4.2.8 Adverse effects on other forms of economic activity

4.3 Summary and weighting of stresses and disturbances likely on the basis of point 4, where appropriate with special consideration of their contribution to global environmental problems

(It must be stated whether environmental impacts are acceptable given the chosen project design, i.e. including protective measures where appropriate, and the specified evaluation criteria).

5. Recommendations for environmentally sound options

5.1 Comments on project location from the environmental viewpoint

5.2 Changes in plant technology

- **Modified production ranges**
- **Alternative production technologies**
- **Alternative raw materials and fuels**
- **Reduced energy consumption**

5.3 Environmental and safety requirements to be fulfilled by a project of the type proposed

5.3.1 Measures to reduce emissions

- Construction and operation of emission control systems: filters and other types of separators for gaseous pollutants
- Treatment plants for wastewater
- Requirements regarding utilisation of residual (waste) materials
- Treatment and incineration plants for solid wastes, landfills
- Connection to disposal systems, recycling

5.3.2 Other measures in the project context

- Reduction of problems during the construction phase
- Reforestation requirements (natural regeneration, restocking) in connection with forest management
- Recultivation measures in connection with extraction of mineral resources
- Groundwater recharging measures
- Inclusion of protective and buffer zones as well as protective forests such as green belts
- Back-up regional development planning

5.3.3 Training and awareness-raising measures for personnel with regard to occupational safety and environmental protection

5.3.4 Development of monitoring measures

- **General organisation of local monitoring and advisory services**
- **Measurement and monitoring by the operator**
- **Monitoring by third parties**
- **Capacities of these institutions**

5.3.5 Organisational arrangements to ensure that planned protective measures are implemented

1. Examination of alternative ways of achieving the project purpose, baseline state.

2. Comments on national environmental regulations and their implementation.

6. Overall assessment and decision-making aids

6.1 <u>Are the project's impacts foreseeable and assessable?</u>

6.2 <u>How is the project to be rated from the environmental viewpoint?</u>

- **As having positive effects on the environment**
- **As having no environmental significance**
- **As defensible, i.e. acceptable with additional conditions imposed where necessary**
- **To be rejected on environmental grounds**

Cross-sectoral planning

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1. Spatial and regional planning

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1. Scope and purpose of spatial and regional planning in developing countries

1.1 Definition of terms / delineation of sector

The terms spatial planning and regional planning are used to denote (integrated) area planning[1)] which covers all sectors and is carried out at regional level by the authorities working hand in hand with national development planning and policy bodies. Regional planning relates to a sub-national planning area with delineation criteria which can be geographical, administrative, based on economic policy or specific to given problems.

1) The term will be construed and used throughout as a generic term for spatial and regional planning.

This brief is a general text for the overall planning of the various sectors (planning of locations,

transport and traffic planning, energy master planning etc.). It includes many cross-references to environmental briefs dealing with the existing and potential environmental impact of projects in individual sectors. Besides affecting those sectors, their impact is also particularly important in the fields of 'forestry planning', 'raw materials management', 'mineral extraction (guideline planning)' and 'urban development planning'.

Area and regional planning projects interfere with natural resources due to:

- **emphasis placed on economic aspects of development planning (area development and housing structure planning, infrastructure planning)**
- **function allocations, area allocation and scale of land-use (type and intensity) and the resulting land-use pattern (area and land-use structure)**
- **location and scale of land-uses and individual projects; influence on existing and future pattern of land-use**
- **influence on regional policy decisions (e.g. through allocation of financial resources).**

Such interventions have an impact on the environment (cf. section 2.3).

1.2 Tasks and functions

Integrated area planning identifies and assesses both land-use potential and the scale of land-use requirements in terms of their character and geographical distribution or allocation. Integrated area planning is designed to cover all sectors and should accordingly perform the following functions:

- regulatory functions: control of land-use through allocation to particular functions, restrictions on land-use and, where applicable, the imposition of conditions so as to avoid or minimise conflicts and risks and optimise potential, through choice of location and other factors.
- coordination functions: reconciliation of individual and sectoral objectives and measures (compatibility, congruence, internal consistency etc.) to meet regional objectives of programme planning (identification of conflicting objectives).
- information functions: acquisition and processing of data on specific problems as the basis for performing the above-mentioned functions and for policy consultation purposes (preparation and justification of regional policy and development policy decisions, e.g. on the allocation of financial resources and manpower, assistance programmes, investment subsidies etc.).

Besides these tasks, institutionalised regional planning can also play an important part in mediating between national and any local planning bodies or interested parties which may exist, with the aim of upholding regional in favour of national interests.

Furthermore, regional planning (programme planning) can also help to coordinate and synchronise programmes of various sponsoring organisations by establishing general conditions and incentives.

Thanks to the cross-sectional approach[2)] (regulation and coordination), regional planning by its nature has the effect of relieving environmental burdens (e.g. by confining burdens to particular areas), but in view of the environmental problems being faced, planners must give priority to

dealing with problems of the environment and resource management[3)]

[2)] The cross-sectional approach is regarded as a strength of integrated planning as compared with sector-specific planning

[3)] cf. also the approaches described in Integrated Regional Developmemt Planning (DRD 1984); 'Economic-cum-Ecological Planning' and 'Regional Environmental Development Planning (ADB 1988)

- in rural areas concentrating on the problem of changes to the ecosystem and the threat to existence posed by irreversible degradation resulting from inappropriate forms and intensities of land-use;
- in urban/industrial areas concentrating on problems of atmospheric emissions endangering human health, either directly or through contamination of the natural systems on which life depends, and problems of environmental rehabilitation and renewal. Here the aim must be to develop rehabilitation programmes (housing, transport, waste disposal) on the basis of maximum permissible immission levels, reducing current levels of emission and avoiding as far as possible any increase in these levels as a result of further housing and industrial development.

1.3 Status and constraints

(Integrated) area planning still has comparatively low status in many countries. The reasons for

this are:

- a whole range of general conditions running counter to area planning, such as an inadequate legal framework, a lack of procedural regulations, lack of financial resources, absence of environmental awareness, shortage of manpower etc.;

- the highly complex nature of general planning activities[4)] which is often difficult - if not impossible - to overcome, because of a lack of political continuity or because of unpredictable changes in terms of general conditions (e.g. through natural disasters, civil war etc.);[4)] Scheduling the requisite preparatory and accompanying planning measures in numerous social, economic and policy fields as well as public relations and consultancy work

- the relative difficulty in implementing area planning measures in the face of opposing economic interests or overuse of the ecosystem in the struggle for survival. Inadequate monitoring of compliance with planning requirements and the failure to punish offenders undermine area planning measures and hinder their implementation in the political and administrative fields.

- the lack of political priority afforded to regional planning in particular, mainly because of planning, administrative and decision-making structures which are centralised and specific to individual sectors, denying regional planning its proper institutional status. To improve the status of integrated area planning it would be necessary

- to improve currently inadequate financial and manpower provisions, particularly at lower levels,

- to broaden the limited areas of competence and responsibilities,
- to strengthen powers to exert authority and take decisions and
- to encourage its incorporation in the administrative structure (cf. section 3).

Last but not least, constraints in the planning process, for example due to lack (i.e. inaccessibility or unavailability) of information, in terms of content, impede realistic problem analysis (causal research, reciprocal effects), the production of realistic forecasts and, where the relevant political and financial factors are out of synchronisation with each other, place question marks over the regulatory, guiding function of area planning and the production of development forecasts.

Besides the restrictions on area planning already mentioned, attempts to take environmental aspects into account are hampered by further constraints, of which the following are examples:

- widespread poverty and deprivation, rendering environmental protection considerations an apparent luxury, at least in the short term,
- absence of environmental awareness (ignorance of the problems) among planners, political decision-makers and those affected, and/or a lack of environmentally acceptable alternative courses of action,
- a lack of manpower and expertise for the assessment of ecological issues, particularly in rural areas,
- the ineffectiveness of area planning measures[5)] aimed at resolving environmental problems in the face of national or international economic interests and dependencies (e.g. over-exploitation of tropical hardwoods; growing of cash crops etc.).

5) Inadequate implementation, ability to monitor and/or punish offenders

Against this background both the range of tools for ecological planning outlined in section 2 (which must incorporate breadth and depth) and the premises for the promotion of area planning and incorporation of environmental aspects (section 3) must be adapted to local problems and circumstances.

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2. An outline of area planning on environmental lines

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2.1 Tools

The central tool for implementing spatial and regional planning decisions is a planning document with detailed explanations of major thematic and area problems to act as an 'information system' and as a basis for decision-making by other planning bodies and political representatives. However, attention should not be directed primarily towards this sort of 'end product' but much more, in sympathy with local institutional and information policy requirements, towards the priority implementation of the planning process and above all the performance of coordinating and

regulatory functions as measures for environmental protection. The range of ecological planning tools (environmental information system, impact analysis, compatibility or risk assessment) is described in more detail in section 2.2.

Performance of regulatory function

Spatial and regional planning should have a positive formative influence on the economic and social development of a country; for example, this involves steering the process of land-use by developing appropriate area and community structure plans. The conceptual models used as a basis for decision-making ('axis models', 'locally centred multi-stage structure' or 'balanced functional area' models, attempts at decentralisation such as 'independent regional development') should be analysed not merely from the ecological point of view for their applicability or relevance to the case in hand.

There are both disadvantages and advantages in a locally centred multi-stage structure as the guiding element inherent in the structural development of an area: the former include a cluster effect on settlement and infrastructural measures resulting in the concentration of adverse environmental impacts in particular areas. The advantages relate to the promotion of medium-sized centres and sub-centres as lines of development primarily for major city centres which have hitherto suffered badly.

The basic principle however, should be to avoid and alleviate the consequences of urban concentration as a priority in the affected areas themselves[6)] before attempting to spread the load. This applies particularly if the intended relief cannot be guaranteed and/or where geostructural

development measures will impose a burden on previously unspoiled areas or those worthy of protection. Likewise in the planning of infrastructural measures for land development and energy supply, care must be taken to ensure that these areas worth protecting are kept as 'no-go areas' and not tampered with or broken up.

6) e.g. through rehabilitation measures and technical environmental protection measures to reduce emissions

An improvement in the ability of densely-populated conurbations to function internally is the most environmentally relevant goal of regulatory and development concepts for the structure of settlements and communities. The primary aim is to improve living conditions and the quality of life by alleviating the worst consequences of population density. Ways of achieving this goal include:

- planning and/or repair/expansion of the transport infrastructure (confining it where applicable) with particular emphasis on public transport planned with the environment in mind (rail);
- planning, maintenance and expansion of the utilities infrastructure (particularly drinking water supply and public energy supply);
- planning and expansion of installations for refuse and waste water/sewage collection and treatment or dumping;
- preservation, development and rehabilitation of open spaces/parks bearing in mind their role as areas which compensate for overcrowded areas. In order to safeguard undeveloped open spaces it is vital to clarify questions of legal ownership of land, access and land price policy as well as functional development and, where applicable, the

rehabilitation of polluted areas.

The principle of functional separation (geographical break-up) particularly in populated areas helps to avoid or reduce stresses arising from incompatible forms of use. In particular the separation of utility, residential and leisure functions from forms of use which generate pollution and noise (industrial production centres, roads, refuse tips) helps to achieve this goal. However the separation principle referred to above can also lead to increased infrastructural expenditure and above all increased traffic because of the greater distances between homes, workplaces and utilities. For this reason, major geographical separations are not desirable from the environmental point of view (concentration of functions increases utilisation of capacity of mains services, for example, and hence their effectiveness). From the ecological point of view close proximity of functions is in fact desirable whilst adhering to minimum distances and conditions of use (restrictions on emissions). The requisite minimum distances e.g. from industrial plants are indicated in the relevant literature[7)]. These distances should be increased by a safety margin (doubled if necessary) because very often compliance with environmental regulations is not guaranteed because of difficulties of enforcement. Minimum distances between areas for food production (agriculture, fisheries) and land-uses which generate emissions (traffic, refuse tips, mines, fossil fuel extraction) should also be adhered to in rural areas.

[7)] cf. ARL 1982; MAGS 1982

In the case of new allocations, particularly of locations for individual projects, the suitability and sensitive characteristics of the area concerned must be considered in conjunction with any existing

designated conservation areas. It may be helpful to draw up project-related 'exclusion criteria' during the search for a suitable location.

Furthermore, it is important from the ecological point of view - as with the procedure for designating priority areas (cf. DOMHARDT 1988) - to designate and demarcate areas reserved for major environmental uses (agriculture, forestry, water management, even recreation), avoiding overlaps wherever possible.

Demarcation should be based not only on productivity criteria (e.g. potential yield) but also on sensitivity criteria; for example, areas susceptible to erosion would not be given designated priority for agricultural use. The designation of priority areas should not merely be taken as a means of setting priorities to safeguard usage/exploitability but also as justification for the right to protection against environmental deterioration.

Performance of coordinating function

This function is greatly influenced by the relevant institutional structures and the nature of their involvement and is therefore difficult to describe in specific terms. The most important coordination task is the promotion of the flow of information between sectoral planning processes. In this it is important to focus attention on the congruence of different environmental objectives. For example, reduction of erosion is in the interest both of agriculture (preserving yield) and of water resources management (prevention of silting because of water erosion). Moreover the coordination function may also help resolve conflicts between the objectives of different sectors through the establishment of separate geographical objectives and, where applicable, by presenting

development alternatives. Finally, central coordination in the planning of activities and programmes may help set geographical and chronological priorities based on a 'cross-sectoral' and cross-sectional approach.

The potential for coordination increases with growing powers to exert authority and take decisions in integrated area planning, as for example in the ability to test sector plans against established standards.

2.2 Incorporation of environmental aspects

In procedural terms, relatively costly procedures for the incorporation of ecological considerations by means of 'environmental relevance tests' or independent specialist planning, similar to Germany's environmental planning system, are unrealistic in many countries at the present time but should nevertheless be a long term goal.

'Secondary integration' of elements of general environmental planning into the regional planning system offers certain advantages from the ecological point of view:

- an independent specialist plan (in this case: general environmental plan) may perform the function of an 'environmental relevance test' and may examine area and regional planning objectives for their environmental relevance,
- the needs of nature and environmental conservation can be portrayed from the point of view of the specialist i.e. without making concessions or compromises at an early stage,
- the incorporation of ecological objectives and measures (e.g. inclusion of conservation

area boundaries, restrictions on use, removal of planned developments from sensitive areas) is a political process in which political priorities have to be set. The ability to compare initial plans with the 'integration product' would improve transparency and comprehensibility (what is technically necessary and what is a political decision) to a significant degree.

However, against the background of the restrictions already quoted, 'primary integration' i.e. 'consideration of ecological factors in development planning' is a more practicable approach and ought to be looked at first of all, with the subsidiary aim of making cross-sectional planning approaches more generally acceptable.

Ecological questions are dealt with as a subsidiary task of regional planning and are incorporated into the individual processing stages (cf. Fig. 1). Objectives, priorities and requirements are harmonised within the administration; the aim should be to optimise the overall geographical development factors in terms of environmental conservation and alleviation of environmental damage.

As a form of integration some sort of "code of practice" may be incorporated into the planning process (mutual exchange of information and harmonisation and allowance for, i.e. adaptation and where applicable modification of, planners' findings).

In order to examine the compatibility of large-scale individual projects, procedures organised along the lines, for example, of German area planning or assessment procedures governing the conduct of investigations into environmental relevance, provide a framework for the incorporation

(consideration) of environmental aspects in decision-making and approval procedures for large-scale projects.

The following chart shows the ideal typical stages in integrated planning alongside those of ecological planning and the required information and integration procedures.

***Fig. 1* - Incorporation of ecological factors into integrated planning**

2.3 Features and methodology of ecological planning

The aim of ecological planning is to preserve or restore the productive capacity of natural resources and to sustain them in the long term[8]. With this in mind the existing and planned land-use pattern must be examined for its compatibility with the specific regional characteristics of the area. In areas of high population density, besides the objectives of safeguarding and developing or regenerating natural resources, the aspects of environmental hygiene and technical environmental protection, i.e. rehabilitation objectives to alleviate existing pollution and other problems, are particularly important.

8) For aspects of 'ecological planning' cf. PIETSCH 1981, BMELF 1985;THNI et al 1990

An inventory of the overall ecological situation involves ascertaining and evaluating the protective functions and benefits of natural resources on the basis of their suitability and sensitivity characteristics as well as relevant land-uses and their environmental effects. Once the causal connections (originator - environmental impact - effects on the resource in question [environmental

impact]) are known, the status quo i.e. the scale of existing problems ('initial loading') can be determined. This provides the basis for a forecast of future environmental threats from planned land-uses and individual projects. The methodological approach on which this procedure is based is known as ecological risk analysis (see Fig. 2)[9)].

