cost that is required. Collection and transport logistics and potentially limited capacity of the new medical incinerator at Banská Bystrica, will all need to be checked before deciding if a new facility is justified for Nitra Kraj originated medical waste. Alternatives may be to send waste to Bratislava, to an alternative facility outside the area or to Banská Bystrica.

Objective: to provide safe, effective treatment of medical wastes as soon as possible.

(W5) Waste Transfer

The need to rationalise the numbers and quality of operation of the existing network of municipal waste disposal sites in the country has been recognised in the SR Waste Management Plan (Ref. 15.1). The suggestion is for 71 regional sites, virtually one site per Okres. These are to provide all the major capacity for municipal waste disposal, thereby providing an economy of scale and facilitating better control of disposal operations. However, a major implication of this National Policy will be to affect impact on present practices of the transport of waste to disposal sites.

One of the main reasons given by operators for selection of sites, is to minimise transport costs from waste generation areas to the disposal points (Ipodex-Onyx pers comm). With only one disposal location per Okres, minimal travel costs will no longer be available to municipal authorities, and the concept of transfer stations will have to be embraced.

Assuming that regional (Okres) sites are adopted, then they are going to mean large quantities of waste being directed to a limited number of major sites. At present, the quality of the WCVs (Waste Collection Vehicles) is variable. The waste is collected from the residential areas of the municipalities and transferred directly to the waste disposal sites. To some extent, the condition of the disposal fleet is not critical of present disposal purposes, but when regional landfill facilities become the norm, the use of small, poorly maintained WCVs will become impracticable. Both the small capacity of the vehicles and their ability to travel considerable distances in a cost effective manner, will militate against their future usage.

The result will be that large capacity transfer vehicles will be required to move waste from central collection facilities – transfer stations – to the disposal sites. There are very few such facilities presently in operation in the Study Area, and the concept of using transfer stations is not well known. This situation will have to change with the implementation of the strategy of regional waste disposal sites.

An advantage of waste transfer stations is that they allow the segregation of waste for both reclamation and composting purposes. Again, it requires investment to establish such facilities, but the regional municipalities will be required to develop these facilities, if the national strategy for regional landfills is enforced. Investigation of the costs and implications of developing integrated transfer stations should be investigated as an integral part of any regional or sub-regional management strategy or plan. The investigations should not only address the obvious issue of household/municipal waste transport, but also if integration with industrial waste sources can be included.

Objective: to investigate the potential development of a rationalised waste handling and transport network within the Study Area.

(W6) Old Environmental Loads (OELs)

A large number of the declared 550 OELs within the Study Area (RSO data) have been earmarked for removal or reclamation, with a proportion already having been dealt with. As with most of the statistical data for waste, information on the OELs seems to be variable. In this instance the figures from the Okres WMPs indicate that 83 sites had been reclaimed in the Study Area up to 1995 (Refs. 15-7 through 15-16), whilst the Banska Bystrica Kraj WMP (Ref. 15-6) indicates that 151 sites had been reclaimed in the period 1993-1996.

There are still, nevertheless, a large number of sites to be reclaimed, with an inherent cost. It will not be possible for all these sites to be dealt with in the near future, so that some form of prioritisation should be established for the sites. In order to effect this, a recommendation from the Interim Report (Ref. 3-12), namely to create a database of all waste sites, past and present, should be developed. It is suggested that the original GSSR database should be updated, with the municipal authorities pooling their resources, data and knowledge, in order to develop a suitable list. This can then be used to priorities the reclamation and treatment of those sites which pose the greatest environmental risk to local communities. It may be appropriate to refer to a number of other sources of information to assist in the selection of the most vulnerable sites. One such data source could usefully be the landfill suitability map (See Map 5.4 - 1), which indicates the locations of the existing OELs, together with the composite map that identifies areas suitable for the location of landfill sites.

The selection of the sites will require a thorough investigation of those locations that remain to be treated. This will include site investigation to determine the exact nature and extent of the

in situ waste. It will also require an evaluation of the costs of the relative reclamation exercises, so that some form of cost-effectiveness can be undertaken. This should be refined on the basis of an examination of the content of the OELs, given that the nature of material disposed of at the sites may not be known. In order to make a cost-effective assessment of the sites to be reclaimed or restored, it may be necessary to undertake further investigations of the remaining OELs, notably to determine the environmental risk associated with each site. This may require extensive study, but will be a cost-effective exercise in the longer term, if it can help prioritise the order of reclamation of the remaining OELs.

Objectives: to develop a prioritisation for the reclamation or removal of OELs.

(W7) Monitoring of Landfill Sites

At the present time, monitoring of landfills is largely restricted to recently established locations, where monitoring points, eg for groundwater (boreholes) and biogas emissions (venting pipework), are installed as part of the site development. Information is collected on a regular basis, dictated by the municipal authority, to detect potential contamination of groundwater, and determine the rate of production of landfill gas. Surface water monitoring could also be required if there was an obvious watercourse affected by the landfill.

OELs are not monitored in this fashion, so that it is unknown in many instances what effects the abandoned waste sites may be having on the local environment. This situation is not satisfactory, but with limited budgets, it is very difficult for the municipal authorities to undertake monitoring of all OELs under their jurisdiction. Consequently, there needs to be some form of prioritisation, so that those sites which pose the largest possible environmental risk, can be monitored to ensure that localised contamination is not occurring.

Before the exact nature of waste monitoring can be determined for the OELs, it is necessary for the waste deposits to be examined so that the chemical contents of the sites are known. This will require a sampling exercise to be undertaken. Where potentially toxic or high levels of contaminants are noted, then the sampling should be used as the basis for future monitoring programmes.

The results of the sampling programmes should be reviewed on a regular basis, by either SAZP, SHMU or SIZP, so that a record of present levels of contamination can be established and risk levels attached to the respective sites. The results should also be used to assist municipal authorities in prioritising the reclamation of the OELs.

Objective: to establish a comprehensive monitoring programme for all major landfill facilities and OELs, in order to identify significant environmental risks in the Study Area.