9) For methodology or ecological risk analysis cf. BACHFISCHER 1980; EBERLE 1984; for application cf LFU 1987

No generally applicable criteria can be identified for analysis of the environmental loading situation (degree of impairment); it is necessary to 'regionalise' the selection of natural resources affected and/or their suitability and sensitivity characteristics with reference to the natural regional characteristics of the planning area and specify these in concrete terms in relation to the problems/questions arising.

***Fig.2* - Steps to determine ecological risks**

***Table 1:* Analysis of the natural environment on the basis of suitability and sensitivity characteristics of natural resources**

Suitability and sensitivity characteristics of	Possible causes and contributory factors (examples)	Beneficial and protective functions of natural	Necessary information/cartographic documentation

natural resources and parameters for determining these		resources affected by adverse circumstances	(examples)
I. SOIL			
a) General aspects	-		Pedological, general or locational maps, maps of natural area potential
b) Natural productive capacity	Agriculture/ forestry (cultivation, compaction, salinisation, acidification) Settlement (build-ing development) Wind and water erosion Introduction of pollutants (national)	Productive function Food supply	see I a); Details of soil type, soil quality, slopes (relief maps), rainfall quantity and distribution Where applicable, 'soil analysis' by the agricultural authorities
c) Sensitivity to wind and water erosion - Soil type - Influence of	Erosion-promoting forms of use (arable farming, deforestation)	Productive function Regulating (filtering) function Filtration/ storage capacity	see I a); Actual use mapping Details of intensity of agricultural use Arable farming in areas

groundwater and catchment water - Slope /relief - Wind force - Rainfall intensity		Retention capacity Habitat function and locational conditions	liable to flood (flood plains, lowlands) Rainfall quantity and intensity (climatic data)
d) Sensitivity to soil compaction - Soil type - Skeletal content - Humus content - Water content	Agriculture, particularly close to groundwater (lowlands) Forestry (e.g. through use of heavy machinery)	Regulating function - Filtration/ storage capacity - Retention capacity Productive function Habitat function	see I a); Actual use mapping
e) Sensitivity to pollutant con-centration and mobility – physico chemical filtration properties of the soil type - humus content - pH value (acidity)	Settlement/ industry/ commerce Solid waste disposal system (contamination) Agriculture (pesticides, fertilisers) Accidents with substances hazardous to water and soil	Productive function (-> contamination due to concen-tration) Control function - overloading of filtration and storage capacity Habitat function (changes to locational conditions)	See I a); Actual use mapping; Area usage plans (where available); Indicators for high-intensity land-use; trade and industrial locations; plants generating power from fossil fuels; areas of intensive farming (fertiliser and pesticide use), refuse and waste-

	National pollution	Human health In some cases residential and re-creational functions	water treatment plants
II. WATER			
a) General aspects	-		Hydrogeological maps
<u>Groundwater:</u> b) Rate of ground-water recharge/ availability - Soil type - Slope - Actual use/vegetation - Climate. Water resource management	Sealing through building development Soil compaction Tapping of groundwater Lowering of water table Alteration of drainage behaviour of surface water	Potable and industrial water supply Habitat functions/ land characteristics (water system) Productive functions (production conditions)	Soil maps, topo-graphic maps Actual use mapping General water resources management planning (catchment areas) Climatic data
c) Sensitivity to groundwater contamination - Type and thickness	Emmissions from traffic, housing developments, industry and	Potable and industrial water supply Human health	Actual use mapping General water resources management planning (hydrogeological maps,

of confining beds - Filtration or storage capacity (field capacity)	commerce Agriculture (irrigation, pesticide use) Quarrying, mining (groundwater exposure) Refuse and waste water disposal		groundwater level curves)
Surface water: d) Retention capacity - Water absorp- tion capacity - Runoff behaviour of flowing waters - Relief/slope - Vegetation/ type of use	Coverage by building/ sealing of land, especially in flood plains Forestry (deforestation) Water resources management (construction of dams)	Groundwater recharge Erosion control Protection against disaster (flood prevention)	as per 1 a) Actual use mapping Area usage plans (where available) Topographic maps Hydrological maps
e) Sensitivity to contamination of still and flowing waters	Refuse and wastewater disposal	Self-purification capacity Habitat function	General water resources management planning Area usage plans (where

	Industrial, power station and mining emissions (waste heat, salt, waste water) Traffic (shipping) Fisheries Drawing of water	Recreational function Productive function (Water) supply function	available) Water quality mapping Emission data (sewage treatment plants, industrial installations, settlements)
II. WATER			
a) General aspects	-		Hydrogeological maps
<u>Groundwater:</u> b) Rate of ground-water recharge/ availability - Soil type - Slope - Actual use/vegetation - Climate. Water resource management	Sealing through building development Soil compaction Tapping of groundwater Lowering of water table Alteration of drainage behaviour of surface water	Potable and industrial water supply Habitat functions/ land characteristics (water system) Productive functions (production conditions)	Soil maps, topo-graphic maps Actual use mapping General water resources management planning (catchment areas) Climatic data
c) Sensitivity to groundwater	Emmissions from traffic, housing	Potable and industrial water	Actual use mapping General water resources

contamination - Type and thickness of confining beds - Filtration or storage capacity (field capacity)	developments, industry and commerce Agriculture (irrigation, pesticide use) Quarrying, mining (groundwater exposure) Refuse and waste water disposal	supply Human health	management planning (hydrogeological maps, groundwater level curves)
<u>Surface water</u>: d) Retention capacity - Water absorp- tion capacity - Runoff behaviour of flowing waters - Relief/slope - Vegetation/ type of use	Coverage by building/ sealing of land, especially in flood plains Forestry (deforestation) Water resources management (construction of dams)	Groundwater recharge Erosion control Protection against disaster (flood prevention)	as per 1 a) Actual use mapping Area usage plans (where available) Topographic maps Hydrological maps
e) Sensitivity to	Refuse and	Self-purification	General water resources

contamination of still and flowing waters	wastewater disposal Industrial, power station and mining emissions (waste heat, salt, waste water) Traffic (shipping) Fisheries Drawing of water	capacity Habitat function Recreational function Productive function (Water) supply function	management planning Area usage plans (where available) Water quality mapping Emission data (sewage treatment plants, industrial installations, settlements)
III. CLIMATE / AIR PURITY			
a) General aspects		-	Long-term temperature and rainfall measure-ments, including those of specialist planners
Origination and movement of fresh air Temperature and humidity regulation Atmospheric emission protection	Pollutant emissions from power stations, homes, trade, indus-try: - Warming - Interruption of air transit paths through inadequate	Climatic regeneration and balancing functions for populated areas (Residential and recreational function)	Actual use mapping General forestry planning (trade/ industrial locations) Area usage plans

	construction Quarrying/mining: Dust emissions Forestry: - Deforestation of stocks affording atmospheric emission protection - Afforestation in air transit paths		
Origination of cold air/late frost danger	Forestry - Deforestation - Afforestation	Residential functions Recreational functions Productive functions	Vegetation stocks Topographic maps
IV. SPECIES AND BIOCONOSES			
a) General aspects			Natural geographical units Ecosystem types
b) Conservation worthiness Conservation areas of regional, national	- All intensive uses	- Habitat function for (endangered) flora and fauna	Actual use mapping Proven occurrence of protected species National parks, reserves,

and inter-national significance			areas protected under international conventions Non-intersected areas/ecosystem s; animal migration routes
c) Sensitivity to: - Area losses, intersections/ islanding - Introduction of nutrients and pollutants	Traffic arteries roads, rail, canals) Tourism Forestry (deforestation) Agriculture intensification, changes of location) Water management (water pollution, change of area water system)	Function as food source (wild plants, wild animals) Productive function (reservoir for cultivatable species, genopotential) Misc. protective functions (e.g. retention, erosion control, climatic protection)	Actual use mapping National tourism development planning General forestry planning Information on intensity of agricultural use General water resources management planning
V. LANDSCAPE (as affecting quality of life)			
a) Variety, structural richness, closeness to nature, uniqueness	All intensive uses	Recreational function/experience of nature (residential	Actual use mapping Biotopical structure mapping

		function)	Natural geographical units; cultural history (historical monuments, places of traditional cultural interest etc.)
b) Sensitivity to reshaping/open nature/ transparency of landscapes	Reshaping (excavation, power lines, building, deforestation, drainage, coastal works, reservoir construction, dams etc.)	Recreational function Habitat function	Actual use mapping Biotopical structure mapping Natural geographical units; cultural history (historical monuments, places of traditional cultural interest etc.)

The following summary lists possible questions arising at the level of integrated area planning as elements of an ecological risk analysis. These must be tailored to each individual case, above all in terms of their weighting (relevance); the order in which they are listed is not necessarily indicative of the working procedure, indeed, analysis of the suitability and sensitivity characteristics of the natural resources and analysis of the usage pattern affecting these as a result of interactive relationships often overlap.

[continue](#)

Summary 1 **- Questions arising within the framework of ecological planning**

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What are the natural geographical characteristics of the planning area?

Description of landscape factors with the aid of geological, hydrological, pedological, botanical, zoological and climatological documentation.

- What ecosystem types are there?
- Which of the above-mentioned landscape factors are particularly significant to the ecosystem?

Feedback: Does the demarcation of the planning area take sufficient account of the ecosystem networks and functional connections?

If not: (Proposals for) inclusion of areas recognised as important

Identification and evaluation of the suitability and sensitivity characteristics of natural resources as

a basis for appraisal of land capability (suitability for certain uses) and sensitivity to specific burdens (cf. Table 1).

Designation and geographical demarcation of areas with high potential (e.g. land with 'high agricultural recovery potential'; areas with high groundwater recharge);

Designation and geographical demarcation of areas with high sensitivity to environmental influences (such as introduction of pollutants, sealing, soil erosion, division, lowering of the water table); flood plains, areas of little groundwater depth (marshes), flowing water systems, land susceptible to erosion, incidence of rare and endangered ecosystems (flora and fauna);

Designation and geographical demarcation of sensitive land-uses (e.g. residential use, drinking water supplies, national and regional conservation area categories).

Type and extent of initial loading due to existing land-use patterns, impositions on natural resources

Designation and geographical demarcation of areas with high initial loading and those with comparatively few such problems

Identification of initial geostructural loading (e.g. due to settlement/infrastructure)

What existing or planned land-uses/requirements for land use are provided for in the integrated area or specialised area plans?

Schedule of environmental land-uses?

List of specialist planning objectives and measures, in terms of sectors

Which land-uses impose a burden on which natural resources?

Where do land-uses impose a burden on or disturb natural resources which in turn form the basis for other uses?

Geographical demarcation of individual and overlapping land-use demands

Establishment of concentrations and conflicts of use

Why do conflicting uses occur (juxtaposition or geographical concentration of incompatible uses, overlapping), where is human health directly endangered (e.g. through pollutant contamination, inadequate hygiene etc.)?

What are the environmental impacts of these land-use demands and what effects do they have on the relevant resources to be protected?

Establishment of cause/effect relationships

Ascertainment of impact factors and the relevant resources to be protected (natural resources, human beings, cultural aspects)

What are the natural geographical characteristics of the planning area?

Description of landscape factors with the aid of geological, hydrological, pedological, botanical, zoological and climatological documentation.

- What ecosystem types are there?
- Which of the above-mentioned landscape factors are particularly significant to the ecosystems?

Feedback: Does the demarcation of the planning area take sufficient account of the ecosystem networks and functional connections?

If not: (Proposals for) inclusion of areas recognised as important

Ascertainment of burdens/adverse impacts and their intensity based on indicators

How can the areas of impact be demarcated geographically?

Ascertainment of local, regional and national scope and geographical/functional interactions

Where do overlaps arise between usages which impose major adverse impacts?

Feedback: does demarcation of the planning area take account of this?

What is the significance of the environmental burdens expected in the short and long term for national and regional development potential?

Where is the sustainability of natural resources endangered?

What restrictions are there on the exploitability of natural resources?

What burdens are justifiable in view of existing development pressure?

What economic problems are to be expected as a result of environmental damage?

What are the main points to be taken into account in an ecologically oriented target concept?

What particular aspects of environmental and social compatibility have to be considered?

What are the geographical and chronological target priorities?

How should objectives be organised hierarchically (criteria)?

What potential and limits of land-use development exist (in the region) against the background of an ecologically oriented target concept?

What are the alternatives to the existing general system of land-use development?

What are the alternatives for individual specialist plans in different sectors?

For what (geographical and subject) areas should conservation, development and rehabilitation proposals be ascertained?

What conservation, development and redevelopment measures should be proposed?

What are the requirements in terms of conflict and risk avoidance and what are the possibilities over and above the measures referred to above?

Recognition of environmental impacts and clarification of effective interactions (impact models) are important elements in the forecasting of environmental risks. The term "environmental impact" refers to the creation of modifications to the characteristics of the natural resources which may limit their productivity and the sustainability; these are called environmental effects.

The range of environmental impacts to be investigated includes not only direct effects on the location in question but also those affecting neighbouring areas (for ranges see GASSNER/WINKELBRANDT 1990) as well as potential secondary effects and cumulative effects. It is also necessary to consider remote effects (e.g. due to movement of atmospheric pollution) and long-term effects (accumulation of pollutants). The geographical overlap of ranges and distinctions as to type and intensity of environmental impacts results in a system of environmental loading zones which may, for example, reveal regional loading concentrations and indicate a need for action or priorities.

Depending on land-uses the environmental impacts to be expected are essentially as follows:

- **pollutant emissions (gaseous, liquid, solid)**

- noise emissions
- sealing through building, occupation of land area
- sectionalisation/obstruction of compensatory and functional areas
- soil loss through excavation; erosion
- soil compaction/structural change
- salination/degradation, humus depletion (degradation), over-fertilisation (salination)
- lowering of the water table
- alteration of runoff dynamics of regional water system
- exploitation of areas of vegetation/open spaces worthy of conservation.

Within the context of problem analysis and as the basis for problem-oriented planning of objectives and measures it is necessary to establish interactive relationships between those causing and those affected by the impacts. As far as possible the type, extent and direction of changes caused by existing land-uses should be analysed and the areas affected by environmental impacts should be geographically demarcated.

In the human context, the most important function of the environment is to satisfy basic needs; but from the environmental point of view, the protection of psychological and physical well-being (health) and quality of life are also overriding considerations. Indirectly, these existential needs can also be met through preservation of the natural systems on which life depends. Environmental uses and cultural resources (e.g. traditional lifestyles or ways of using natural resources) must be considered among other things in terms of social acceptability as resources worth protecting. Staff with specific knowledge of the local ecology are needed to analyse effective interactions and create impact models.

Summary 2 lists a number of uses or project types which must be assessed in terms of their environmental relevance in relation to the specific regional patterns of use:

***Summary 2* - Environmentally relevant uses**

- **Housing construction**
- **Trade and industry locations**
- **Transport facilities (road, rail, water)**
- **Utility installations**
- **Refuse and wastewater disposal installations, tips**
- **Quarrying/mining**
- **Deep storage of resources (e.g. oil, gas)**
- **Power generation (installations)**
- **Agriculture**
- **Forestry**
- **Inland and coastal fisheries**
- **Recreation/tourism**
- **Water regulation and development**
- **Tapping of groundwater**
- **Outfalls into surface waters**

The intensity of use or the more easily identifiable intensity of loading can be estimated in quality terms on the basis of indicators (cf. e.g. GASSNER, WINKELBRANDT 1990), given that measurement data on the condition of the environmental media atmosphere, soil and water are only very rarely available.

The following are examples of indicators which can be used:

> **Agriculture: prevailing operating methods, use of external energy (frequency of treatment, mechanisation, use of fertilisers and pesticides; irrigated cultivation; special cultivation; grazing frequency and density; forms of stock-rearing)**
> **Wastewater disposal: number and type of discharges (origin of discharge pipes domestic/industrial); existence / state of development of sewerage system and treatment works**
> **Trade/industry: types of establishments, standard of environmental engineering; nature and extent of gaseous/liquid/solid emissions**
> **Traffic: volumes of traffic, state of development; proportion of heavy goods vehicle traffic.**

The evaluation framework must be adapted to regional and/or local conditions; e.g. in sensitive ecosystems, certain forms of land-use must be classified as ('relatively') intensive, whilst in other areas, the same form of land-use may be regarded as relatively extensive.