(W9) Summary of Objectives and Recommendations

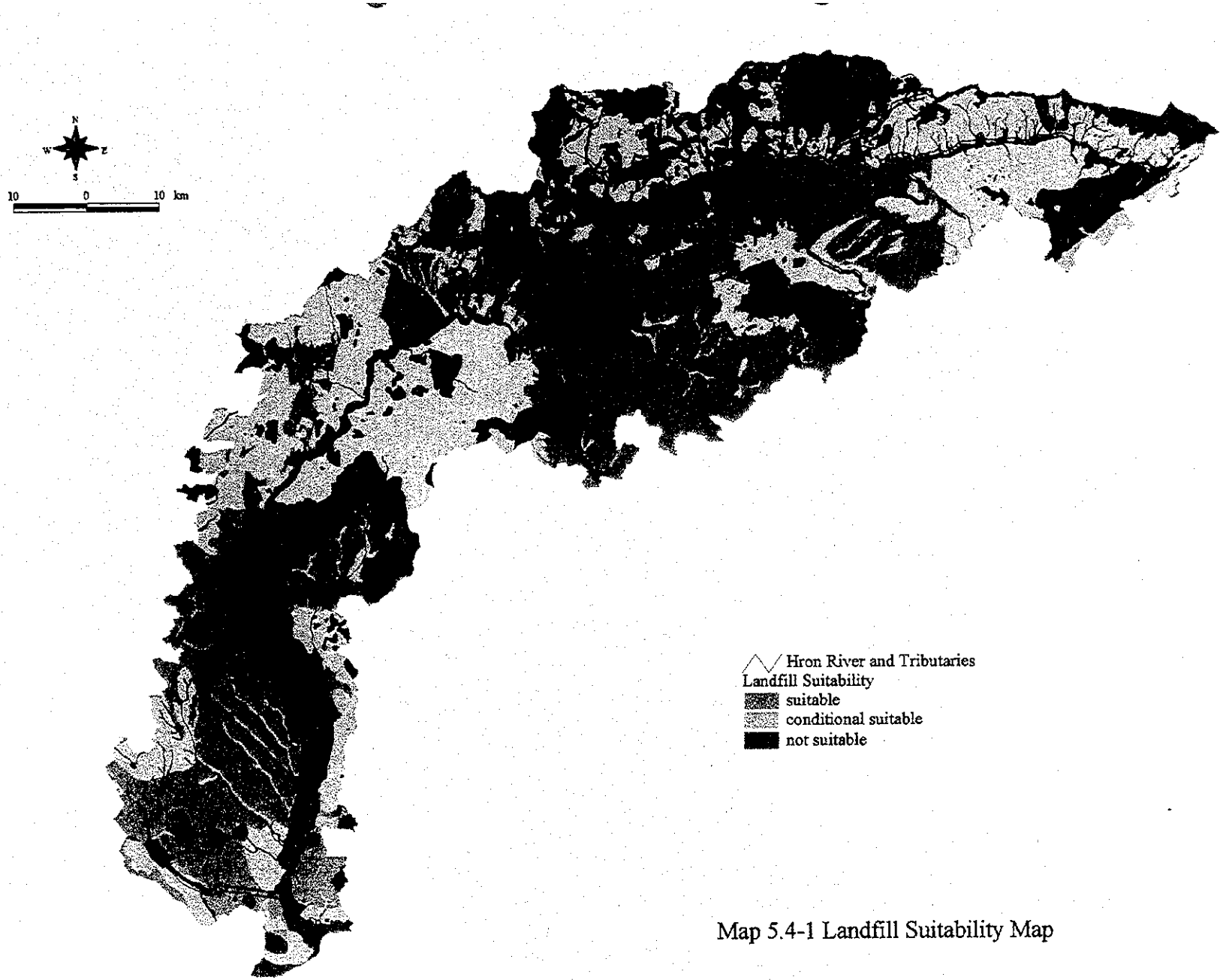
The main objective of the solid waste section is to ensure that methods and approaches are operated that will ensure the long term effective management and disposal of waste within the Study Area. These main objectives are presented below in Table 5.4-16.

Table 5.4 - 16 Summary List of Objectives and Recommendations

Issue	Objective	Target	Measure	Agency
(W1) Waste Classification	Objective: to rationalise the waste classification system further, in order to simplify completion of the waste statistics forms	Simplification of the number of waste types, to avoid confusion for operators, with respect to the range of wastes for which statistical data are required	(W1.1) Continual review of the existing list waste types with a view to reducing the number of waste types within the statistical record	SAZP (COH) SOSR Ministry of Environment
(W1.2) Creation of Waste Statistics	Objective: to develop a waste-disposal based statistical record, removing double-accounting for waste production figures and placing the onus on data collection in the hands of the waste disposal operators.	Create a database of waste disposal derived statistics, as well as from waste production figures, thereby requiring additional sources of accountable data. Disposers as well as producers will become involved with the provision of long term statistical information.	(W1.2) Modification of legal requirement to require additional statistics to be provided by waste disposers as well as data being provided by waste producers	SAZP (COH) SOSR Ministry of Environment Kraj / Okres Authorities Waste Producers
(W1.3) Collation and Publication of Waste Statistics	Objective: for SAZP (COH) and SOSR, in conjunction with the Ministry of Environment, to rationalisation the collection, collation and presentation of waste disposal statistics, so that one organisation takes responsibility for the management of the data, even if another publishes the information.	Develop SAZP (COH) as the single compiler of waste statistics, together with publication data in Partial Monitoring System, plus SOSR having responsible for publication of national statistics for waste	(W1.3) Establish a clear method for collection of waste statistics from producers or (later) disposers, so that unambiguous data are collected on the basis of a single waste questionnaire	SAZP (COH) SOSR Ministry of Environment
(W2) Regional or Sub-regional Waste Plans	Objective: to develop a clear and quantified understanding of the future waste management requirements for the Study Area, either as a whole or on suitable sub-regional bases.	Derive costed integrated waste management strategies on a regional or sub-regional basis by 2001 for implementation by 2003	(W2.1) Produce strategic sub-regional waste management plans for all Okres in the Study Area by 2001, which consider future waste disposal requirements, including waste disposal sites and strategies. Financial considerations also evaluated through open discussions between adjacent authorities	Kraj / Okres Authorities Industrial Waste Producers

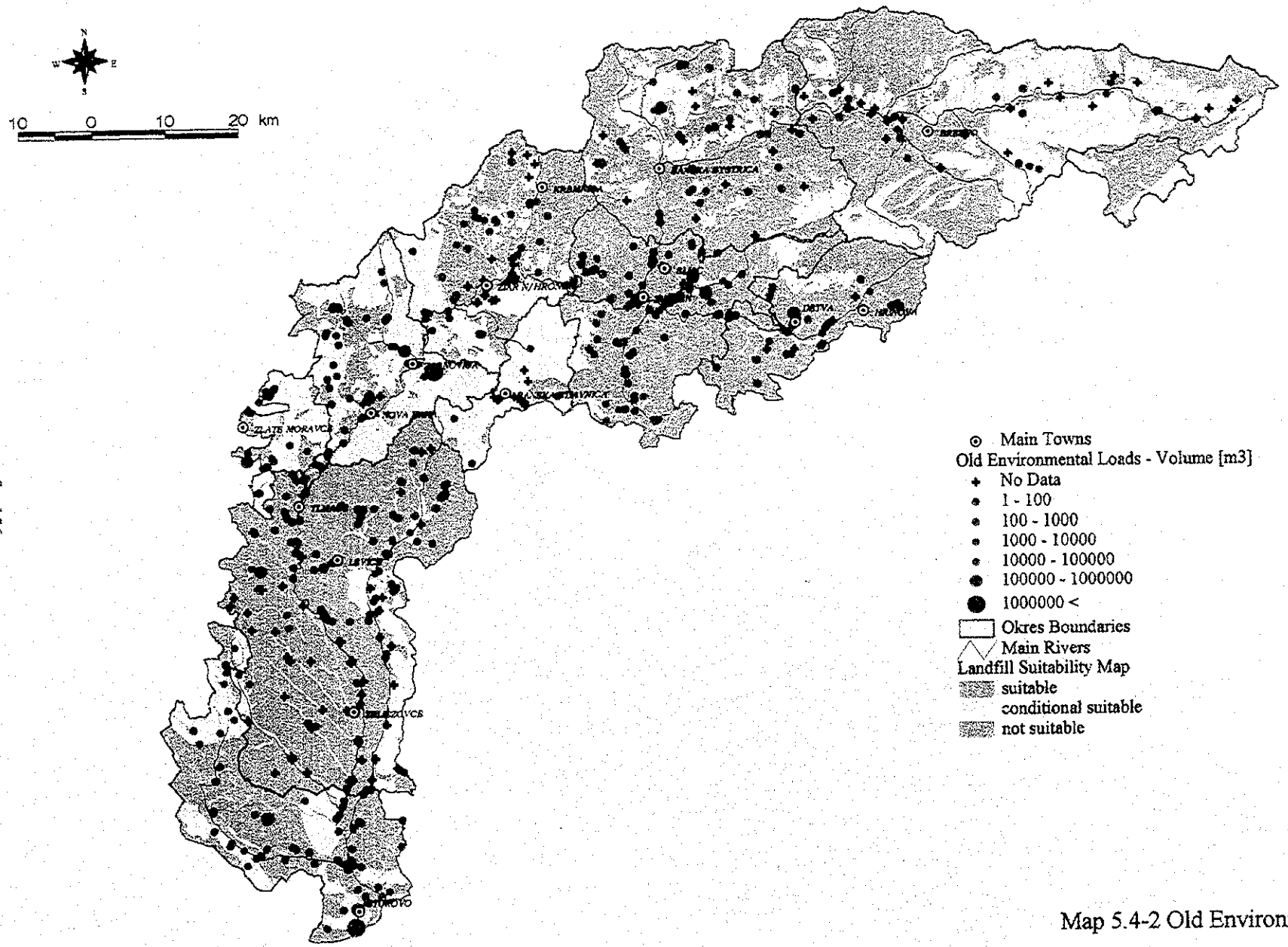
Issue	Objective	Target	Measure	Agency
(W3) Old Environmental Loads	Objectives: to develop a prioritisation for the reclamation or removal of OELs.	i) Identify sites of greatest environmental risk, through a mix of chemical analyses and GIS-based reference to existing information files ii) compile a listing of all past and present waste disposal sites, utilising and updating the original GSSR database, supplemented with site investigations to determine the nature of waste content, supported by photographs, with an evaluation of the likely environmental risk of the site	(W3.1) i) Prepare a prioritisation list of sites that require to be reclaimed or removed ii) all Okres combine efforts and historical knowledge so as to provide the best starting-point for the exercise. Agreement should be reached on the prioritisation of sites to be reclaimed, and to work to securing appropriate funding, possibly from external agencies, eg. EU	Ministry of Environment Kraj / Okres Authorities GSSR
(W4) Medical Incinerator Operation	Objective: to provide safe, effective treatment of medical wastes, as soon as possible.	To ensure that the newly constructed medical incinerator at Roosevelt Hospital in Banská Bystrica is made operational to handle the medical disposal needs for the Kraj; similar facility needs to be established for Nitra Kraj	(W4.1) To complete commissioning, and have the facility fully operational by the end of 1999, if it is not already.	Municipal Authority Hospital Authority Ministry of Environment
(W5) Waste Transfer	Objective: to investigate the potential development of a rationalised waste handling and transport network within the Study Area.	Make municipalities and Okres aware of the needs to develop facilities suitable for the collection and segregation of community wastes, together with the establishment of a fleet of WDV (waste disposal vehicles) suitable for the transport of wastes to regional disposal sites	(W5.1) Review waste disposal requirements in the light of the costed WMP, so that location of disposal sites are known, together with distance to travel + quantity of waste. Determine the number of vehicles that will be necessary for the effective transport of wastes, assuming distance to disposal site is too great for existing small collection vehicles. Establish transfer stations with facilities to reclaim waste, after sorting. Propose strategic locations for such transfer stations	Kraj / Okres Authorities Waste Disposal Operators
(W6.1) Alternative Waste Treatment	Objective: to improve public awareness with respect to waste recycling and improve industries adoption of waste minimisation, through educational programmes and realistic pricing mechanisms for waste disposal.	Encourage the general public to support community recycling programmes and industry to improve their reclamation and waste minimisation performance	(W6.1) Develop a range of public and industry awareness programmes with respect to waste recycling and minimisation respectively, with cost saving as a major feature	Ministry of Environment Kraj / Okres Authorities NGOs and Community Groups

Issue	Objective	Target	Measure	Agency
(W6.2)	Objective: to identify alternative methods of waste treatment and re-use	Encourage the involvement of a wider range of institutions, to devise, amongst other things, commercially viable methods for waste ru-use	(W6.2) Encourage the involvement of scientific and achademic institutions in the research and identification of alternative means of waste recycling, re-use and treatment	Ministry of Environment, GSSR, SAZp, MZP and SAV
(W7) Monitoring of Landfill Sites	Objective: to establish a comprehensive monitoring programme for all major landfill facilities and OELs, in order to identify significant environmental risks in the Study Area.	Implement environmental monitoring for all major landfill sites (as per legislative requirements) together with coverage of OELs by 2003	(W7.1) Establish a list of sites to be monitored together with a list of parameters to be assessed on an annual or bi-annual basis	Kraj / Okres Authorities SAZP (COH) SHMU SIZP