(Geo)-structural and/or socio-economic changes are brought about along with settlement structure planning (expansion), trade and industry planning (search for locations) and traffic and transport

planning (development), which then have secondary effects on the natural and socio-economic environment. Individual projects may also trigger chain reactions, some of which may have serious national repercussions.

Typical secondary effects, e.g. of infrastructural development, are:

- **settlement of colonies and clearing of territory (e.g. Amazonia)**
- **uncontrolled establishment of trade/industry with subsequent movement of settlements and/or expansion as a result of migration**
- **intensification of land-use with possible consequent degradation**
- **increase in liquid, solid and gaseous pollutant emissions (e.g. occurrence of or increase in refuse and/or wastewater due to expansion of settlements) and**
- **changes in general socio-economic conditions through changes in structures for the supply and marketing of goods or through demand-led increase in land prices or cost of housing (socio-economic displacement processes).**

The latter aspect should be investigated primarily within the framework of social compatibility surveys (vulnerability of ethnic minorities, women and children, traditional lifestyles and family structures).

The main problem with secondary effects is that they are difficult to estimate and the planning guidelines therefore require a great deal of effort. It may be possible to counter these with supporting measures at national level.

At area and regional planning level, it is vital above all to analyse any cumulative and/or synergetic effects. For example, reciprocal effects such as deforestation and simultaneous cultivation of land susceptible to erosion may result in irreversible degradation processes (cumulative effects). Consideration of projects in isolation will fail to satisfy the requirement for analysis of the adverse overall impact on an area, e.g. by combining all the planned projects which impinge on that region.

Ascertainment of all the loading factors must be offset against the productiveness or sensitivity of the natural resources. Initial loading must be taken into account in this process.

Risk assessment is based on an evaluation framework involving a comparison of assessed environmental impacts (intensity of use or disturbance) and assessed characteristic features or sensitivities of the natural resources.

Furthermore, demographic, economic, social and development policy factors as well as legal and institutional factors have a part to play at regional level in the development of the environmental situation in particular, yet extending beyond the scope of area planning. Changes in these factors in the interest of environmental protection should be viewed in the context of the creation/ improvement of suitable general conditions for environment-oriented area planning.

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3. Approaches

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An important prerequisite for effective regional planning is the transfer of political and administrative power, decision-making and management structures to regional and local level. Countries differ in the progress made in this respect and are often found wanting. Only very few countries have created institutions at regional level endowed with appropriate authority, planning powers and finance[10)]. In some cases regional planning is largely done by the national planning bodies and thus has little connection with the region. The failure of decentralisation initiatives often results from:

[10)] Where political subdivisions exist (departments, districts, states, provinces) these levels are used to implement regional planning

- fears that power will be lost as a result
- the financial resources required (cost factor) or insufficient allocations to lower levels
- the additional monitoring which decentralisation must entail (with its foreseeable inadequacies)
- conflicts of distribution and demarcation (clashes)
- lack of suitably qualified staff prepared to commit themselves to the region
- policies that are still biased towards the country's capital.

This means that numerous obstacles have to be overcome in the political and administrative

spheres, such as

- imposing regional (cross-sectional) interests as opposed to the sector-bias in politics and administration
- strengthening decentralised interests as opposed to structurally privileged national interests
- coordinating subregional institutional interests (e.g. of communes) at regional level
- mobilising and motivating local/regional self-help initiatives (public involvement, information etc.).

3.1 Prerequisites and general conditions

As a prerequisite, national and regional planning bodies as well as planning procedures, structures and tools must be strengthened and developed. This involves learning technical skills, improving efficiency and increasing the possibility of exerting influence on sector plans and regional policy (policy consultation). The planning bodies must be able to carry out and implement procedure-based area planning.

This can only be achieved in the long term if conditions in terms of institutions, organisations, information and staff are improved step by step and made to work together in optimum fashion. For project preparation in conjunction with a 'feasibility' study, the preconditions listed in Summary 3 should be checked (deficit analysis), and from this it is possible to identify initial development objectives and to prioritise these where appropriate; the findings from the initial situation or deficit analysis are of fundamental importance to the structuring of the work. The following summary shows a possible method of approach and lists principal subject areas for structuring the development objectives in area planning.

***Summary 3* - Analysis of prerequisites for area planning**

Institutional organisation

Objective: Promotion/optimisation of the development organisation (position in political/administrative system) and of the executive organisation (communication and coordination capability in relation to other executive bodies and decision-makers)

Analysis of institutional development organisation (integration into horizontal and vertical)

- **Level and location of institution responsible for area planning**
- **Existence of other environmentally relevant planning bodies - demarcation of competencies**
- **Powers to exert authority and take decisions**
- **Existence of coordinating and interfacing bodies**
- **Existence and organisation of testing, inspection and approval bodies; compliance monitoring bodies**
- **Existence of state and non-state organisations outside the administration (particularly environmental and women's organisations), estimation of potential for collaboration**

Analysis of executive organisation for integrated area planning

- **Existence of procedural rules and regulations for planning process**

- Analysis of possible forms of participation
- Procedural rules for execution of coordination tasks (information, participation and harmonisation and approval procedures)
- Possibility of involvement by those affected (organisations, associations etc.)

Prerequisites in terms of information

Objective: Targeted, problem-oriented elimination of information deficits.

Long-term: Establishment of an information system.

Identification of information holders (institutions)

- Nature/subject area of data
- Accessibility
- Form in which available, degree to which data has been processed

Prerequisites in terms of staff

Objective: To improve the technical qualifications of staff responsible for area planning, particularly in respect of problems posed by environmental conservation and rural ecology; promotion of interdisciplinary working groups

- Quantity and training of staff
- Training and further education (see above)

- Which tasks can be undertaken with existing personnel?
- Are interdisciplinary working groups possible?
- Who can undertake, and above all continue, coordination and guidance of the working groups?

Public relations activities

- Sensitivity of the political and administrative establishment and of those dealing with environmental problems (increasing consciousness, problem-awareness)
- Existing participatory initiatives (through women's groups etc.)
- Exchange of information with organisations and those affected

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Other important general conditions for the implementation of environment-oriented area planning are: The status of and potential for public involvement, planning law and administration (procedural) law, the status of national environmental legislation and national environmental programmes. The following are some of the aspects to be considered when assessing the possibilities of implementation:

***Summary 4* - General legal conditions of implementation**

General legal conditions

Objective: To ascertain the complementary measures necessary to improve the general conditions of implementation, particularly ecological factors, in addition to 'institution-building' measures

Environmental law

- **Status of environmental legislation for the different environmental media (e.g. water laws, immission laws) as well as limits and guideline values based on such legislation for emission control or 'immission limits', particularly of pollutants, for sensitive land-uses (e.g. habitation, drinking water protection, protection of (flowing) waters)**
- **Existence of minimum quality requirements for food and drinking water and guidelines for handling substances hazardous to water, soil and health**
- **Existence of specialised planning laws (e.g. for refuse and wastewater management) covering organisation of the sponsoring organisation and treatment of substances which affect the environment**
- **Existence of international conservation area conventions and national conservation regulations**

Planning and procedural law

- **Existence of legally enshrined norms and standards for planning and building**
- **Status of legislation governing spatial and regional planning (area planning laws)**
- **Status of legislation covering participation, coordination and approval procedures; regulation of harmonisation obligations**

Disciplinary and criminal law

- **Status of organisation and institutionalisation of state enforcement bodies (e.g. TV (technical inspection association), industrial emission monitoring authority, state forestry authority for timber use)**

The status of environmental, administrative and planning law[11)] depends on the degree of decentralisation and environmental awareness on the part of the political establishment. However, environmental conservation in area planning fails more often because enforcement cannot be verified rather than because of the lack of a legal framework. The main enforcement pitfalls are institutional, informational and organisational shortcomings in administration, the fragmentation of responsibilities and the absence of decision-making and supervisory powers.

[11)] cf. international environmental legislation documentation (Environmental Law Center, Bonn). In the absence of environmental regulations, reference must be made to international atmospheric emission protection data (e.g. from the WHO) or else Federal German standards may be used (e.g. those in the Federal Immission Control Act [BImSchG]) (with safety margins/worst case assumptions where applicable).

For area planning, land law (e.g. communal ownership) is also a fundamental problem when implementing planning functions (particularly in connection with uncontrolled growth of settlements and slum development), since very often rights of ownership, conditions of access and rights of use

are not clearly regulated.

Environmental regulations are often flouted by the population, partly from ignorance and partly from need. Particularly in rural areas, traditional modes of behaviour and social control mechanisms are more highly regarded than legal requirements. On the other hand, traditional, ecologically balanced uses of resources are being displaced by modern developments (e.g. modernisation of agriculture). In this case the planners' function is to analyse the status ante-quo and promote appropriate further development.

Numerous countries have established various forms of national environmental (protection) plans or programmes (e.g. national environmental action plans, within the framework of 5-year plans, cf. IUCN bibliography). If agriculture, forestry or water ministries are responsible for devising these plans, they will generally be limited in terms of geographical scope (e.g. rural areas only) and/or concentrated on problems of individual sectors. Environmental programmes are frequently ineffective due to inadequately specified initiatives, lack of geographical scope or the fact that the programme is not geared to the problems of the sector or environmental medium in question. To improve implementation, as in the case of area planning, it is necessary to modify numerous general conditions or implement additional measures[12)] (particularly in the socio-economic sphere).

[12)] e.g. legislation, land price and stockpiling policy, rights of ownership, fiscal policy, economic and market policy etc.

The existence of national environmental programmes may make it easier to allow for

environmental aspects in area planning if they enable political objectives to be tackled; problem by problem these must then be differentiated, clearly specified and regionalised with the creation of a geographical frame of reference.

An important starting point for improving both preconditions and the chances of implementation is the procurement and preparation of information relevant to the planning and in particular to the environmental aspects. In many countries a serious lack of information must be expected, particularly relating to issues of land ecology. International environmental information systems are available, such as GRID (Global Resource Information Data Base, UNEP); INFOTERRA (International System of Environmental Information, UNEP/UN).

During the 'run-up' stage it is often necessary to establish basic information. From the ecological point of view (cf. ARSU 1989), this should:

- **be gathered and evaluated with full area coverage**
- **be geographically assigned (regionalisable)**
- **cover the different environmental media (soil, water, air)**
- **allow problem-related generation of significant indicators for ecological questions**
- **be capable of continuation, to allow environmental monitoring where applicable (success verification).**

Underlying environmental data must be gathered and evaluated taking account of regional problem areas. The planner must reach decisions in each individual case on the type and extent of the information needed and the way it has to be processed. However, it is important that the data

should reflect the essential resource-specific characteristics (and sensitivities) of the region.

Very often the use of electronic data processing is not justified in rural regions or even in some countries as a whole for reasons of cost, given that it may be impossible to guarantee the long-term management and updating of the information and that the use of technology does not necessarily lead to solutions, with the particular risk that it may become an end in itself. Simple information systems such as maps and plans as well as surveys and land registers are preferable.

"Second generation" satellite pictures (LANDSAT-5-TM, SPOT, KFA-1000) are extremely important sources of information for regional planning (scale > 1:50,000). Assuming they are justified in terms of time and cost, these may be used:

- **to generate underlying maps (topographic maps)**
- **to generate land-use maps (actual use)**
- **to make assessments under certain ecological conditions[13)] such as:**
- **location and identification of vegetation stocks, their composition and vitality (forest damage mapping)**
- **hydrological, geological and pedological mapping**
- **recording of land damage (due to erosion, felling, flood, landslide, forest damage etc.).**

[13)] Possible with LANDSAT Thematic Mapper Images and images with thermal scanners

Other important information sources include - if available - environmental conservation plans and sector-specific plans (particularly for the agriculture, forestry and water management sectors). The

latter, as 'handed-down' plans, are often based on relatively good land maps, climatic data and sometimes also hydrological data, though often the degree of sophistication of such data leaves much to be desired.

The data is processed with the aim of producing a cartographic representation of problem areas and conflicts. The maps should be arranged thematically according to individual natural resources[14)] or alternatively according to problem subject areas (e.g. pollutant emissions and natural resources affected; extent of erosion in evidence and the consequences). Problem and conflict areas can be revealed by means of overlays.

14) cf ARL 1990: Maps of natural regional potential

Through the processing and compression of data in the planning process, the planning documents and results themselves develop into an information tool, assuming a key position among the coordinating and regulatory tools available to the planners.

The information tools 'structural program' or 'regional plan' must therefore be conceived with ease of access for other planning and decision-making bodies in mind (black-white representation, thematic survey maps, tabular summaries and surveys, data registers etc.).

3.2 Incorporation/application of elements of ecological planning

In countries where area structure plans exist or where regional planning is already quite well established, it is possible to use siting procedures geared primarily to functional aspects (e.g. state

of development, foundation soil, proximity to mains supply and disposal facilities, occurrence of raw materials, workforce potential), combined with exclusion criteria[15] relating to each particular type of project (e.g. position in flood plain, proximity to residential areas) and with the identification of 'no-go areas'[16] for projects with major environmental impacts. The latter must be demarcated on the basis of conservability criteria and on the basis of loading criteria (sensitivity of environmental resources and uses). Designated conservation areas of national and international significance for the protection of species and habitats[17] must be regarded as strict 'no-go areas'; likewise national parks, nature conservation areas and zones which shall or should receive similar status in future.

15) cf. the (sector-specific) checklist approach of various 'Environmental Guidelines'. ADB 1987, ADB 1988a and 1988b; MORGAN/NG 1990; WORLD BANK 1988.

16) cf. also ADB 1989: 'Ecologically Sensitive Areas'.

17) cf. IUCN bibliography (Directory of Internationally Significant Conservation Areas).

'No-go areas' may include the following:

- **conservation areas for specific environmental uses (e.g. (drinking) water conservation areas, recreational areas close to areas of human habitation)**
- **areas with special conservation, compensating and regenerative functions, such as**
- **flooding or retention areas for regulation and regeneration of the water system**

- areas with immission protection and climatic regeneration functions (particularly in towns and cities)
- vegetation stocks protecting against climatic effects, immissions and erosion
- areas with problems, in need of protection or particularly sensitive areas such as
- categorized areas in environmental protection plans (e.g. air pollution control areas), parameters e.g. for noise reduction or thermal load distribution, refuse and wastewater disposal
- areas highly susceptible to erosion.

The aim of geographical delineation of no-go areas should be to safeguard certain resource and conservation functions of nature and to prevent other forms of use which cause problems (conflict avoidance). The efficacy of this measure increases with growing political authority in integrated area planning as opposed to sector-specific planning.

3.3 Sector-oriented and cross-sectoral approaches

In countries where integrated area planning is not yet established or is difficult to implement, environment-oriented planning initiatives must be adopted for pragmatic reasons as part of the process of 'ecologisation of sector planning' or of promotion of integrated planning initiatives (e.g. integrated rural development); sector plans (above all for their political enforcement potential) may prove helpful in the implementation of ecological objectives. For this it is necessary to develop foundations/criteria for the 'ecologisation of sector planning' or for its 'extension to cover environmental aspects' (e.g. refer to DOOLETTE/MAGRATH 1990 in respect of water resources management).

In addition, criteria can be devised for use appropriate to the site and geared to sustainability and incorporated into the objectives of sector plans; these criteria are aimed primarily at limiting intensity of use.

The problem lies in determining the limits of 'ecological viability' of a site, beyond which degradation phenomena and environmental damage (caused primarily by arable farming or stock-rearing on land unsuited to that purpose) will occur. The first step is therefore to establish criteria relating to the ecosystem in question for geographical demarcation of areas not suitable for arable farming or stock-rearing. The standard for determining the 'acceptable degree of exploitation' of natural potential is the preservation of lasting capacity for qualitative and quantitative regeneration within the system context. It may be necessary to suggest alternative forms of use (e.g. mixed agro-forestry use) to safeguard the food supply. Various 'eco-development' approaches may be applied, particularly in respect of agriculture and forestry appropriate to their particular location. In this context reference should also be made to the promotion of appropriate technologies.

A precondition for the development of sector-oriented measures and requirements is the formulation of a cross-sectional system of objectives for environment-oriented development covering the entire region. The contributions made by sector plans can be measured and assessed against these proposed objectives (checked against standards).

The chances of implementing sector planning requirements through retrospective restrictions and conditions of use are regarded as remote, because enforcement and punishment of violations cannot be guaranteed.

Integrated planning approaches specially related to the promotion of rural development also have positive impacts from the ecological point of view through their coordinating effect in terms of the harmonisation of development objectives and environmental planning measures in the different sectors (agriculture, forestry and water management). However, the very complexity of the coordination tasks to be performed within the context of these approaches shows the limits of what is achievable within the framework of development objectives.

4. Summary

The exploitation of a country's natural resources is essential to its socio-economic development. The 'limits of ecological viability' are exceeded when overuse and uncontrolled pollutant emissions cause irreversible degradation of the ecosystems combined with a fall in productivity, resulting in contamination of the systems on which food production depends and direct endangerment of health. Integrated area planning and the range of measures available to it are required to help relieve the situation through the establishment of general socio-economic and ecological conditions. From the ecological point of view, this is possible:

- **through plans aimed at environment-oriented development of land-use patterns, taking account of sensitivity and the need for protection of the natural environment**
- **through rehabilitation plans for improvement in particular of environmental quality in areas where adverse impacts on the environment are highly concentrated**
- **through conservation and regeneration plans aimed at avoiding additional environmental**

problems and restoring the productiveness of natural resources
- through the development and creation of environment-oriented data bases as an indispensable prerequisite for consideration of ecological factors.

The following may be summarised as guidelines for environment-oriented integrated area planning:

(1) There must be general analysis of transferability to the country in question of area development plans. The concepts governing spatial and regional planning policies as well as tools and procedures must be geared to local problems and what is 'feasible' (reasonable, on an appropriate scale) in the country concerned.

(2) Area planning as a process requires a long-term guarantee of suitable support or general conditions.

(3) In the context of environmental care ecological interests must be incorporated into the planning process as early as possible. Work must therefore often begin during the data preparation phase.

Geographical allocation of uses should not increase adverse impacts at all; instead of rigid functional separation, a mix of functions should be sought, with adherence to land-use regulations and pollution/(emission) limits. Objectives and measures should be geared more closely to environmental care.

(4) The aim of ecological planning, to preserve the productive capacity of the natural environment and ensure the sustainability of natural resources, must be incorporated into integrated planning

and into sector planning.

Against the background of restrictions to which area planning is subject in many countries, often the first task is to create or improve the general conditions necessary for implementation in terms of information, staff, institutions and organisations.

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2. Planning of locations for trade and industry

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1. Scope

Decisions on locations for industrial and commercial projects or industrial/commercial zones are taken as part of regional and local planning. Since decisions on locations are environmentally

relevant the minimisation of environmental loads must constitute a permanent element of such planning.

Location decisions must take account of:

- requirements relating to location (topography, traffic connections, soil characteristics, supply and disposal facilities etc.)
- sensitivity of the location and its surroundings to certain influences (existing air or water pollution, flora and fauna worth conserving etc.).

The nature and extent of environmental pollution depend on how far the forecasts and regulations made in the planning process coincide with actual environmental impact in subsequent settlement and can be implemented.

While certain environmental impacts such as land use, sealing of land etc. can be forecast quite accurately in the location planning process, other environmental impacts such as accident risks are factors of uncertainty. This uncertainty is partly due to the fact that the actual nature and size of the businesses to be established later is not known at the planning stage.

Unless sufficient allowance is made in the planning process for these factors of uncertainty, a decision on settlement can have serious environmental consequences.

2. Environmental impacts and protective measures

Any large-scale work, particularly the development of industrial and commercial establishments, will have a substantial impact on the environment.

This includes effects on the population, fauna, flora, soil, water, air, climate, landscape, property (including buildings of architectural merit and archaeological remains) and the interactive and synergetic effects of these factors.

Area planning in itself has no direct environmental impact. However, this planning creates a reliable basis for specific settlements which in turn have environmental effects. The nature and extent of the effects depend on the significance of the location within the ecological context and on the nature and size of the businesses to be established there. Therefore the environmental protection function of area planning does not end with selection of the location.

When a location has been established either statements should be made on the type of industry to be established there or a guarantee must be given that the specific environmental impacts will be re-examined and scrutinised if settlement takes place later (environmental monitoring).

If for legal or other reasons it is not feasible or possible to lay down specific parameters for subsequent settlement, the location decision made during the planning must assume the worst case (development of installations with high emissions and high risk potential).

The environmental impacts of industrial developments can be divided into three areas:

- environmental impacts due to construction and operation of industrial and commercial establishments
- environmental impacts due to accompanying infrastructural measures and
- environmental impacts due to socio-economic secondary effects.

These impacts can be countered by means of the following location planning activities:

I. Choice of "macro" location

Here it should be remembered that an industrialisation strategy concentrating on a small number of regions or on one region will exacerbate migration from the land and intensify urbanisation trends with attendant environmental problems (cf. environmental briefs Provision of Housing, Spatial Planning) and may lead to regional concentration of environmental loading and over-use of resources.

II. Choice of "micro" location

The choice of location should be the one from which the fewest adverse environmental impacts are anticipated, taking into account current land-use, adjacent uses and any inherited problems, together with natural features (geological subsoil, water resources, climate, wind conditions, soil, flora and fauna).

III. Conditions and requirements

For type and scale of businesses, particularly in relation to emissions, risk potential, waste,

wastewater, use of resources (water, power), establishment of compensatory measures and environmental monitoring measures/technologies.

The most effective environmental protection measures are those aimed directly at preventing or reducing emissions, land-use and resource consumption.

This can be achieved through

- technical measures, for example by imposing special requirements on the businesses to be located there in respect of minimisation of emissions or air pollutants and noise, wastewater pollutant concentrations, power and water consumption, prevention of soil and groundwater contamination, determination of minimum number of floors in buildings, etc.;
- restriction of types of industrial and commercial operations to sectors producing little pollution or operations suitable for the location;
- geographical allocation of establishments within the industrial area and structural measures to protect residential areas, particularly against noise emissions;
- construction of wastewater treatment plants for purification of industrial and commercial effluents;
- selection of businesses according to criteria such as:
recycling potential, utilisation of process heat e.g. between establishments;
- introduction of precautionary measures relating to installations and devices protecting against outside influences.

If a strategy of prevention and reduction of environmental disturbances as close as possible to their source is not possible for economic, political, planning or legal reasons, the location of the industrial or commercial area must be established so that the interaction with natural local features and surrounding local land-uses gives rise to the lowest possible environmental loading.

2.1 Environmental impact of industrial and commercial businesses

When selecting a location, the following land types are to be preferred:

- land that is unsuited or poorly suited to agriculture
- of little value in terms of protection of species
- lacking in groundwater reserves or having reserves with dense overlying strata and ground with high filtration and buffering capacity
- in climatic positions favouring the dispersion of air pollutants
- at a sufficient distance from sensitive land-uses such as housing and agriculture.

Using this method of site location acute environmental loading can be avoided by diluting pollutants and exploiting the natural regenerative and buffering capacity of the environmental media.

Even so, creeping environmental destruction (high chimney policy, acid rain) may result, and this must be countered at an early stage through constant and extensive environmental observation and monitoring. Possible secondary consequences include the break-up of places of habitation and work, leading to greater environmental problems through increased traffic and the destruction of urban structures.

The natural framework will be impaired by the very choice of a site for the location of industrial or commercial installations, before the activities themselves (e.g. production) have even begun. Therefore the use and intensity of use of an industrial or commercial development and its effects on the environment should be forecast at an early stage and for the long term.

For this purpose, the following information should be gathered (following Simmleit (29)):

Information on the most viable alternative solutions and details of essential selection criteria with regard to environmental impact

Location criteria

- **meteorological and microclimatic situation and air purity**
- **water quality and hydrological situation**
- **hydro(geological) and pedological situation**
- **noise**
- **earthquake risk**
- **vibrations**
- **conservation areas and rare biotopes**
- **islanding effects for flora and fauna**
- **intersection of land areas and neighbouring land use**
- **displacement of agricultural production**
- **utilisation of natural resources**
- **protection of cultural heritage (buildings, archaeological digs etc.)**

- infrastructure (roads, buildings, power and water supply)
- wastewater infrastructure
- waste disposal infrastructure
- transport links
- traffic volume

It is also necessary to indicate:

- alternative production processes
- alternative raw materials
- alternative construction methods
- alternative wastewater and waste air treatment plants
- alternative waste treatment or recycling facilities
- alternative energy supply
- alternative storage facilities for dangerous goods

Detailed description of project

- description of physical characteristics
- project location
- nature of industrial or commercial operation
- size of industrial or commercial operation
- land area required during construction and operation
- description of principal features of production processes

- type and quantity of materials to be used
- storage and transportation of raw materials, semifinished products and finished products
- type and quality of expected residues and emissions during construction and operation of installation
- susceptibility to malfunction and risk potential
- water requirement
- wastewater volume
- waste volume
- possible contamination of soil, groundwater and surface water
- pollutant emissions into the atmosphere (gaseous, particle)
- energy consumption
- light emission
- heat emission
- other radiant emission
- vibrations

Description of the environment that may be significantly disturbed by the proposed settlement

- population (resettlement)
- fauna
- flora
- soil
- water
- air

- climate
- properties (including buildings of architectural merit and archaeological remains)
- landscape (recreational areas)
- interactive and synergetic effects between factors listed above

Chronological description of possible substantial environmental impacts of the proposed industrial or commercial development as a consequence of

- existence of the industrial or commercial installations
- use of natural resources and
- emission of pollutants, the generation of environmental nuisance and the treatment of waste.

This description should cover direct and also any indirect, secondary, cumulative, short-, medium- and long-term, permanent and sporadic, positive and negative effects of the development project.

A precise assessment of certain sector-specific effects can be carried out on the basis of the environmental briefs relating to the field of trade and industry.

2.2 Environmental impacts of associated infrastructural measures

A substantial prerequisite for the operation of an industrial or commercial location is an infrastructure (supply and disposal system) geared to the requirements in question. Planning of locations for industry and commerce must therefore include a plan for the necessary infrastructural installations, which for their part have environmental impacts, some of them major.

In particular the following infrastructural fields are affected by location planning:

Traffic

An essential requirement for an industrial/commercial location is an efficient transport network (road, rail, water, air) for transportation of employees, goods, means of production and waste materials.

This creates problems for people and the ecosystem through noise, vibration, air pollution, water pollution, sealing of land, intersection of open spaces etc. The population affected experience considerable traffic nuisance, particularly from heavy goods vehicles.

See also environmental briefs Transport and Traffic Planning, Road Construction and Maintenance, Road Traffic, Railways and Railway Operation, Airports, Shipping on Inland Waterways.

Energy supply

There can be a substantial energy requirement for certain industrial sectors such as steel production, particularly where electric furnaces or smelting plants for non-ferrous metals (aluminium smelters) are used, and for the generation of heat and steam in large furnaces using solid, liquid or gaseous fuels. This may necessitate the new construction or expansion of power stations of all types, transformer stations, power lines etc. The resulting secondary environmental effects (e.g. air pollution) may in some cases be considerable.

See also environmental briefs: Energy Overall Planning, Power Transmission and Power Distribution.

Water supply

The industrial supply of coolant water, service water and potable water can inflict serious problems on the local population through consumption of scarce resources, particularly in arid areas.

The use of water supply pumps may cause a noise nuisance.

Apart from power stations, the most significant industrial water consumers are the steel, paper, cement and chemical industries, to varying degrees depending on the production methods used.

See also environmental briefs: Water Framework Planning, Urban Water Supply, Rural Water Supply, Wastewater Treatment.

Sewage and wastewater treatment is closely connected with the field of water supply. Health risks and disturbances to the ecosystem caused by industrial wastewater (e.g. heavy metal content) must be prevented by means of an environmentally sound overall concept.

See also environmental briefs: Wastewater and Rainwater, Solid Waste Disposal.

The problem of industrial waste and the treatment thereof assumes central importance because of the major potential environmental impact in terms of hygiene, soil, water and air, particularly in the case of highly dangerous toxic wastes (special waste).

See also environmental briefs: Waste Management and Disposal of Hazardous Waste.

Reference is made to the briefs on mining and energy as well as trade and industry in addition to the environmental briefs on infrastructure already quoted for a detailed assessment of environmental impacts by infrastructural installations.

2.3 Social implications

Resettlement of and new settlements for people are consequential effects of an industrial location being planned.

Workforce migration can cause severe problems in terms of housing, mains services, traffic, refuse and sewage volumes, fuel and water consumption etc.; established social structures may also disintegrate.

There is also a danger that the policy of minimising adverse effects on the environment through distance will gradually become less and less effective as separate industrial/commercial and residential areas steadily grow towards one another.

3. Notes on the analysis and evaluation of environmental impacts

As already mentioned, all industrial and commercial activities affect the environment adversely to some degree. At best, therefore, the aim of observing environmental impacts can only be that of

allowing selection of those locations and uses which impose the lowest environmental loads.

The methodological procedure for data-gathering, forecasting and evaluation of location planning from the point of view of environmental impacts should be based on the following scheme:

Inventory and assessment of the initial situation at the various alternative locations (location alternatives) in terms of

- **current land-uses and functions for people (e.g. climatic function, recreational function)**
- **scope, quality and exploitability of natural resources**
- **function of protecting species and biotopes.**

Status quo forecast (how the site will develop without the arrival of industry or commerce.

Quantification of impact (industrial or commercial area with associated infrastructure) and possible measures to alleviate and compensate for disturbance (technical alternatives in terms of resulting adverse impact factors), e.g. by means of

- **wastewater treatment plants**
- **spent air cleaning plants**
- **reuse of waste (recycling etc.)**
- **recultivation measures**
- **use of non-polluting raw materials**
- **use of low-emission production methods.**

Description of socio-economic secondary effects and problems they cause.

Description of the sensitivity of the natural environment, of resources and of uses in terms of the expected load factors (e.g. initial loading of air and water).

Forecast of effects of an industrial development, including measures to reduce and compensate for impairments in the various locations.

Evaluation of the situation after completion of the industrial or commercial development.

Environmental considerations can be catered for more easily if a comprehensive legal framework exists governing planning and construction processes on the basis of which approval procedures for a specific industrial project can be undertaken.

Ordinances for individual businesses may for example lay down emission limits for protecting the natural systems on which life depends when industrial and commercial developments are planned and constructed. However, unlike immission limits, these emission limits only govern adverse environmental impacts indirectly.

It should be noted that limits do not yet exist for all environmental problems relating to industrial or commercial developments (e.g. impacts on the natural environment). In these cases operating guidelines should be developed and recommended to protect human health and the natural environment.

To accommodate environmental concerns when planning locations for trade and industry,

international guidelines of the EC, WHO or other organisations (see section 6, references no. 12, 32-37) provide important reference values, but these should only be applied taking into account local circumstances (inherited environmental problems, future development trends etc.) of the country or region.

4. Interaction with other sectors

Planning of locations for trade and industry must take account of interactions with other sectors because close `dovetailing' may produce negative synergetic effects, resulting not only in the exceeding of emission limits and excessive consumption of natural resources but also in a reduction of their regenerative capacity.

Planning of locations for trade and industry makes allowance for possible environmental effects not only of the installations but also of the associated infrastructure. Certain important links with other sectors have already been mentioned.

5. Summary assessment of environmental relevance

Planning of locations for trade and industry is a tool for implementing economic and structural policy. The resulting measures always involve impacts on the natural environment and the

landscape which can hardly ever be reversed if important environmental and social effects are not considered in the planning phase.

Therefore a precise forecast of the consequential effects on people and the environment is required, including an examination of the possible alternatives (cf. 2.1).

In principle, forecast and assessment of environmental impacts due to selection of a particular location for industrial or commercial projects can have three outcomes:

- **a recommendation that the location is suitable for industrial or commercial purposes, because no serious environmental effects are anticipated, or the planning data submitted is enough to show that there is no possibility of reducing the effects or of finding an alternative location.**
- **a recommendation that the location should not be put to industrial or commercial use on the grounds of adverse environmental impact.**
- **a recommendation that the location should only be used for the development subject to implementation of certain improvements or compensatory measures.**

This may refer to the location as a whole, or to certain areas used for specific types of production.

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3. Overall energy planning

Contents

1. Scope

The energy system of a country comprises all the components of primary production of energy (e.g. coal mining, oil production, collection of biomass in rural areas, energy imports), the entire conversion sector (production of secondary energy sources, e.g. manufacture of petroleum products from crude oil in refineries or generation of electricity in coal- or oil-fired power stations or using hydroelectric power, or the "refinement" of biomass, e.g. using charcoal kilns), the infrastructure necessary for distribution and storage of energy sources (e.g. tank farms, pipelines, power lines) and technologies for eventual energy use (e.g. motor vehicles, stoves, lamps, refrigerators etc.).