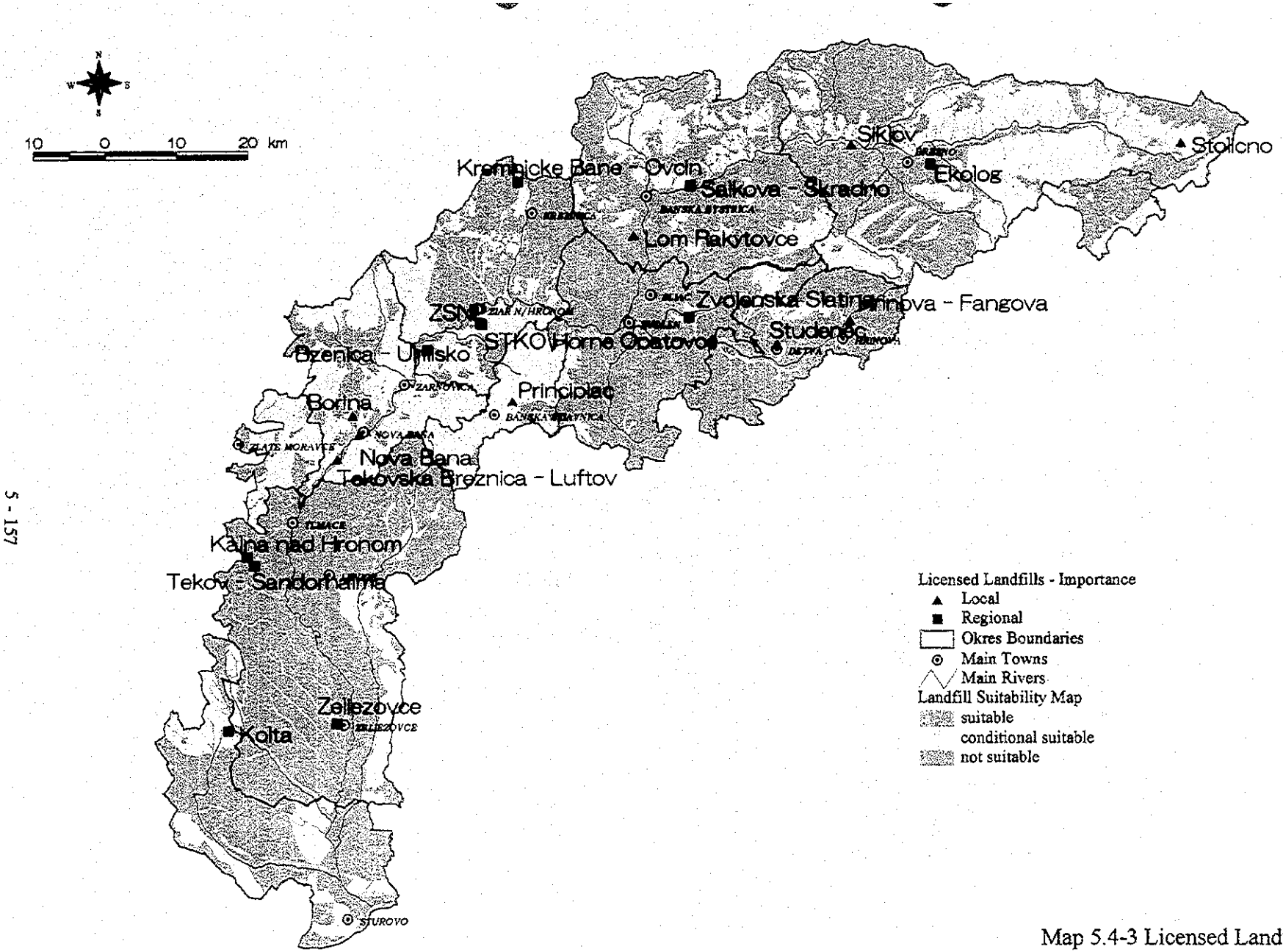


Map 5.4-1 Landfill Suitability Map

Data Source : GSSR , Map Prepeared by JICA Study Team



Map 5.4-2 Old Environmental Loads



Map 5.4-3 Licensed Landfills

5.5 ECOLOGY AND BIODIVERSITY

The ecology and biodiversity of the Hron basin are indicators of the conditions of the human environment for residents and visitors to the area. Good ecological conditions and a high biodiversity provide an environment that is pleasing for all people and which generally increases the quality of life as well as giving a basis for outdoor recreation and tourism. In today's society in Slovakia a high value is placed on ecology and biodiversity. This is demonstrated by the popularity of outdoor activities such as, for example, hunting, fishing, walking, cycling and berry picking. These activities mainly take place in and require areas with good conditions of ecology and biodiversity.

At the same time, many commercial activities are based directly on the management of the Hron's ecological resources and biodiversity eg forestry, farming, tourism. Other activities affect their quality eg discharges of industrial and domestic wastes to water, air or ground. Thus the management of the Hron basin should proceed in ways that allow economic activities to proceed and develop without undue damage to the resources that both sustain them and contribute to the quality of life in the valley.

This chapter initially reviews the main activities that have affected the Hron's ecology and biodiversity and then describes their existing status and conditions. Finally, recommendations are made for measures which will improve the management of ecology and biodiversity.

5.5.1 ACTIVITIES AFFECTING ECOLOGY AND BIODIVERSITY

The ecology and biodiversity of the Hron basin have been affected by Man's activities over many centuries. The most significant of these has been forest clearance for intensive agriculture in the lower Hron basin. Forest management for commercial timber in the middle and upper Hron basin has also caused changes, but on a much smaller scale. All, to a large extent, were essential for the socio-economic development of the region and country. Such changes are not unique to the Hron basin, having occurred throughout Slovakia and Europe as a whole. In Slovakia, compared to many European countries, such historical changes in biodiversity are low due mainly to the maintenance of well managed extensive forests. Agricultural activities, chiefly in the development of pastures for low-intensity grazing in forested areas such as Pol'ana PLA, have increased biodiversity by creating a rich grassland fauna and flora in such localities.

Man's present-day activities also affect ecology and biodiversity in the Hron basin, though forest clearance for agriculture has now stopped. This section reviews current activities that affect the

Hron basin's fauna, flora and ecosystems.

(1) Air Pollution

Air pollution from industrial, domestic and transport sources has adversely affected forest health condition throughout much of Europe in the latter half of the 20th Century. Such effects have been intensively studied and monitored throughout Slovakia (including the Hron basin) by the Forest Research Institute (Map 5.5-1).

Forest health in Slovakia is assessed by measuring the following parameters:

- leaf defoliation;
- leaf discoloration and chemical composition;
- tree damage by insects, fungi, drought, frosts etc.

The average defoliation of selected tree species in the Hron basin compared to Slovakia as a whole, is given in Table 5.5-1. Comparisons are difficult to make, but the figures do show that high proportions of trees in both the Hron basin and the rest of the country suffer from significant leaf loss. The average defoliation of tree species since 1987 (Table 5.5-2) ranged from 23-30%. The most damaged conifer species were *Pinus sylvestris* (Scots pine) and *Abies alba* (fir) whilst *Robinia pseudoacacia* (locust tree) and *Quercus* spp (oaks) were the most affected broadleaved species.

Over the nine year monitoring period the degree of defoliation of both conifer and broadleaved species has changed little. Forest health therefore seems to be in a stable condition, although there are variations from year to year. These are probably related to climatic conditions, especially drought. Thus in 1991, defoliation levels were at their least whilst rainfall levels were high. The marked decrease in production of sulphur dioxide in Europe (40% less in 1992 than 1988) did not cause any apparent improvement in forest health.

Compared to other countries in Europe, levels of tree defoliation in Slovakia are high (Table 5.5-3). For conifers, Slovakia had the 26th worst levels of defoliation out of 33 European countries. For broadleaved species the country ranked 19th out of 31, and overall was ranked 23rd out of 31 countries. Overall therefore, in 1996, some 75% of European forests were in better condition than those of Slovakia, including the Hron basin. The situation was similar for other years for which data are available (1988-1995).