Fig. 1 - The energy system and its adverse environmental impacts

An energy system is an essential supply sector the principal purpose of which is to provide energy services (e.g. for cooking, lighting, air-conditioning, transport etc.). Energy systems are flexible within certain limits, i.e. the energy service desired can be provided by means of a number of different technologies based on different energy sources (e.g. electricity, petrol, coal etc.).

Because of its great significance for the functioning of a community and the long periods which sometimes elapse between the identification of a requirement, the investment decision and the commissioning of plants and networks, together with long-term impacts on the environment and on society, overall energy planning (OEP) assumes an important role as a coordinating tool.

The range of tasks covered by OEP includes clarification at local, regional and national level of when, where and how much of the various types of energy (electricity, fuels, heat etc.) has to be provided and what measures are necessary to satisfy demand (increasing requirement, demand forecast). Existing supply systems (fuels etc.) are investigated in terms of their financial, economic and ecological feasibility. This takes into account current and anticipated future general circumstances of the country in question, technological progress and probable changes in the world energy sector (looking ahead for 10 to 30 years). From analyses of various demand structures and potential ways of meeting demand it is possible to devise scenarios whereby energy-policy decisions, such as investments in power stations and networks, formulation of pricing policy (tariffs, charges, taxes, subsidies) and identification of environmentally acceptable supply routes in terms of their prerequisites and anticipated impacts can be opened up to public debate and compared. In this respect fair distribution of energy in regional and social terms is particularly important.

In the case of projects involving public utilities or state controlling authorities, general energy/economic statistics are of central importance in terms of the energy requirement of all areas of supply. Specific factors (preferences, consumption habits, ability to pay, costs, availability of energy) must be taken into account when dealing with sector-specific and regional sub-structures of the energy-producing industry, as is the case with special studies for trade, industry and for private households (plant designs, local and regional energy concepts). This also facilitates the development of so-called "tailor-made" solutions. Ideally findings in these subsidiary areas should be used to fine tune OEP at national level, to find solutions which improve not only the economy but also other aspects such as fairness of distribution.

National energy systems throughout the world vary widely:

- First of all, the structure of energy consumption varies. In some cases -with the exception of hydroelectric power - fossil fuels (e.g. coal, oil, gas) are used almost exclusively. Nuclear energy will be disregarded in what follows[1)]. In some countries there is still very widespread use of biomass (firewood, agricultural residues, dung). Use of renewable energy sources such as solar and wind energy is still very limited. The structure and level of energy consumption frequently varies considerably from town to country.

[1)] In what follows the use of nuclear energy is disregarded because its environmental acceptability is still the subject of much controversy in industrialised countries and it is impossible to make a definitive assessment (particularly given problems of final storage of radioactive waste) and

because it is used and/or considered for use in very few developing countries (particularly in view of stringent operating requirements and high investment costs).

- There are also wide differences in the level of energy consumption. High-income countries on average consume 230 GJ per head of population (USA 360 GJ, Germany 200 GJ), but the figure for medium-income countries is around 125 GJ and for low-income countries 25 GJ.

If we consider only those energy sources traded on world markets, the differences are even more extreme: per capita consumption in medium-income countries falls to around 15 GJ and in low-income countries to 4 GJ, i.e. only one 60th of consumption in high-income countries.

In many countries, future energy demand will develop along two different characteristic lines: (1) A growing population, rapid urbanisation, increasing industrialisation and mechanisation of agriculture will cause energy demand to grow more strongly. (2) Fossil fuels will account for a greater proportion of overall consumption in developing countries because certain energy services are directly dependent on them, and cheap, efficient alternatives are not available for the time being. For example, the use of petrol and diesel fuel will still be of major significance for road transport in future. Where adequate supplies of hydroelectric power are unavailable, countries will look to increased use of fossil fuels to meet growing electricity demand.

Energy planning must react to these needs, but can also analyse reported demand and take account of possible alternative forms of development.

2. Energy installations and fuels - Environmental impacts and protective measures

All forms of (man-made/industrial) energy supply and all uses of energy are environmentally detrimental and exert some degree of human impact. The nature and intensity of these impacts depend on the way in which the actual energy service is provided. Early consideration of the environmental impacts of the various energy systems (i.e. as early as the planning process) is advantageous for two reasons:

- Social priorities and probable impacts of various energy supply methods can be compared with one another. By looking at the costs and benefits of different supply methods or projects for different social groups - if possible with the involvement of the population groups affected - decisions can be made transparent.
- The avoidance or minimisation of environmental problems *beforehand* (preventive environmental conservation) is generally far more effective and economical than subsequent cleaning up or "rehabilitation" of a polluted and partly destroyed environment *afterwards* (reactive environmental protection).

The OEP in itself has no direct impact on the environment, but planning outcomes differ considerably in terms of their environmental relevance. Therefore at this point we merely refer to other environmental briefs in which the environmental impacts of energy installations for production, conversion and utilisation of various energy media are identified and evaluated:

- Rural Hydraulic Engineering
- Large-Scale Hydraulic Engineering, Dams and Weirs
- Surface Mining
- Underground Mining
- Minerals - Handling and Processing
- Thermal Power Stations
- Petroleum and Natural Gas - Exploration, Production, Handling, Storage
- Power Transmission and Distribution
- Coking Plants, Coal-to-Gas Plants, Gas Production and Distribution
- Renewable Sources of Energies.

3. Notes on the analysis and evaluation of environmental impacts

At all planning stages, OEP must take full account of the diverse impacts of the energy system on the environment. Planning must take account of the current situation of the country. The level and structure of energy consumption vary according to economic strength, availability of resources and geographical position; existing burdens on the different environmental media vary, and different forms of development are possible depending on technological and financial capacity.

For a realistic assessment of environmental loads generated by energy, the entire process chain must be examined from primary production of energy, including individual conversion stages and actual energy use by the "consumer", right through to disposal of waste and residual materials. In

other words, it is not sufficient to carry out analyses simply on the basis of a specific project plan (e.g. power station, supply line); upstream and downstream aspects and also, where applicable, the pretreatment of materials, must also be taken into account.

A prerequisite for analysis and evaluation of environmental impacts is a reliable database, which also describes the current environmental situation (initial loading) of the country or region in question. In this way it is possible to determine the extent of existing environmental loading and changes due to measures already executed or planned can be measured or estimated. Such data (e.g. environmental registers describing the extent of immissions in a region) are often unavailable, and must be gathered in order to arrive at a reasonable concept assessment, or replaced with suitable indicators allowing appropriate judgements to be made. When designing an environmentally acceptable energy system, national regulating bodies in other countries and international organisations can provide important information, even though such information can rarely be applied directly to the case in question. For example, when defining limits for discharge of pollutants into surface waters, it is essential to take the use of watercourses into account as well. The problem is often that the design of an energy system will displace pressing environmental problems to other regions or environmental sectors (substitution of firewood with kerosene, flue gas purification in power stations and disposal or use of filter dust and gypsum).

An important part of framework planning is the assessment of possible alternative forms of development and expansion. Such an assessment, which should also cover development caused by the energy supply and its possible environmental impacts, must proceed from the same objectives, i.e. it must refer to the same energy services to be provided. Attempts to evaluate alternatives based on a single assessment criterion (e.g. an "index of harm" or efficiency) have proved to be of

little use. It is more a question of presenting specific environmental impacts in a disaggregated form to the decision-makers, identifying certain individual options in political agreement processes as viable and others as unacceptable. Various methods and computer-assisted procedures are now available to help with this task.

Nevertheless, individual options can be formulated under general objectives and assessed in terms of their climatic relevance, for example (individual quantities of pollutants emitted are aggregated in terms of their impact on the climate). This may also include "least-cost planning" studies (here an attempt is made to incorporate "environmental costs" and the costs of protective installations into planning calculations, and also e.g. costs of energy-saving measures). Particular reference is made to those projects in which economic objectives are placed alongside environmental objectives and accorded at least equal status. Creating this type of framework may also serve to identify, out of the large number of possible aspects involving adverse environmental impacts, those which are especially relevant to the assessment of the energy system. Such criteria range from the more technical parameters (e.g. degree of efficiency), to pollution variables (e.g. air pollutants, soil damage) through to risks, health considerations and rules on conditions in the workplace. Thus those projects or development variants which fail to satisfy certain minimum requirements (e.g. no use of hydroelectric power or no mining of deposits in conservation areas is permitted) can be ruled out from the outset; alternatively a preselection can be made on the basis of assessment of the contribution made by the energy supply system to an environmental problem.

Absolute priority in energy planning must be given to the search for options which, in all important aspects, involve the least environmental impairment. Coupled systems (use of an energy

medium for simultaneous power and heat generation) and above all the use of renewable fuels are ideal in this respect. Even if a search for such options is unsuccessful, it is necessary to weigh up the individual aspects identified as important.

Changes to the energy system which subsequently help prevent or reduce adverse environmental impacts can basically be made in four areas:

(a) Energy saving

This range of measures takes existing structures and looks for possible ways of energy saving, with the side-effect of relieving pressure on the environment. Both technical resources and environmentally aware behaviour have a decisive role to play in this area. Many processes of energy use can be designed in such a way that substantial energy savings can be achieved (targeted replacement of inefficient components in old plants; greater use of coupled systems, i.e. simultaneous use of heat in electricity generation; use of combined processes in power stations to improve efficiency; instant measures such as use of fuel-efficient cooking stoves). But incentives for this are only provided if the price structure at least covers costs, and wherever possible includes supplements to cover environmental costs.

(b) Fuel substitution

In addition, there may be potential for changes involving individual fuels, e.g. biogas in place of wood, low-sulphur coal instead of sulphur-rich coal. More fundamental changes may also be possible (e.g. building for a particular climate thus dispensing with the need for air-conditioning).

Greater use of local ("endogenous") potential in decentralised facilities may be a sensible alternative to central solutions (i.e. network- and line-dependent designs), with renewable en-ergy sources (for power and heat applications) being of particular interest. Moreover, decentralised solutions may to a large extent overcome the risks and environmental problems associated with energy transportation.

(c) Technical measures/investment

Pressure on the environment can also be directly relieved through measures to increase efficiency or reduce emissions from existing installations (e.g. flue gas purification, use of catalysts), to ensure optimum system management (e.g. adherence to optimum combustion temperatures) or to propose replacement of installations, with environmental aspects being taken into consideration from the outset. These measures are normally only feasible through additional investment and to some extent overlap with the measures referred to in (a). Pretreatment of fuels (desulphurisation) and special measures for safe storage or reuse following prior examination of residual materials (ash, filter dust) should also be considered at this point.

(d) Behavioural changes

Finally, energy demand notified can be analysed and behavioural changes suggested (changed mobility requirements, use of communal installations e.g. for refrigeration). Energy planning may reveal scope for behavioural changes and suggest recommendations. The question of achievability must be posed, and indeed answered, at political level; with the creation of general economic conditions which foster environmentally acceptable behaviour among the parties concerned

becoming an important tool of OEP. OEP can only prepare for decisions at political level and support these through analyses.

Activities in all four areas rely to a large extent on support through education and the provision of information for the population groups affected (private individuals, trade and industry specialists, decision-makers). The facilities offered by the various media (radio, publications, lectures) must be used intensively and suitable educational provision must be made through the schools and colleges.

Considerable support for this can come from (public and private) institutions and organisations which, with their cross-sectoral expertise, can make effective contributions to finding solutions to environmental problems in the energy sector. "Non-governmental organisations" are increasingly important and such organisations should be supported in their work. However success also depends, in the public sector, on ensuring early coordination of the different development areas.

Influence on general economic conditions also plays an important role, since it is often only at this level that changes can be set in motion in all four of the areas quoted. Besides an active subsidy policy (e.g. for start-up financing), the expedient of fiscal policy (higher taxation of undesirable variants, if necessary to cover all anticipated "external costs") is particularly worthy of mention. But care should also be taken to ensure (particularly in the case of large-scale projects) that the costs do not outstrip the results achieved (taking particular account of the costs to the economy as a whole).

To summarise, once demand has been defined (e.g. the demand arising from the requirements of

an industrial development project), whilst not regarding demand as a fixed quantity, one may proceed on the basis of the following questions:

- **Is the demand understandable/justifiable or is it merely the result of explorations of a trend?**
- **Have all possible means of rational energy use been exhausted and the potential for savings been taken into account? Have alternative technologies and procedural proposals been included in the planning?**
- **Can different energy media be used to provide the services in question? Have all possible means of environmentally favourable energy media substitution been exploited?**
- **Are particular environmental problems in evidence regarding the use of the installations planned and have precautions been taken to reduce these through technical measures? Are disposal plans available for any residual materials? What are the main pollutants or overall environmental loads?**
- **Has account been taken of possible changes to general social and economic conditions which may affect future energy needs? Have the developments induced by energy production and their environmental consequences been noted?**
- **Have conditions been created whereby the measures at technical level will be supported by appropriate educational provision? Have promotional facilities been included and have the organisational requirements for supporting the measures been met?**

Needs in other sectors (households, small consumers, agriculture, transport) can be dealt with in a

similar way. Alternatives which are preferable in environmental terms are often more expensive (from the point of view of the individual business) than conventional solutions. In this case planners must consider whether implementation can be supported by appropriate price policy measures (subsidies, making unwanted variants more expensive etc.).

4. Interaction with other sectors

4.1 General objectives and socio-economic/socio-cultural dimensions

The aim of many countries is to improve their current situation, which may be characterised by population growth, malnutrition, lack of medical provision and hygiene, unemployment and regional discrepancies, and by largely uncontrolled consumption of finite resources. The energy sector is closely linked to these problem areas because adequate and financially viable satisfaction of the demand for energy services (e.g. in connection with drinking water supply and irrigation, medicine, production) may help alleviate these problems.

Overall Energy Planning (OEP) must take account of these guiding principles when the energy system is being developed. The desired positive effects will be achieved mainly in the final phase of development of the energy system, namely during the stage of actual energy use. Supply, i.e. extraction, conversion and distribution of energy must be designed so that positive aspects (of use) are not cancelled out. Conflicting objectives occur mainly where large-scale systems of energy extraction and conversion do not meet the objectives of the population of the region, involve

unmanageable or unacceptable socio-economic and socio-cultural changes and consequences and assign costs and benefits to different social groups.

- OEP must take account of socio-economic and socio-cultural dimensions. This generally requires comprehensive analysis of the current situation and involvement of those affected in the decision-making process.
- In many countries, commercial energy sources do not reach the lowest social groups because of cost. Very often investments to build up infrastructure are not reflected in energy sources prices adequate to cover costs: These subsidies, which are granted on social grounds, do not reach poor population groups, especially those in the countryside, to a sufficient degree, thereby strengthening social inequality. A differentiated study of the preferences and purchasing power of each target group, carried out as part of an energy needs analysis, should provide valuable information for the design of appropriate supply chains and a rational tariff policy. Experience shows that the promotion of a decentralised approach to energy supply is an important tool for rural target groups.
- In the domestic sector, the introduction of new fuels often encounters resistance from the population, as traditional behaviour patterns will be disrupted. For example, attempts to introduce energy-saving coal or wood stoves often fail because insufficient allowance is made for other aspects of the stoves, such as radiation of light and heat, ease of use, safety, hygiene and aesthetics. On the other hand financial factors are often the reason why certain options cannot be taken up.

When it comes to supplying households with energy women are the decision-makers in many countries because they are responsible for production, collection and use of biomass resources

(mainly firewood). Because of their particular position in the domestic energy sector, women have specialist knowledge concerning the use and management of biomass resources. This knowledge must be taken into consideration in the OEP context.

4.2 Interaction with other sectors

OEP must take into account the needs of all demand sectors in its regional and national diversity. However, it should also actively attempt to influence consumption patterns in order to achieve more environmentally acceptable energy systems.

This requires close harmonisation and coordination with a higher-ranking regional planning system to avoid misguided planning and to provide efficient and environmentally acceptable energy services. For example, there will be interaction with other planning areas:

(1) Regional planning: Development objectives of regional planning can be realised by OEP, since the availability of energy is a prerequisite for development processes. The connection of rural regions to the national power grid may also have an effect on urbanisation processes and counteract the flight from the land.

(2) Transport and traffic planning: An effective public transport system in towns and cities may reduce consumption of fuels and the resulting emissions if it has the effect of reducing the use of private cars. The linking of rural regions to a traffic system will increase the attractiveness of those regions, and in many cases is essential for commercial activity (linking to distant markets).

(3) <u>Industrial planning</u>: The development of industry requires an adequate supply of energy, particularly electricity. The decision as to whether one should develop energy-intensive (and at the same time usually environmentally polluting) sectors (basic materials such as steel, aluminium, chemicals) will affect the extent of likely effects on the environment.

(4) <u>Agriculture and forestry</u>: Reference is made to the problem of use of biomass as fuel, and related effects on agricultural land-use. Increased afforestation is required in many regions for fuel and may lead to competition with agricultural use of the soil. The agro-forestry industry may offer possible solutions in this regard.

(5) <u>Water resources management</u>: Environmental impacts mean that OEP must be geared to the needs of general water resources management planning. This applies, for example, to the competing use of water for power generation, irrigation and water supply, and for the introduction of cooling water, or the mutual exclusivity of power station sites and domestic water catchment areas.

In addition, there is a major interface with various political areas, whereby perceived needs can be incorporated in concrete general and detailed planning. Besides the field of energy policy which is discussed below, these of course include other areas such as the industrial policy or environmental policy adopted.

(6) <u>Energy policy</u>: Promoting the objectives of environmentally acceptable energy planning calls for an energy policy which takes account of the actual social costs of provision and utilisation of the energy sources. These objectives can be achieved to some extent through legislation (e.g. emission

control regulations, safety requirements, import guidelines), but the attainment of other objectives relies on individual decisions by users. In this case, influence can only be brought to bear through pricing. For example, in many countries the - environmentally desirable - process of substituting the use of firewood by liquid gas or kerosene suffered a severe setback when crude oil prices increased. Attempts to introduce environmentally friendly technologies (e.g. photovoltaic systems with energy-saving lamps, super-efficient wood stoves and ovens) often fail in rural areas due to lack of financial resources. Environment-oriented policy must take account of these circumstances through the introduction of suitable financing arrangements, subsidies or fiscal policies.

Basically it is necessary to decide whether possible ways of bringing targeted influence to bear on development processes is to be exploited through planning, which will then however depend on the availability of adequate financial resources to support desirable energy options, or whether "market forces" should basically shape this development.

5. Summary assessment of environmental relevance

Environmental impacts of the energy system will increase with growing energy consumption, and in densely populated areas have already reached levels (of air pollution for example) which pose an acute health hazard. OEP must take this situation into account with a view to alleviating environmental problems and reducing environmental loading to a tolerable level and, even at this early stage, laying the foundations for longer-term changes to the energy system.

It must be assumed that in many countries no great importance is attached as yet to the problem of carbon dioxide emissions, in view of very low per capita energy consumption. But if current growth rates (1980 to 1987) for fossil fuel consumption continue, developing countries will be responsible for 50% of CO_2 emissions within the next twenty years. (Even though the deterioration in the greenhouse effect so far has been almost entirely due to the economic development of the industrialised countries, they will still bear primary responsibility for the problem). Only a global effort will have any chance of defeating the problem.

The basic elements of a strategy to reduce adverse environmental effects from the energy sector must be as follows:

(1) Saving of energy through rational, demand-led, economic use of energy in all areas. Here, as in the areas mentioned below, education and consciousness-raising are just as important as improved technical methods. Targeted use of financial incentives (pricing, taxes) or shaping of the economic framework, e.g. through dismantling of subsidies, are fundamentally important.

(2) Use of substitutes to replace energy sources which have a particularly adverse impact on the environment. Greater use of local resources and particularly of renewable energies. Here too, costs and financing are important issues.

(3) Full use of all possible technical and administrative means of reducing emissions of all kinds and of achieving acceptable ways of disposing of waste materials and residues. Development of appropriate (for the relevant target group) financing plans for requisite investments.

(4) Determination of the scope offered by changes in individual behaviour patterns and in general social and political conditions for shaping the future energy supply system. The OEP process should be anchored in a suitable institution representing the environmental concerns of OEP at all levels of planning and decision-making.

OEP has a wide range of tools to help it perform these tasks, ranging from direct financial incentives and regulatory measures to the promotion of research and development and provision of information to the public.

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4. Water framework planning

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[6. References](#)

1. Scope

1.1 General

Water occurs as surface water and groundwater and is regarded as a renewable resource. The water supply of a region is normally limited. Quantitative renewal through the hydrological cycle depends essentially on rainfall, with wide quantitative and periodic variations as well as considerable regional differences.

The water supply rarely meets demand in terms of quantitative, periodic and geographical distribution, or in terms of water quality. This calls for controlling measures, i.e. targeted water resources management. Water resources management therefore signifies the regulation of all human uses of, and effects on, surface water and groundwater, thereby necessitating the development of objectives and general conditions covering all sectors for the utilisation of water resources by competing users, guaranteeing the environmental compatibility of water resources management activities.

Over-use, changes in land-use, climatic shifts etc. may in the long term impair the capacity for renewal, thereby reducing water supplies and their use.

A distinction should be made between those uses which do not involve actual water consumption (e.g. water used for cooling purposes) and those in which water is wholly or partially consumed or contaminated. Measures to protect against the damaging effects of water (e.g. flood protection) should be regarded as uses.

Peripheral conditions of water resources management are determined not only by technical and economic considerations but also by sociological, socio-cultural, legal, medical/hygienic and political aspects.

Water resources management is a vital tool of infrastructure policy and is particularly important for

- **safeguarding the basis of life in rural and urban areas of habitation, through the provision of an adequate supply of safe drinking water**
- **improving hygiene in rural and urban areas of habitation, through controlled removal of sewage and waste, with measures to check the spread of water-borne diseases where necessary**
- **increasing agricultural production through soil improvement, irrigation and drainage**
- **promoting industrial production through the supply of potable and industrial water**
- **developing the transport system through the development of shipping routes on rivers, canals and lakes**
- **improving energy supply through development of hydroelectric power and supply of cooling water for thermal power stations**
- **extracting mineral resources through regulated pumping and discharge of groundwater**

(mine drainage water)
- protecting and preserving natural habitats by satisfying ecological water demand and measures to protect areas of water
- developing aquaculture by safeguarding natural and artificial habitats for aquatic organisms
- safeguarding habitats and agricultural and industrial production sites through measures to protect against flood and, where applicable, erosion, desiccation and desertification
- reducing the workload of women through targeted water provision
- developing tourism by safeguarding recreational areas on rivers, lakes and coasts.

In certain cases, these activities may be in competition with one another.

1.2 Definitions and principles of water framework planning

According to the relevant German guideline (16), the General Water Resources Management Plan embodies interrelated aspects and dependencies of the water resources management system within a planning area. It should set out water resource conditions in this planning area and allow an assessment of the likely effects of changes.

General Water Resources Management Plans are normally drawn up for natural geographical units, i.e. river basins or parts thereof. The area limits are the overground watersheds. General Water Resources Management Plans for economic areas or parts of economic areas should if possible be developed on the basis of general plans for the relevant river basins.

For the planning area it is necessary to clarify at the different levels (local, regional, national) when, where and how much water is available or needs to be provided, and where applicable in what quality, and what water resources management activities are necessary to balance supply and demand. These measures should be examined in terms of their financial, economic and ecological viability. In this process it is necessary to take account of current and foreseeable future general conditions within the planning area and within the overall natural geographical unit (e.g. river catchment area). Planning horizons are normally between 10 and 30 years.

A General Water Resources Management Plan summarises statements on

- current and foreseeable water demand
- possible ways of meeting water demand out of the water supply in the form of hydrological balances
- hydrogeological conditions in the planning area
- current and future occurrence and availability of water in terms of quantity and quality and periodic and geographical fluctuations
- possible ways of developing usable supply (formation of new supply, regenerative capacity)
- drainage control and flood protection (flood risks, high-water peaks, flood plains)
- maintenance of water purity (burden imposed by outfalls, self-cleaning properties)
- potential risks for surface water or groundwater due to existing or future uses (accidents, unsafe transportation of harmful substances, improper storage of refuse, commercial and industrial waste, discharge of agricultural pollutants such as fertilisers and pesticides)

- need for regulations covering those who discharge contaminants (quantities, quality, degree of pretreatment).

It is necessary to examine not only standard circumstances but also critical circumstances and periods, which are particularly important for correct design of water management schemes. Investigations must be carried out to see which bodies of water and which hydrologically important areas and regions require precautionary safeguards.

A General Water Resources Management Plan does not provide planning data and dimensional values for specific individual projects. Rather, it provides a basis for defining general conditions applicable to large areas for overall infrastructural development, e.g.:

- housing policy (urban and regional planning, rural development)
- location issues for the development of trade and industry
- conservation areas (flood plains, erosion protection, groundwater protection, with resettlement measures where necessary)
- statutory safeguards and conservation measures
- conditions governing emergency water supplies.

A General Water Resources Management Plan does however embrace the applicable general conditions of water management, and incorporates relevant measures. Only in this way can appropriate solutions be found and the important goal of regionally and socially fair distribution of water be achieved.

The General Water Resources Management Plan is a governmental (i.e. state) function which in Germany is performed at a number of levels:

- **ministry, highest water authority**
- **water management administration (relevant offices, hydro-meteorological, hydrometric and hydro-geological departments)**
- **independent administrations (associations, user groups, cooperatives, traditional structures at target-group level).**

To establish priorities for the utilisation and protection of water resources and keep the General Water Resources Management Plan permanently updated it is necessary to have a suitable legal framework and a properly functioning administration with the requisite powers and technical expertise; this includes the ability to resolve international problems.

2. Environmental impacts and protective measures

Very often the impact of an individual project, such as a small dam or the diversion of a small part of the runoff, is minimal and is limited to the local area, making a quantitative assessment of the impact difficult. If a number of projects are combined, such as chains of dams on a river course, or if the entire discharge is diverted, the effects may be serious.

Regulatory water management activities and the impact which they have essentially relate to:

- the damming and diversion of surface water (dams, reservoirs, small barrages, diversion works, pumping stations, open channels, pipelines) for the purpose of discharge regulation, flood protection, supply of drinking water and industrial water, hydroelectric power generation etc.); activities often serve a number of purposes at once (e.g. multi-purpose reservoirs), which means that many different aspects have to be coordinated within a complex framework;
- extraction of groundwater (dug wells, bore wells, spring water chambers), preferably for supplying drinking water and irrigation water; if these facilities are not properly designed, there is a high risk of contamination both of water drawn and of underground water stocks;
- transportation from the place of extraction to the place of consumption (portable vessels, open channels, pipelines); there is a high risk of contamination with all open and accessible systems;
- collection and utilisation of rainfall (cisterns, "rainwater harvesting"); over-use of this naturally limited supply is largely ruled out.

Water stocks can be adversely affected both in terms of quantity, i.e. in their quantitative, geographical and periodic availability (over-use), and in terms of their quality (pollutants).

In the case of surface waters, a change in runoff conditions means changes of flow cross-section, head, roughness and runoff rates. Changed flow behaviour causes changes to erosion and sedimentation processes. Damming can reduce high-water peaks, but also causes flooding of ecologically valuable areas, forces resettlement, creates stillwater zones and interferes with the habitats of aquatic flora and fauna, particularly migration conditions for fish. In addition, water that

is accessible to humans and animals promotes the spread of water-borne diseases (malaria, bilharzia, parasitic diseases and dysentery).

The large number of hydrological and hydraulic variables alone necessitates the provision of a reliable database, backed up by long-term observations. Flawed planning assumptions, e.g. of possible flood discharges, causing dam failure or incorrect operation of barrages, can cause excessive flooding, resulting in serious damage.

In the case of groundwater, over-use may be caused by wells that are situated too close together or where drawdowns overlap, causing progressive lowering of the water table. Formation of new water reserves can be adversely affected by changes in land-use. Discharges of pollutants, be they intermittent (accidents, improper storage of waste, well contamination) or widespread (agricultural fertilisers and pesticides, large-area disinfestation of locusts etc.), may impair groundwater quality.

Long-term lowering of the water table over large areas may be necessary in the case of land used for agricultural purposes in order to prevent saturation and salination. However, in most cases this is harmful to natural vegetation and crops which then increase water demand because of the irrigation required and may intensify existing over-use.

Connate groundwater is a non-renewable water resource and therefore should not be exploited if at all possible.

Improved water resources management frequently generates secondary and tertiary effects such as an increase in demand (increase in per capita consumption of drinking water, increase in

livestock numbers, expansion of agricultural irrigation) with further effects on the ecological and social framework for example (destruction of vegetation and soil through over-grazing and trampling by livestock, deforestation to create farming land, intensification of erosion by water and wind, conversion of nomads to a settled form of existence, concentration of habitation in well-supplied areas, closer contact and also conflicts of interest between different ethnic groups).

Often the situation arises where urgent environmental problems can only be resolved by considering other regions in a national analysis (otherwise, for example, building flood defences may expose those living downstream to greater risk of flood).

A General Water Resources Management Plan should contribute to the sustainability of water management projects through a long-term, multi-sector and large-area approach, preserving natural water resources and ensuring maximum environmental compatibility.

An essential conservation element in a General Water Resources Management Plan involves early consideration of the environmental effects of water management activities for the following reasons:

> **- Development planning and social priorities and likely effects of water management activities should be compared and evaluated; different activities or activities planned for different social groups and decisions should be made transparent by setting out the costs and benefits (the involvement of the population groups affected is extremely important); this will enable alternative solutions to be developed at an early stage;**
> **- Preventive environmental protection i.e. the avoidance or minimisation of environmental**

problems in advance is generally far more effective and economical than corrective environmental protection, i.e. a subsequent clean-up or "rehabilitation" of polluted and partially destroyed environments afterwards.

A General Water Resources Management Plan provides planners with a tool whereby negative environmental effects and flawed developments can be avoided or at least alleviated, and requisite counter-measures or compensatory measures can be envisaged.

Depending on geo-ecological conditions and utilisation of the natural geographical unit, water management activities may, for example, affect the following:

- the climate (e.g. air temperature, air humidity, evaporation, radiation and heat),
- the quantity of available groundwater and surface water (acceleration of drainage through flood control, drainage retardation, infiltration),
- the quality of the groundwater and surface water (dilution, reduction or concentration of pollutants),
- soil quality and the area usable for agricultural and forestry purposes (groundwater level, soil degradation, erosion, sedimentation),
- habitats for terrestrial and aquatic flora and fauna (alteration and intersection of habitats, marshes, swamps),
- health and hygiene (living conditions for pathogenic organisms, drainage and sewage).

Measures to prevent negative environmental effects in the various areas of use (e.g. agriculture, industry) must be set forth in the General Water Resources Management Plan, but they must be

tackled in the individual sectors.

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3. Notes on the analysis and evaluation of environmental impacts

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3.1 Interrelated aspects

A General Water Resources Management Plan must take account of all possible effects of water management activities on the environment. It must deal with the present situation in the planning area, which can vary considerably from one country to another.

The water situation may be characterised by the following:

- **extremely high or low annual rainfall depending on the region,**
- **risk of no rain falling for several years,**
- **very low rates of groundwater regeneration,**

- extremely heavy rainfall and flooding,
- low level of consumption and low percentage of population being supplied,
- unreliable supply,
- irrigation accounting for a high percentage of demand,
- extensive re-use of waste water and salt water, inclusion of sea water desalination.

For analysis and assessment of the environmental effects of water management activities it is necessary to consider the entire process chain i.e. the hydrological cycle from the primary stage of rainfall through to the disposal of sewage and waste materials.

A prerequisite for the above is a reliable database which also describes the present environmental situation (inherited problems) of the natural geographical unit in question or of the region. In this way it is possible to establish the scale of the current environmental problem i.e. the changes brought about by past activities, and to estimate the effects of measures planned.

Such databases (e.g. hydrological journals, environmental registers, geological reports) are unavailable in many countries and must first be compiled or replaced with suitable indicators in order to make a reasonable assessment of measures planned. National regulatory bodies and international organisations may be able to provide important information; such information can rarely be transferred directly to the case in hand, partly because individual regulations and parameters should be understood as part of an overall system, which cannot be assumed to exist in all countries. For example, when determining the limits for discharge of pollutants into surface waters, the uses and self-cleaning properties of water-courses must be taken into account.

The framework plan provides a valuable basis for assessing possible alternative forms of development and expansion. Such evaluations must, however, proceed from the same objectives. Attempts to evaluate alternatives on the basis of a single assessment criterion (e.g. cost index, "index of harm") fail to take account of the many different aspects involved.

It is important to reduce the almost infinite number of possible criteria to be included. For example, it is possible to exclude from the outset those projects or development variants which fail to satisfy certain minimum requirements (for example, no housing or industrial developments or removal of groundwater should be permitted in water conservation areas or flood plains).