A further indication of forest health in the Hron basin is provided by the Lesoprojekt's classification of forest areas into pollution categories (Table 5.5-4). These indicate the likelihood, under presently prevailing conditions, of the Hron basin's forests dying within the given time periods. These figures indicate that, overall, forest longevity is little affected by prevailing levels of air pollution. Only a negligible amount (110 ha) of the Hron basin's forests are so badly affected as to be likely to die within 40 years. These pollution category A and B forest areas are mainly located around industrial plants at Slovenska Lupca and Brezno. The Forest Research Institute and Lesoproject are undertaking studies to determine the most effective way of revitalizing these areas. Such measures may include liming of the soil to reduce acidity. Previously pollution-damaged forests around Ziar nad Hronom are recovering following reduction of emissions in that area.

A recently completed study by Mankovska (Ref. 4-45) showed that the forest trees of the Hron basin, including those of the national parks and PLAs, are contaminated with a large range of pollutants (Table 5.5-5). The data show that in 14 instances the high or limit values are exceeded or equalled by average concentrations in leaf tissue (eg arsenic, cobalt, zinc). They also show that maximum tissue values for all substances exceed the high or limit values.

Since at least the 1970s tree health and condition have declined in the Hron basin and Slovakia in general. The symptoms are loss of foliage, discolouration of leaves and needles and decreased vitality and vigour of the trees. Decreasing tree health is not due however to any single factor (such as air pollution), but to a variety of causes acting together on trees and forest ecology (Table 5.5-6).

The various factors and aspects listed in Table 5.5-6 represent the stress factors that can act on trees and affect their health. The precise nature and interactions of these many factors are not clearly understood, although air pollution is generally considered to be one of the most important factors.

Table 5.5 - 1 Defoliation of Forest Trees in the Hron Basin and Slovakia, 1995-1997

Type of Tree	Defoliation Class	% Defoliation in Hron Valley*	% Defoliation in Rest of Slovakia*
Fagus spp (Beech)	0	12.2	29.2
	1	70.9	51.9
	2	16.9	18.2
	3	0.0	0.4
	4	0.0	0.2
Quercus spp (Oak)	0	1.4	3.3
	1	60.2	49.4
	2	35.8	42.9
	3	0.7	1.8
	4	1.8	2.6
Picea abies (Fir)	0	5.2	12.9
	1	47.6	42.6
	2	42.7	39.8
	3	2.9	3.5
	4	1.6	1.2
Pinus sylvestris (Scots pine)	0	1.3	6.9
	1	72.0	48.2
	2	26.6	38.8
	3	0.0	3.8
	4	0.0	2.3

* Average of 16 sites * Average of 95 sites

Defoliation Class 0: Negligible defoliation (0-10%)
Defoliation Class 1: Low defoliation (11-25%)
Defoliation Class 2: Moderate defoliation (26-60%)
Defoliation Class 3: Severe defoliation (61-99%)
Defoliation Class 4: Dead

Source: Forestry Research Institute, Zvolen, 1998.

Table 5.5 - 2 Average Defoliation (%) of Tree Species in Slovakia

Species	Average Annual Defoliation (%)								
	1987	1988	1989	1990	1991	1992	1993	1994	1995
Broadleaved trees									
Fagus sp (beech)	23	19	23	17	13	17	17	21	21
Quercus spp (oak)	24	30	35	31	25	27	27	30	31
Carpinus betulus (elm)	18	14	20	18	13	18	25	20	22
Fraxinus spp (ash)	29	23	29	38	40	38	30	40	33
Acer spp (maple)	39	35	46	39	33	30	29	32	28
Populus spp (poplar)	26	40	37	38	45	50	32	36	37
Robinia pseudoacacia (locust tree)	32	37	36	74	46	61	51	37	48
Total Broadleaved	**24**	**23**	**27**	**25**	**19**	**23**	**23**	**32**	**25**
Conifer trees									
Picea abies (spruce)	34	28	31	29	25	27	29	32	32
Abies alba (fir)	52	31	39	37	21	33	32	33	32
Pinus spp (pine)	40	45	44	44	33	42	29	32	33
Larix decidua (larch)	24	20	33	30	17	26	27	30	28
Total Conifers	**35**	**32**	**35**	**33**	**27**	**29**	**29**	**32**	**32**
Total Species	**30**	**27**	**30**	**28**	**23**	**26**	**26**	**28**	**28**

Source:Ref. 4-46

Table 5.5 - 3 Levels and Ranking of Tree Defoliation in Slovakia and Other European Countries, 1996

	Average % Defoliation in Classes 2-4*		
	Broadleaved	Conifer	All Species
% Defoliation	28	41	34
Rank	19/31	26/33	23/31

* Class 2: Moderate defoliation (25-60%)
Class 3: Severe defoliation (60-99%)
Class 4: Dead

Source: Ref. 4-46

Table 5.5 - 4 Pollution Categories of Hron Basin Forests

Pollution Category of Forest	Area Affected	
	Ha	%
A – likely to die within 20 years	17	0.01
B – likely to die within 40 years	93	0.04
C – likely to die within 60 years	33 398	16.1
D – likely to die within 80 years	173 842	83.8
	207 350	100.00

Source: Lesoprojekt, 1999

Table 5.5 - 5 Concentrations of Selected Atmospheric Pollutants in Leaves of Deciduous and Coniferous Tree Species in National Parks and Protected Landscape Areas of the Hron Basin

Pollution Indicator	High or Limit Value (mg/kg)	Mean and Upper Values (mg/kg)		Protected Areas in which High or Limit Values Exceeded
		Deciduous	Coniferous	
Aluminium	200	137 : 979	160 : 1 668	1,2,3,4,5
Arsenic	0.2	0.6 : 13.8	0.6 : 34.18	1,2,3,4,5
Barium	150	90.8 : 603	48.3 : 452.0	1,2,3,4.5
Cadmium	0.5	0.2 : 3.9	0.2 : 2.0	None
Chromium	2.0	1.0 : 47.1	0.7 : 20.9	1,2,3,5
Cobalt	0.2	0.2 : 3.9	0.2 : 3.6	1,2,3,4,5
Copper	10.0	9.7 : 154.1	5.8 : 107.6	1,2,3,5
Fluorine	5.0	5.6 : 18.8	6.6 : 152.9	1,2,3,5
Iron	200	189 : 39 300	140 : 14 005	1,2,3,4,5
Lead	6	3.1 : 237.6	2.0 : 59.7	1,2,3,5
Manganese	2000	1 208 : 9 773	1 066 : 8 112	1,2,3,4,5
Mercury	0.12	0.1 : 1.3	0.11 : 4.0	1,2,3,5
Nickel	2.0	4.4 : 36.6	2.8 : 27.3	1,2,3,5
Selenium	0.05	0.06 : 1.3	0.06 : 6.3	1,2,3,4,5
Strontium	50	21.3 : 64.6	21.9 : 359.6	1,2,3,4,5
Sulphur	2000	2 401 : 9 666	2 007 : 11 400	1,2,3,5
Vanadium	0.8	0.4 : 11.9	1.0 : 46.9	1,2,3
Zinc	45	38.4 : 691	45.4 : 413	1,2,3,5