Environmental impacts should be prioritised in different ways depending on the existing water situation;

- **Regions with scarce water resources: Priority given to adequate quantitative provision, water-saving measures.**
- **Regions with adequate supply: Priority given to health and hygiene, quality assurance.**
- **Regions with a (temporary) surplus: Priority given to flood prevention.**

Generally speaking, problems of water wastage (e.g. irrigation with connate groundwater) demand greater attention.

3.2 Analysis of use and quality of natural water resources

3.2.1 Determination of natural water supply

The natural water supply is determined by processes in the hydrological cycle, essentially by rainfall and factors such as evapotranspiration, overground and underground drainage, seepage, new groundwater formation etc. Considerable influence is brought to bear by controlling variables such as climate, vegetation, topography, soil, geo-hydrological conditions etc., and also anthropogenic influences such as land-use (large area irrigation, areas of habitation with low infiltration and increased runoff).

The supply is mainly determined by

- **stocks in overground reservoirs,**
- **drainage into bodies of surface water,**
- **underground water stocks including the geological (connate) water stocks which, however, are not renewable and should not, therefore, be regarded as usable stocks where possible,**
- **new groundwater formation (normally only a small fraction of rainfall, depending mainly on evaporation, surface drainage, infiltration, climate, vegetation, soil type, topography, groundwater level, geo-hydrological conditions).**

Drainage, new groundwater formation or other parameters of the hydrological cycle are normally compared with averages over many years, including a description of extreme values (wet years, dry years). For the Water Resources Management Plan these details are vital for orientation, but must also be considered in the context of a chronological and geographical breakdown as there may be extreme seasonal and regional variations. If, for example, the hydrological year consists of a decidedly dry season and a rainy season, but in addition there are substantial fluctuations in rainfall

quantity from year to year, long-term average values for surface drainage and groundwater supply should not be used in project planning.

In many countries the database is often inadequate. The measuring stations are too far apart. A Water Resources Management Plan provides information on how the measuring network density may be increased. The necessary data (e.g. water levels and run-offs, detritus and suspended matter in surface waters, groundwater levels, physical, chemical and biological parameters of water quality, hydrometeorological and hydrogeological data) must be observed and evaluated according to applicable international standards (such as WMO, FAO, WHO). These must be published regularly in hydrological journals in the interests of sound planning, otherwise separate measuring campaigns will be necessary, which will be costly yet inadequate in view of their brevity.

3.2.2 Determination of usable water supply

The usable water supply is regarded as that proportion of the natural water supply which can be exploited, taking the following aspects into account:

- Catchment	Nature and position of body of water or aquifer, geological and geomorphological conditions for well construction, diversion works and reservoirs, available technologies.

- Distribution	Periodic and quantitative redistribution (storage), geographical redistribution (transfer)
- Economy	Costs of development, extraction, treatment and distribution, wastewater treatment
- Chemical/hygienic toxicology	Water quality, risks of contamination, treatment technology, water pollution control measures for bodies of water, recycling
- Ecological, resource protection and use-related aspects	Destruction of valuable, groundwater-dependent vegetation stocks, drying-up of water holes and water courses, karstification of soils, erosion, drying-up of marshes and swamps
- Other reasons for water management	e.g. shipping, hydroelectric power generation, priority of use outside

	the planning area

Certain minimum requirements (of quantity, area etc.) must be satisfied as a matter of priority in order to allow for ecological considerations.

3.2.3 Determination of water demand

Water demand comprises essentially the following components:

- drinking water for people and animals, trade and industry and - at least in densely populated areas - for fighting fires
- water for industrial use
- irrigation water
- water to maintain a minimum rate of flow and for shipping
- water for hydroelectric power generation
- service water, e.g. cooling water for power stations

Future demand is forecast from an analysis of current demand and changes in demand over past years, a comparison with similar periods in other regions and a knowledge of changes in population, of per capita consumption, which depends in particular on the level of sophistication of household water supplies (well, communal standpipe, house connected to main), the development of trade and industry and irrigation development.

In many countries, irrigation needs account for the majority of demand, while industrial and

commercial demand is still relatively modest, but must be expected to grow with increasing industrialisation in many countries.

As far as the drinking water supply is concerned, the basic demand that may be considered adequate and reasonable depends on the consumption habits of the population and climatic and cultural conditions. According to (4), an adequate basic supply can be achieved with 20-40 l/cd. These values increase with rising standards of supply. The following may be assumed as guidelines to reasonable consumption quantities:

up to 40 l/cd with communal standpipes

up to 60 l/cd with outdoor mains connection

up to 120 l/cd with indoor mains connection.

Losses in many distribution systems amount to 50 to 100% of actual consumption and must be taken into consideration when assessing demand.

Future changes in water demand are determined by

- **growing population**
- **agglomeration in densely populated areas**
- **expansion of food supply and thus of irrigation systems**
- **development of trade and industry**
- **rise in per capita consumption**

- increased demand for hydroelectric power.

When attempting to forecast future development of water demand there is a risk of estimates proving wrong due to unforeseen changes of a demographic, socio-economic or technical nature. Therefore a General Water Resources Management Plan should be designed so as to be flexible and must be updated at suitable intervals so that specific estimates can be made of alternative forms of development or development scenarios, assessing their effects on ecosystems, natural resources and resource utilisation.

In all demand analyses, possible ways of controlling consumption and of controlling development trends should also be examined (priorities, quotas, tariffs, reliability of supply). In particular, ensuring that tariff revenue fully covers costs is an important means of promoting efficient water use; this also enforces the "polluter pays principle". It may be necessary to defer the development of new water reserves, until all possible ways of saving water or rehabilitating contaminated water have been fully exploited.

3.2.4 Hydrological balance and general planning

Various measures can be derived from a comparison of usable supply and demand in the hydrological balance, taking aspects of nature and resource conservation into account:

To increase resource utilisation:

- building reservoirs

- tapping groundwater
- increasing rates of delivery
- expanding the distribution system
- desalination of seawater, where applicable

To improve the quality of treated water:

- improvement of treatment technology
- mixing with less contaminated water from other areas

To protect the quantity and quality of the resource:

- erosion protection, reforestation
- designation of water conservation areas, restriction of pesticide and fertiliser use
- improvement of sanitation and hygiene education
- building of sewage treatment plants
- restriction of discharge of pollutants into surface waters
- rehabilitation of bodies of water
- preservation of self-cleaning properties of bodies of water by refraining from expansion or through expansion in a way similar to nature
- "conjunctive use" of surface water and groundwater

To reduce water consumption and promote rational use of water reserves:

- fundamental changes in behaviour through consciousness-raising
- water-saving (elimination of leaks in supply networks, control of consumption with water meters, water and sewage tariffs adequate to cover costs)
- induced recharge of groundwater
- use of rainwater
- separation of service water and drinking water supplies
- multiple use of water in households, trade and industry
- use of water-saving irrigation techniques (tariffs adequate to cover costs)

To protect soil and vegetation

- rehydration and induced recharge of groundwater
- lowering water table to protect against salination.

Shaping of general economic conditions is vitally important in all the areas mentioned. Many changes can be decisively instigated and controlled through an active subsidy policy (e.g. through start-up financing), through fiscal policy (e.g. higher taxation of undesirable variants) and through the establishment and imposition of tariffs (price policy). The question of feasibility and also the abilities of the affected population should also be considered very carefully. The widely held opinion that water is "free" is false. People must be made conscious of the value of the resource.

3.3 Analysis of effects on ecosystem, natural resources and resource utilisation

Water resources management projects can have a major impact on ecosystems and natural

resources, which are either observable directly or only through a number of indirect consequential effects.

Direct effects normally arise immediately through

- water extraction:

lowering of surface waters and decline of groundwater table, runoff depletion, destruction of flora and fauna habitats

- water storage:

raising of water level, inundation of land

- contamination:

discharge of dangerous and/or oxygen-depleting substances, discoloration, odour

- water retention:

endangerment of periodically flooded areas (such as swamps, marshes)

Secondary and tertiary effects may also occur through complex interactions, for example due to socio-economic or socio-cultural effects, and may only be observable in the long term. Two examples will serve to illustrate this:

> **- To assess the major effects which a barrage dam may have on the environment, it is not sufficient merely to examine the feasibility of the project in terms of soil physics, hydraulics and engineering. Information is also needed to allow a realistic assessment of**

water demand, water supply, sediment transport and deposition in the reservoir, changes in the downstream flow regime and conflicts of use between catchment area, user area and downstream area.

- The construction of deep wells equipped with motor-driven pumps in the savanna of the northern Sahel resulted in previously nomadic livestock farmers becoming partially settled, with a simultaneous increase in livestock numbers. Particularly when certain wells dry up, overgrazing and progressive desertification occurs in the area of facilities which are still productive. Since living conditions are no longer regulated by the available water supply in the upper groundwater levels of the region, the ecological and socio-economic situation suffers accelerated deterioration.

Increased availability of water may also result in salination of soils if unsuitable irrigation techniques are used in arid and semi-arid areas.

3.4 Analysis of effect on health and hygiene

When assessing the water supply in a planning area, attention should be paid to the availability of hygienic and non-toxic water. Not only the quantity but also the quality of the water is important. Furthermore the quality parameters to be considered depend on the use envisaged, and may differ widely depending on whether, for example, drinking water, irrigation water or power-generating water is required.

Water quality can be affected positively through water quality and conservation objectives formulated on the basis of a General Water Resources Management Plan, through wastewater

treatment, through restrictions on use of bodies of water, through the designation of groundwater conservation areas and through hygiene education activities carried out in parallel with water supply projects.

In the assessment of the future changes in water consumption it is frequently overlooked, for example, that increased consumption will result in an increased volume of wastewater. Wastewater is often collected in open channels and fed to surface waters, or simply allowed to seep away in the immediate vicinity of the source. This has the effect of polluting the surface water, while the groundwater is subject to the greatest risk. For example, watering of vegetable plantations with wastewater may cause permanent health damage.

Therefore no water supply should be laid on without adequate drainage to alleviate environmental loading. This applies both to the drinking water and to agricultural irrigation water.

Additional efforts to promote organised self-help in the form of education and hygiene campaigns, which women often play a decisive role in planning and implementing, help to avoid over-use and contamination of water.

The rapid development of agricultural production in many countries not only creates steadily growing demand for irrigation water, but also results in greater consumption of artificial fertilisers and pesticides. Uncontrolled use of these chemicals can also lead to pollution of surface waters and groundwater. The use of drainage water for agricultural irrigation - a process that is often repeated several times in succession - may increase the salt content of the water, thereby causing salination problems for downstream users.

Damming of surface water causes solids carried by the incoming water to become deposited in the reservoir. This causes progressive silting and, with the introduction of nutrients, eutrophication of the water. This nutrient-rich shallow-water environment - in conjunction with the climatic conditions prevailing in many countries - causes vectors to flourish, resulting in the spread of water-borne diseases such as malaria, bilharzia or guinea worm.

3.5 Socio-economic and socio-cultural impact

The hydrological balance set out in a General Water Resources Management Plan is an important factor in targeted regional development. It also provides a basis for decisive and far-reaching socio-economic and socio-cultural changes.

The opening-up of new supplies of usable water may lead to an uncontrolled influx of large groups of people from water shortage areas. Besides the risk of over-use of the natural resources, this may also bring people from different groups together; social systems previously functioning as the basis for survival strategies, may become threatened and vulnerable.

The ecological consequences of barrages to protect against flood and to safeguard the supply may affect the livelihoods of fishermen living by the water if the fish population changes. In the storage basin area, agricultural and horticultural land will be lost and normally cannot be replaced, for topographical and pedological reasons. This may have serious socio-economic consequences for the affected population. In the downstream area, this may result in a depleted flow of water with consequent lowering of the water table, or to deterioration of soil quality in the fields along the watercourse, if the land is no longer periodically flooded with nutrient-rich water. This likewise

impairs the economic basis of the population.

Improved irrigation facilities for agriculture and horticulture can lead to changes in cultivation practices (artificial fertilisation, monocultures), so that after a brief increase in yield the soil will become progressively depleted, leading in turn to increased fertiliser use. Furthermore it may lead to salination of the soil and serious material contamination of surface waters and groundwater.

A socio-economic analysis should include sex-specific and group-specific investigations showing to what extent women or individual social groups are affected by water resources management activities, as either injured parties or beneficiaries.

Regional and traditional forms of land-use, often unwritten water, soil and grazing rights, ethnic structures, preferential rights of upstream river dwellers etc. are all important and may also be restrictive. It is imperative that a General Water Resources Management Plan take account of these factors.

3.6 Administrative and political framework

A General Water Resources Management Plan requires an administrative and legal framework (water legislation). It must be possible to establish rules and also policy objectives (priority of uses, prohibition of multiple use, allowance for traditional forms of use, international and cross-border rules etc.) for implementation by means of a suitable administration or appropriate organisations.

It is therefore vital to create or strengthen the authority or institution responsible for water

resources management. It is essential to establish the necessary decision-making procedures and bodies, to eliminate the fragmentation of powers which is often encountered, to make adequate financial provision and deploy qualified and well-motivated staff. It is crucially important to ensure appropriate involvement of women and other groups in decision-making bodies and procedures.

4. Interaction with other sectors

A General Water Resources Management Plan is absolutely fundamental, not only to the handling of all problems associated with water management. It goes to the heart of overall infrastructural development of the planning area and lays down general conditions for individual plans in the various sectors. It is therefore of overriding importance for planning measures in individual sectors, primarily affecting the following:

- **Spatial and Regional Planning**
- **Planning of Locations for Trade and Industry**
- **Overall Energy Planning**
- **Urban Water Supply**
- **Rural Water Supply**
- **Wastewater Disposal**
- **Solid Waste Disposal**
- **Inland Ports**
- **Shipping on Inland Waterways**

- Ports and Harbours, Harbour Works and Operations
- Shipping
- River and Canal Engineering
- Erosion Control
- Rural Hydraulic Engineering
- Large-Scale Hydraulic Engineering
- Weirs, Hydroelectric Power Stations
- Surface Mining
- Thermal Power Stations

5. Summary assessment of environmental relevance

As a planning tool used at the right time, a General Water Resources Management Plan can contribute significantly to the preservation of natural water resources and help prevent environmental damage by establishing parameters. It enables water resources to be managed in such a way as to protect resources and ensure their long-term sustainability.

A General Water Resources Management Plan lays down the basic parameters, not only from the technical and economic points of view, but also embraces and describes the interactions of the many different factors at work within the water system, as well as taking account of ecological, socio-economic and socio-cultural conditions. A General Water Resources Management Plan points in the direction of possible future development of living conditions and economic circumstances in

relation to water. It provides a basis whereby different ways of using water resources may be identified, compared with one another and assessed to see how water resources management projects can be planned and implemented in an environmentally acceptable way.

This planning must take account of possible side-effects and consequences, and the draft plan should include proposals for avoiding adverse effects, monitoring important environmental indicators and possibly implementing compensatory measures. Target groups should be involved from the outset in the development of this draft plan.

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Environmental brief on water planning

<u>Key-words</u>

*** Surface water**
*** Groundwater**
*** Water quality**
*** Climate**
*** Erosion**
*** Desertification**
*** Health**
*** Plant production**
*** Irrigation**
*** Animal production**
*** Tourism**
*** Pesticides**

*** Fertilisers**
*** Sedimentation**
*** Structural and regional planning**
*** Planning of locations**
*** Overall energy planning**
*** Urban water supply**
*** Rural water supply**
*** Wastewater disposal**
*** Waste disposal**
*** Ports on inland waterways**
*** Shipping on inland waterways**
*** River and canal Engineering**
*** Erosion control**
*** Rural hydraulic engineering**
*** Large-scale hydraulic engineering**
*** Mining - open cast**
*** Thermal power stations**

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5. Transport and traffic planning

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1. Scope

1.1 Definition of "Transport and Traffic"

Transport and traffic serve the purpose of relocation of people and goods, as well as the conveying of information. The demands imposed on transport and traffic result from the interaction of those areas where people live and where commerce and industry are located, which are interlinked at many different levels and which are

- **influenced by the number of inhabitants, the structure of human settlement, the general economic standard, the economic-geographical circumstances (such as natural land-use potential, the location of raw materials and production facilities), the production strategies (e.g. just-in-time), and by natural peripheral conditions (the topography),**
- **a consequence of economic policy (e.g. industrial settlement, the demands of the**

agricultural sector) and development planning (national development and regional planning), which can be used to control the transport and traffic demand through centralisation and decentralisation.

The type and intensity of transport and traffic depend on

- **existing transport facilities**
- **operational measures (transport control systems)**
- **decisions relating to transport and traffic policy (tariffs, taxes, laws, state cooperation in the transport sector).**

Motorised and mass transport in particular cause direct damage to both human beings and the environment; in addition, it can also contribute to disproportionate utilisation of resources, and so indirectly cause severe environmental problems [1].

1.2 Forms of transport and traffic

Roads

In many countries, the importance of road transport is predominant. Roads and highways are not only used by private cars and heavy goods vehicles, which cause the greatest environmental and safety problems, they are also used for movement and transport

- **on foot**
- **by cart and barrow**

- by bicycle
- by motorcycle.

The road is therefore a highly flexible carrier of vehicles representing different modes of transport and propulsion systems, though this may lead to a greater number of accidents.

In out-of-town areas, the road essentially serves the function of assisting in development and communication. A characteristic feature of the supra-local road and highway network is its gearing to those areas of population density in which economic development is concentrated. Environment-oriented planning is heavily biased towards natural geographical considerations.

Within populated areas, the road predominantly serves the needs of human habitation and communication, with the result that, in this situation, different user requirements are superimposed on one another.

Railways

As well as conveying people, railways are used mainly for the transport of mass goods (such as raw materials, fuels and crops) over long distances between economically significant node points, without frequent loading and unloading. In many countries, the efficiency of the railway system can only be maintained with difficulty, or is even falling. As a result, railway transport is losing significance, while from an environmental point of view it should in fact be being promoted. Economic railway operation should in particular be possible as a form of direct transport over long distances (e.g. between raw material sources and ports or metropolitan centres).

Waterways

Shipping waterways (whether inland or otherwise), along the coasts and on rivers are widespread in the case of island nations and in regions with only minor altitude differentials (such as South-East Asia), and in remote regions are often the only means of transport available. In addition to local routes linking neighbouring areas of settlement, distinct traditional long-distance links are also found in these places; they are, nevertheless, losing ground to faster methods of transport by road. Specific energy consumption can be very low, even with motorised craft. As with road transport, different types of transport and methods of propulsion are possible, and uncontrolled juxtaposition of different modes entails a high risk of accidents.

Other transport and traffic systems

Other transport and traffic systems worth mentioning, which in many countries play a minor role overall but may well be of great local significance, are:

- **air transport (aeroplanes, helicopters, and possibly even airships)**
- **pipelines for the transport of liquid or gaseous fuels (crude oil, mineral oil products, natural gas, liquified coal)**
- **cable railways, e.g. in raw materials projects (timber and ore extraction)**
- **telecommunications networks, which may in part replace the physical conveying of messages and information.**

With the construction of new transport routes and the development of existing ones, the primary

goal is to link different regions in a new or improved manner, and in this way to expand the market for the raw materials or finished products available in those locations. The intention is that the economic situation of people living in these regions should be improved by the higher levels of employment which are brought about. Very often, as a secondary effect, an improved supply of goods and services from outside the region may also be looked for.

Planning transport routes is aiming increasingly towards the maintenance and support of those which already exist, as well as their further development and the creation of new routes and systems.

2. Environmental impacts and protective measures

2.1 Direct environmental impacts of principal transport modes

The following summary of the direct environmental impacts of the principal transport modes is derived from the OECD report on Transport and the Environment [2]. This report expressly includes death and injury due to accidents as direct damage to human beings.

These effects occur not only during operation, but also

- during the establishment and development of the transport routes themselves,
- in the creation and disposal of facilities or vehicles which are no longer required,

- as an undesirable consequence of the opening up to traffic of areas which were formerly protected, through uncontrolled settlement.

Most environmental burdens are caused by motorised forms of transport, and by vehicular traffic in particular. In certain circumstances, however, even traditional modes of movement can result in environmental damage; for example, in mountainous areas, over-used footpaths may contribute to erosion.

***Figure 1* - Direct environmental impacts of principal transport modes [2]**

Principal transport modes	Air	Water resources	Land resources	Solid waste	Noise	Risks of accidents	Other impacts
Marine and inland water transport		Modification of water systems during port construction and canal cutting and dredging	Land taken for infra-structures; dereliction of obsolete port facilities and	Vessels and craft withdrawn from service		Bulk transport of fuels and hazardous substances	

			canals.				
Rail transport			Land taken for rights of way and terminals; dereliction of obsolete facilities	Abandoned lines, equipment and rolling stock	Noise and vibration around terminals and along railway lines	Derailment or collision of freight carrying hazardous substances	Partition or destruction of neighbour-hoods, farmland and wild life habitats
Road transport	Air pollution (CO, HC, Nox, particulates and fuel additives such as lead) Global Pollution (CO_2, CFC)	Pollution of surface water and groundwater by surface run-off, modification of water systems by road building	Land taken for infra-structures; extraction of road building materials	Abandoned spoil tips and rubble from road works; road vehicles withdrawn from service; waste oil	Noise and vibration from cars, motorcycles and lorries in cities, and along main roads	Deaths, injuries and property damaged from road accidents; risk of transport of hazardous substances; risks of	Partition or destruction of neighbour-hoods, farmland and wild life habitats, congestion

						structural failure in old or worn road facilities	
Air transport	Air pollution	Modification of water tables, river courses and field drainage in airport construction	Land taken for infra-structures; dereliction of obsolete facilities	Aircraft withdrawn from service	Noise around airports		
Pipelines (according to [3])		Pollution of groundwater by leakages					Access roads and air strips and its impacts

A detailed description of the environmental impacts of road, rail, air, and water transport can be found in the relevant environmental briefs. The relevant guidelines from the ADB [4], the ODA [5], and the World Bank [3] also provide a good overview of the environmental impacts from the transport and traffic sector.

2.2 Direct protective measures

Countermeasures can be grouped into the following categories:

I) the establishment of "low-conflict corridors" (route planning and location selection with the lowest possible environmental impact and low accident risk, and the grouping of routes to keep clear of areas which require protection)

II) space-saving, non-eroding and safe layout of transport routes

III) technical measures for reducing emissions from motor vehicles (such as incentives for vehicles with low noise and exhaust emissions, and inspections of the technical condition of the vehicle)

IV) proposals for methods of operation which help preserve the environment and reduce the risk of accidents (e.g. speed regulations)

V) structural and traffic guidance measures (such as spatial and temporal access restrictions in urban areas, preference for public transport in towns (bus lanes), preference for commercial transport essential for the life of the town or city (such as keeping loading areas clear), preference for well-filled private cars (car-sharing), and safety precautions in water conservation areas.

2.3 Environmental impacts of transport and traffic at local, regional, and global levels, and protective measures which can be applied

The background to taking due note of environmental impacts is the principle of the permanent

safeguarding of ecosystems, for the long-term securing of the basic essentials for human life. The risk posed to this by transport and traffic can be considered on three levels:

I) The immediate human environment:

The demand for space for transport routes, and the contamination of soil and drinking water can pose a risk to the basics of both living areas and foodstuffs. Likewise, the killing of domestic animals by road vehicles can be regarded as a considerable impediment to human wellbeing. This gives grounds for the selection of less space-intensive and more emission-free means of transport, in order to achieve routing arrangements which help save space and reduce speed, as well as the introduction of safety measures on the vehicles, traffic education, and the monitoring of both vehicles and drivers.

II) Many countries possess extremely complex and fragile ecosystems, which in addition have been far less investigated than the comparably stable ecosystems of the temperate zones (see [6]). Assaults on the soil and hydrological balance and on the animal kingdom by transport routes are accordingly even more difficult to appraise with regard to their interactive and long-term effects, and are thus to be treated even more cautiously.

In this context, too, consideration should be given to the ecological harm caused by the indirect consequences of transport routes, and of roads in particular, which include

- more intensive agricultural land-use
- the creation of forest aisles for raw materials projects

- unplanned woodland clearance
- and the threat to animal species which are already endangered.

The following measures to reduce these risks are proposed:

- regulations for monitoring land-use in the project regions and efficient supervision
- reinforcing the efficiency of the state supervisory bodies, such as the forestry or national parks administration, by improving training, staffing, equipment, prestige, and legal status
- the development of a rural consultancy and credit system for promoting ecologically adapted and sustainable agricultural land-use
- limited use of roads by specific groups of people (e.g. tourists) and vehicles (heavy goods vehicles)
- the establishment of a Department of the Environment, with sufficient influence among the transport authorities
- the promulgation and implementation of environmental protection laws.

III) The greenhouse effect and the depletion of crude oil reserves are proving to be of global significance. CO_2 emissions and the consumption of mineral oil by today's transport systems will reduce the scope for other CO_2 emitters and oil consumers, such as industry, power stations, and the private sector, with limits being imposed on national emission levels under international agreements, and these restrictions may prove to be a brake on development. In this context it should be noted that CO_2 emissions, by contrast with other air pollutants (such as nitrogen oxides

or hydrocarbons), cannot be reduced by adding devices to vehicles with internal combustion engines (such as catalytic converters).

Moreover, reductions in the diversity of species, particularly in the tropics, which may result from the effects of transport and traffic, are also regarded as a long-term threat to humanity as a whole: Transport routes which cut through areas which have been designated as nature preserves may seriously impair the habitats of animal and plant species and may lead to their decimation [7]. Railway lines are less divisive because they provide the same transport capacity with smaller route cross-sections and lower frequencies than long-distance highways; protection of the areas which remain, along the lines of a nature park scheme, such as that proposed by the World Bank [8], may prevent further reduction of stocks through uncontrolled clearance and human settlement (see II).

2.4 Reduction of road traffic and conversion to other transport modes, by means of regional development planning and a national transport and traffic plan

Vehicular road traffic is the worst of the environmentally-harmful modes of transport. In particular, the specific pollutant emissions and energy consumption of heavy transport is many times that of rail or ship transport, with the same degree of utilisation; moreover, roads inflict more damage on the ecosystem than rails because of the larger surface area required and because of erosion. The more important it is, then, to adopt transport and regional developing planning methods which will reduce road transport in absolute terms or bring about a change to less environmentally harmful modes of transport. This can be achieved in the following ways:

I) Decentralisation of housing, industry and utilities, with a view to shorter transport distances

(while preserving minimum distances from emission sources; see environmental brief Spatial and Regional Planning).

II) A shift away from heavy goods vehicles to less environmentally harmful modes of transport, particularly rail (and possibly water) transport, is a desirable goal. At the present time, however, the advantages of road transport (relative reliability and punctuality, particularly important in the case of perishable goods, fewer formalities, less risk of theft during loading and unloading) overshadow other considerations, even though lorry freight charges may be higher, and even lead to goods being carried by road parallel to railway routes. Reversing this trend will require a substantial improvement in the poor technical and organizational condition of railway facilities, most of which are run by the state.

Appropriate measures such as container transport, combined transport techniques, decentralised goods distribution depots and information systems for optimum interlinking of road vehicles and rail/water systems may not as yet be adequately established in most countries, but should likewise be explored and encouraged. The transport of hazardous goods at least (fuels, other explosive substances and corrosive chemicals) should be moved as far as possible away from the roads and onto ship and rail transport, provided this is not also dangerous. Transport planning should make provision for the future creation of goods transfer points and road connections for them, as an adjunct to programmes of expansion and new construction.

III) For simply structured transport tasks, as in the case of raw material projects, special transport systems such as pipelines, narrow-gauge railways, or cable railways may be not only less damaging to the environment, but also more economical than heavy goods vehicles. In particular this might

also serve to counter the major hazards of uncontrolled settlement and the destruction of natural areas through excessive road-building.

IV) Increased attraction of the "environmental combination" (foot, bicycle, cart, bus), for example in the form of independent tracks and priority regulations, assured by construction measures, especially in local areas.

V) Environment-oriented transport planning also means the restriction of vehicular transport in regions with heavy environmental burdens or which are ecologically sensitive, by halting new construction or expansion programmes, or even by removing a certain number of roads.

It is necessary to see how future changes in the nature and extent of transport demand will have an influence on the environmental effects of the planned transport modes:

Thus, a purely volumetric increase in rail transport demand can be largely met by lengthening train units, while in the case of road transport and air traffic, this would mean a sharp increase in the number of vehicles, and therefore in the environmental burden.

On the other hand, a decrease in transport demand or a change in the periodic pattern of demand, the type of goods being transported or the source-destination relationships may, in the case of rail transport, lead to lower capacity utilisation, so that at least the environmental burden (and also the costs!) per ton or per passenger transported would rise. As a consequence, it is recommended, in cases in which the future requirement volumes and structures are uncertain, that the choice be for means of transport which are comparatively flexible, but still as environment-friendly as possible

(narrow-gauge railways, cable railways, coastal and inland waterways, electric vehicles and vehicles using overhead power lines in countries with hydroelectric power supplies).

2.5 Administrative, regulatory, and financial measures

Administrative, regulatory, and financial measures can also help attain a reduction in the volume of road traffic and the associated environmental burden and a transfer to less environmentally harmful transport modes:

I) Mineral oil taxes and levies can appreciably increase the variable costs of more vehicles, resulting in

- **a higher degree of utilisation (and therefore fewer journeys)**
- **more economical travel,**
- **technical measures for reducing fuel demand (and therefore fewer emissions),**
- **greater competitiveness of rail and water transport.**

This would also result in a part of the external (environmental damage) costs of road transport being absorbed. During a transitional period, part of the additional revenue received by the state could be paid back by reducing the largely fixed outgoings, e.g. by reducing customs duties on spare parts.

II) Regulations and fiscal incentives for improving exhaust gas values:

Introduction and preferential taxation of lead-free petrol, exhaust gas and soot standards for new

vehicles, higher vehicle tax for old vehicles.

III) Approval, extension, and expansion of transport concessions subject to fulfilment of environmental requirements such as

- **motor vehicle inspections,**
- **transport by rail and ship,**
- **driver training,**
- **rules on driver working hours (to avoid accidents).**

IV) Tariff calculations of state railway and shipping bodies geared more towards variable costs, leading to specific cuts in rates for large transport volumes and/or long distances. This will help improve competitiveness as compared with road vehicles.

V) Appropriate timing of events or activities which produce severe concentrations of traffic especially in built-up areas (such as sports or political events, or the start of work or school). The effect is however limited, as experience with flexitime arrangements in industrialised countries has shown.

VI) Education of transport users. It is important for politicians and administrators to set an example by using, say, bicycles or mopeds, or travelling on public transport in the course of their duties (the personal experience of decision-makers can lead to these transport systems being improved). The brochure of the UK Department of Transport [9] describes a successful example.

2.6 Particular features of urban transport planning

Special conditions prevail in urban areas and the following key topics may be mentioned in this regard:

- Improvements in the telephone network and other modern data transfer systems (such as fax machines) may help avoid journeys which serve only as a means of communication (NB: The effect of telecommunications on transport growth is still not entirely certain. The indications are, however, that telecommunications will not replace "physical" transport to any extent worth mentioning, since the increased communication will in turn boost the need to make journeys, taking the place of the "substituted" traffic.
- highway crime (this is a reason for using vehicles)
- (re)introduction of trams to cope with major commuter flows in urban areas
- promotion of the "environmental combination" (see 2.4 IV).

2.7 Environment-oriented transport planning

Transport planning should be regarded as a process of harmonisation between the economy, society, and the environment. On the one hand, transport serves the purpose of meeting basic supply and mobility needs and thus promoting the material welfare of the country; on the other hand, the long-term sustainability of life's essentials must not be overlooked.

Accordingly, national development and transport planning and additional regulatory measures must create the conditions for achievement of the desired living standard,

- with minimal transport demand,
- with environment-friendly modes of transport (rail, ship) accounting for the largest possible proportion of total transport volume,
- using routes which avoid or protect especially sensitive transport corridors,
- with vehicles in satisfactory condition, such that pollutant and noise emissions and energy consumption are kept to an absolute minimum,
- using vehicles in such a way as to ensure that the number and severity of accidents as well as noise, pollutant emissions, and energy consumption are kept to a minimum (e.g. through speed restrictions or rules on driver working hours).

In order to make these goals a reality, transport planning must look to the future, and be integrated into the overall planning picture, paying particular attention to the way it interacts with town planning, regional development planning and also landscape planning. Parallel development of different, competing transport modes needs to be avoided as far as possible, as this not only causes environmental problems (additional demand for space, higher emission levels due to road transport), but is also uneconomical. The main aim should be to make optimum use of the specific advantages of the individual transport mode (road transport: flexible operation with full area coverage; rail: point-to-point transport over long distances and over shorter distances along transport axes; ship: for transport where speed is not an important factor, transport of heavy goods). This often involves cooperation between different forms of transport and requires a fully functional and reliable cargo transfer system.

Environment-oriented transport planning therefore involves not only the construction and development of transport routes, but also and in particular administrative and regulatory measures

and harmonisation with other development plans.

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