1 – Stiavnicke Vrchy PLA
2 – Muranska Planina NP
3 – Nizke Tatry NP
4 - Pol'ana PLA
5 - Vel'ka Fatra PLA

Source: Adapted from Ref. 4-45

Table 5.5 - 6 Factors Influencing Tree Health and Condition in the Hron Basin

Factor	Main Aspects
• Stand characteristics	Species, age, canopy closure.
• Management activities	Felling and regeneration methods, thinning methods.
• Water availability	Rainfall (annual/seasonal), soil retention capacity, water uptake and transpiration.
• Temperature	Heat, cold, winter frosts, spring frosts.
• Pests and diseases	Insect attack, fungi, bacteria, viruses.
• Foliage composition	Content of nitrogen, phosphorous, calcium, magnesium, potassium.
• Soil composition	pH, base saturation, nutrient availability, heavy metal and aluminium concentrations.
• Atmospheric pollution	Concentrations of atmospheric ozone, sulphur dioxide, ammonia, nitrogen oxides, carbon dioxide, fluorine and volatile organic compounds.
• Deposition of atmospheric pollutants and exceedances of critical levels	Distance to sources and transport processes. Tree height, canopy closure, distance to forest edge, soil chemical composition. Rainfall, temperature, windspeed, radiation levels, altitude.
• Mechanical damage	Accidents, mis-management during logging and planting/regeneration. High winds; heavy snows.

Source: Adapted from Ref. 4-46

Air pollution is thought to affect trees both by direct action on the leaves and by increasing soil nutrient levels, heavy metal concentrations and acidity. Thus the oxidation of SO_2 and NO_x to strong acids may destroy the leaf cuticle and/or adversely affect biochemical processes in the leaves, both resulting in damage to the foliage and trees. Critical concentrations in the air, above which tree damage can be expected from SO_2, NO_2 and NH_3 are 20 $\mu g.m^{-3}$, 30 $\mu g.m^{-3}$ and 8 $\mu g.m^{-3}$ respectively for long term (one year) exposure. The critical concentration for ozone (O_3) is 40 ppb, and an accumulated exposure of 10 000 ppb.h over the six-month growing season is the level at which annual growth is adversely affected. Recent studies (Ref. 4-55 and 4-56) have shown high levels of heavy metals in soils near industrial sites at Ziar nad Hronom that appear to be related to levels of tree defoliation.

Critical loads of sulphur and nitrogen deposition are frequently exceeded in the Hron basin, particularly in the higher areas (Map 5.5-2). This may affect tree health and growth in a number of ways, namely:

- increasing soil nutrient levels (nitrogen, sulphur);
- reducing pH (increasing acidity);
- decreasing base saturation;
- increasing uptake of heavy metals;
- increasing the concentration aluminium which reduces root growth and adversely affects the uptake of water and nutrients.

The critical deposition level for nitrogen on trees varies, with species, from 20-35 kg/ha/yr. Such high deposition levels may seriously affect forest condition by causing nutrient imbalances and increased susceptibility to other stress factors. Critical nitrogen deposition levels for the forest understorey range from about 1.3-13 kg/ha/yr and amounts in excess may therefore affect vegetation composition under the dominant forest canopy trees. The critical acidity deposition levels range from 1 000-8 000 vol$_c$/ha/yr, being lowest for conifers and highest for broadleaved species. Conifers are therefore more susceptible to soil pH increases than broadleaved trees.

The precise inter-relationships between tree health, air pollution and the other factors and aspects shown in Table 5.5-6 are not well understood. It is generally thought however that air pollution and increased soil acidity in particular may both affect tree health directly and make them more susceptible to damages from the other factors.

The Forestry Research Institute undertakes many monitoring programmes of relevance to understanding forest dynamics. These are important and should be continued to increase the understanding of the relationships between tree and forest health and their environments. These monitoring programmes will only achieve maximum benefit if their results are interpreted in ways relevant for use in the management of forests, and such information is used to prepare forest management plans and protected areas management plans, particularly for national parks and protected landscape areas.

(2) Water Pollution

River water quality is determined by the regulations of STN 75 7221 *(Classification of Surface Water Quality)* of 1990. Water quality can be measured for six groups of parameters (Table 5.5-7). These can be classified into five categories which are suitable for particular types of uses (Table 5.5-8).

Table 5.5 - 7 Groups and Principal Parameters for Classification of Surface Water Quality

Group	Group of Parameters	Principal Parameters*
A	Oxygen regime	Dissolved oxygen, BOD_5, COD_{Mn} or COD_{Cr}
B	Basic chemical and physical	pH, water temperature, soluble solids or conductivity, ammonium-N, nitrate-N, Total-Phosphorus
C	Complementary chemical	Calcium, magnesium, chlorides, sulphates, anionic surfactants, non-polar extractable substances, organic chloride
D	Heavy metals	Mercury, cadmium, arsenic, lead
E	Biological and microbiological	Saprobe index, coliform bacteria or faecal coliform bacteria
F	Radioactivity	Total volume α - activity, total volume β - activity

* Parameters to be determined for classification in each Group. Total water quality classification must be based upon at least the measurement of the principal parameters in Groups A, B and E.

Source: STN 75 7221 *Classification of Surface Water Quality*

Table 5.5 - 8 Categories and Suitable Uses of Surface Waters

Category	Description	Suitable Uses
I	Very Clean	Domestic water supply, industries requiring high quality water, swimming pools, salmon fish farming. High landscape value
II	Clean	Domestic water supply, water sports, fish farming, industrial supply. Landscape value
III	Polluted	Usually suitable only for industrial supply. Domestic supplies require full treatment. Low landscape value.
IV	Very polluted	Limited use
V	Very highly polluted	Not usually suitable for any purpose.

Source: STN 75 7221 *Classification of Water Quality*

For most of its length, the Hron river and two of its main tributaries are classified as belonging to Categories III, IV or V (Table 5.5-9). Apart perhaps for a short distance below the source near Telgart, none of the Hron belongs to Category I (Very Clean). For water quality parameters in Group A (oxygen regime) the Hron River is in Category II or III from Pohorela to Sturovo. For Group B parameters (basic chemical and physical) the river is in Category II or III from Pohorela to Banska Bystrica, and thereafter Category IV or V to its mouth at Sturovo. For Group E (biological and microbiological parameters) the whole of the river from Pohorela to Sturovo belongs to Category V.

Table 5.5 - 9 Water Quality in the Hron, Bystrica and Slatina Rivers, 1995

River	Group of Parameters	Category of Water Quality	Stretch of River
Hron	A	II	Pohorela - Brusno
		III	Brusno – Trnava
		II	Trnava - Pohr.Ruskov
		III	Pohr.Ruskov – Sturovo
	B	II	Pohorela - Brezno
		III	Brezno – Podbrezova
		II	Podbrezova - Brusno
		III	Brusno – B.Bystrica
		IV	B.Bystrica –Zvolen
		V	Zvolen - Sturovo
	E	V	Pohorela – Sturovo
Bystrica	A	III	Lower 8 km
	B	III	Lower 8 km
	E	V	Lower 8 km
Slatina	A	II	Hrinova – Krivan
		III	Krivan - Zvolen
	B	IV	Hrinova - Zvolen
	E	V	Hrinova - Zvolen

A: Oxygen regime
B: Basic Chemical and Physical
E: Biological and Microbiological

Source: Akost Vody na Vibranich Tokoch, 1995. Map No.6

Little information is available about the Hron river's tributaries. The lower part of the Bystrica river belongs to Category III for Group A and B parameters and Category V for those of Group E. The Slatina river is in Categories II and III for oxygen regime measures, but Categories IV and V for Group B and E parameters. In general, the upper parts of the tributaries are likely to belong to Categories I and II for so long as they are in uninhabited, sparsely populated, non-mined or forested lands. Once they pass into village, urban, heavily mined or intensively farmed land, water quality is likely to be Category III at best.

Pollution of the Hron river and its tributaries comes from the discharge (including run-off) of untreated or partially treated industrial, domestic, agricultural or mine waste waters. The classification of virtually the whole length of the Hron river (Pohorela to Sturovo) as Category V (very highly polluted) for biological and microbiological parameters is proof of the considerable pollution from domestic and agricultural waste water.

Pollution of the Hron river and its tributaries will adversely affect their ecology and biodiversity. In particular, decreased oxygen levels, increases of suspended organic and inorganic materials

and increases in nutrient levels can cause reductions or local extinctions of those fish, invertebrate and plant species dependent on good quality water. They will be replaced by species more tolerant of pollution. There is however little information on the invertebrate fauna of the river. In many countries, aquatic invertebrates are routinely monitored and used as indicators of pollution and water quality. This system has not been developed in Slovakia.

Although the Hron river is polluted for all or most of its length, it is less polluted than other major rivers in Slovakia eg Ipel, Nitra, Vah. This is due to the relatively low levels of industrial development and population density in much of the Hron basin. Additionally, water quality in the Hron river has improved in recent years. For example, in 1991/92 the river was Category IV or V from Val'kovna to Sturovo (261 km) for oxygen parameters and Category III to V for basic chemical and physical parameters. Such improvements are due to a combination of factors - decreasing industrial activity, improved water treatment facilities for some industrial and urban areas, decreased use of fertilisers and other chemicals in agriculture as well as fewer numbers of livestock.

Although improving, further improvements are possible and highly desirable, particularly in relation to Group B and Group E parameters.

(3) Forestry

The forests of the middle and upper Hron basin generally have a rich and diversified flora and fauna that is significant at both the national and international level. This is readily apparent from the presence of large areas of native hardwood, conifer and mixed forests with key vertebrate species such as bear, wolf, lynx, wildcat, otter, deer, chamois, and many birds of prey.

The existing biodiversity in planted forest areas is however less than that existing in areas of virgin forest and less than it could be in managed ones. Virgin (natural) forests unaffected by human activities have an undisturbed ecology and the highest possible biodiversity. The ecology and biodiversity of planted (managed) forests are adversely affected to a greater or lesser extent depending upon how different they are from natural forests and management methods.

The significant tree planting programme that started in much of the Hron basin around 100 years ago, and that has continued throughout this century, has given rise to forests with reduced biodiversity. Such reductions are also increased by some forest management practices. Examples of forestry management procedures that adversely affect biodiversity are:

- increasing the amounts of conifer trees at the expense of hardwood species eg spruce instead of beech;
- planting monocultures instead of mixed species stands;
- high stand densities.
- infrequent thinning;
- planting species in areas where they are not the best ecologically adapted, especially to soil, climate and wind conditions;
- clear felling;
- reforestation by planting rather than natural regeneration;
- logging operations (felling, hauling, bucking, transport) that can cause ecological damages to soil and water courses;
- poor maintenance of forest roads that increases soil erosion and rainfall run-off.

The detailed effects of past and present forestry management methods on forest ecology and biodiversity in the Hron basin are not known. Effects in general will be mainly felt by invertebrate species and the ground layer of vegetation including algae, lichens, mosses, liverworts and fungi. As these species are affected, so in turn are those dependent upon them. The ecosystems are therefore simplified and biodiversity reduced. So far as known, detailed comparative studies on the flora and fauna of virgin and managed forests in the Hron basin have not been undertaken.

Many current forestry management methods (as listed above) are also believed to make forests more susceptible to damaging influences from events such as drought, frost, high winds, insect and pest attacks, diseases and air pollution. If these cause severe and extensive damage to forests, then ecology and biodiversity will also be adversely affected. Recent authoritative reviews identify, in general terms, the links between forest management and ecology and biodiversity (Ref. 4-47, 4-48, 4-49, 4-50, 4-51, 4-53).

(4) Agriculture

The development of intensive agriculture in the lowlands of the Hron basin has led to significant adverse changes to the ecology and biodiversity of the area (Ref. 4-52). They have taken place over many centuries, though at an accelerated rate in the 20th Century. The changes include:

- extensive loss of lowland deciduous forests (mainly oak), including flood plain forests of the Hron river and tributaries;
- the near elimination of steppe and forest steppe communities, including salt steppes with saline soils;

- loss of pastures and meadow lands to arable or invasive scrub;
- decrease in biodiversity in surviving meadows and pastures due to ploughing and replanting with two or three grass species, intensive fertilisation and drainage;
- reductions in wetlands (ponds, lakes, bogs etc.) and wet meadow habitats due to land reclamation schemes;
- reduction in quality of remaining ponds and lakes due to eutrophication and chemical and sediment pollution by run-off from agricultural areas;
- enlargement of field sizes with subsequent loss of wildlife habitats such as boundary trees, hedges, walls;
- heavy usage of pesticides.

The result of all these changes is that biodiversity is much reduced in the lower Hron basin, although the precise nature of total effects is not known. In lower parts of the Hron basin, 30% of the area has no forest, 50% has less than 1% and 20% has only 2%. The river bank trees provide the only wooded areas in 30 municipalities and even here the woodlands seem to be drying out due to river engineering projects. Areas of forest, steppe, wetland and other habitats remain but are generally small and fragmented. This makes movement of species between them difficult or impossible. Consequently they are liable to further biodiversity decreases as individual populations of species die out. Many of the small forest areas are less than the size required for long term survival and are likely to die out in the future. They are vulnerable to natural disasters such as drought, high winds, pest attacks and to accidents such as fire. Small areas of woodland (less than about 100 ha) cannot support the full range of bird and mammal species that typically live in lowland forests. The more isolated and apart such small forest areas are, the fewer species they will support.

The conversion of forest, steppe, wetland and other natural habitats to agriculture will always have adverse effects on ecology and biodiversity. Such changes are inevitable and necessary to some extent to provide food for expanding and high populations. However, improvements to agricultural and other land management procedures can improve ecology and biodiversity with no adverse effects on agricultural production.

In some parts of the Hron basin eg Detva, Pol'ana and the montane grasslands of Vel'ka Fatra PLA and the Nizke Tatry and Muranska Planina National Parks, agriculture can be beneficial to ecology, biodiversity and landscape values. In all these areas, agricultural practices such as grazing pressure and the use of fertilisers and pesticides need to be carefully planned to maintain these benefits.

(5) Tourism

The national parks and PLAs of the middle and upper Hron basin have very high potential for tourism activity and development. This is due to their extremely attractive mountain landscapes, particularly the summit and ridge top grasslands, the glacial and forest formations and the traditionally farmed landscapes of the Nizke Tatry and Muranska Planina National Parks and the Vel'ka Fatra and Pol'ana PLAs.

At the present time, tourism activities are only extensively developed in the Nizke Tatry National Park, which receives an estimated one million visitors per year (not all to the Hron basin). The most popular attractions are the walking and skiing areas of the summit ridges and upper slopes. Tourism is less developed in the other protected areas but can be expected to increase rapidly in the future. The many additional attractions of the area include nature watching and wildlife photography, camping, fishing, hunting, climbing, canoeing, mountain hiking, fruit and berry picking, cycling, traditional agriculture and other cultural and historical features.

Tourist pressures are reported to be causing problems for ecology and biodiversity in the Nizke Tatry National Park, particularly in and around the montane grasslands and the upper tree line areas. These include:

- soil erosion and vegetation losses alongside footpaths and ski trails;
- disturbance of mammals and birds, with likely effects on breeding and feeding;
- disruptions to ecology and life cycles by the use of artificial snow fields, which significantly prolong snow cover in the spring;
- damage caused by machinery, soil compaction and soil disposal during the construction of pipelines to bring water (for making artificial snow) to the ski slopes;
- threats to the existence of rare and very small localised populations of plants from theft or trampling eg *Saxifraga mutata* which grows next to footpaths on Salatin Hill in Nizke Tatry National Park, its only occurrence in Slovakia, and *Daphne arbuscula*, a species endemic to Slovakia and occurring at only a few localities in the Muranska Planina National Park.

Such effects on biodiversity and ecology are localised (but still serious). However, they occur in and are caused by the activities of people attracted to areas precisely because they have attractive landscapes in "undisturbed" settings. The ecological damages are also accompanied by landscape damages, which make the areas less attractive for future visitors. Highly visible damages to national parks and PLAs should be avoided since they attract adverse comment about the management of them.

In general, tourism damages are caused by high concentrations of visitors in a few localities, inappropriate developments and management of tourists in these areas (especially ski areas), insufficient information about good environmental standards of behaviour and low environmental awareness of visitors and employees at tourist resorts. These have led to a deterioration of ecology, biodiversity and landscape through the prioritisation of values other than, and incompatible with, nature conservation.

The interests of tourism and nature conservation can readily be harmonised, but require careful planning.

(6) Hunting

Annual quotas are fixed each year for each species of hunted animal. In general, the quotas are set for each hunting area by the hunting association responsible for it. They are based on the estimated population sizes and approved by the Ministry of Agriculture, Food, Forestry and Water Management. For large protected mammals (eg bear, lynx) quotas are set directly by the Ministry, which also determines the areas where they can be shot. All population estimates are made by the hunters themselves. The effectiveness of the quota system is partially dependent upon accurate population estimates and a quota (proportion) that is accurate enough not to cause undue increase or decrease in the game stock. It is also dependent upon there being no other hunting (poaching) and a shooting policy that does not unduly concentrate on the best trophy animals.

It is thought that many of the population estimates are too high - possibly by 300%. This is due to the same animals being counted more than once and included in more than one hunting association's estimates of game stock. Such overestimates could lead to too high quotas being set and too many animals being shot. It is particularly liable to happen for those species with large home ranges eg bear, wolf, lynx. Very little scientific research is done on the numbers and ecology of game species of mammals and birds.

Illegal hunting (poaching) is known to be a major cause of animal deaths. After the socio-political changes of 1989 for example, poaching throughout the Hron basin (and Slovakia in general) has increased considerably. It has resulted in up to 70% decreases in game populations over the 1990s decade.

The hunting laws allow protected and endangered species to be hunted. In total, some fifteen game species are classed as endangered and two are protected. The Ministry of Environment

wants protection of such species to be governed by the obligations of international conventions, which would completely stop or severely restrict current (legal) hunting pressures. The Ministry of Agriculture, Food, Forestry and Water Management wishes hunting to continue in compliance with existing national laws and controls to be maintained by the setting of quotas and close seasons. However, it has recently called for the existing law to be changed (Ref. 4-49).

Some hunters ignore the hunting laws altogether, and the wolf and lynx are believed to have declined in numbers because of this. Some hunters also prefer to shoot only good trophy animals, particularly those with good antlers or horns of a large size. Such selective shooting, often against the regulations of the hunting association, leads to a decline in the genetic (and physical) quality of the game species.

Some animals have become extinct or very rare in the Hron basin (and in Slovakia) as a result of hunting (and trapping). These include the moose, European bison, beaver and otter. Other major species such as bear, wolf and lynx, which naturally occur in low numbers, are not presently in imminent danger of disappearing from the Hron basin. They have however disappeared from most of Europe, mainly through overhunting, and it must not be assumed that it could never happen in the Hron valley.

(7) River Engineering

The Hron river has had many engineering projects carried out on it, mainly in this century and from the 1960s. The principal works have been for flood control and water storage purposes. Flood control measures, involving straightening the river channel and building levees, have been undertaken especially in the Banska Bystrica, Zvolen, Levice and the lower Hron from Kamenin to the Danube. Such measures result in altered river flows, generally by increasing current speeds and cutting out or reducing river meanders. They also reduce or eliminate flooding on the floodplain. In total, the lower Hron has been shortened by 11 km by river straightening projects. The consequences of such measures are alterations to the natural ecology of the river, particularly to fish, plants and invertebrates, and a lowering of the water table on lands adjacent to the river. The latter in turn causes a drying out of floodplain soils with adverse effects on the ecology and biodiversity of surviving remnants of flood plain forests. Forests now survive only on deep soils or very close to the river. Unless flooding regimes and/or water tables are restored to former levels, such forested areas are unlikely to survive in the long term. Generally, water tables have been lowered by about 1.5 m and now reside in the sands and gravels that underlie the soil.

The biggest dam across the Hron river is at Kozmalovce near Levice. Its reservoir provides

cooling water for the nuclear power station at Mochovce and irrigation water, via the Perec canal, for lands to the east of the lower Hron. Other barriers across the Hron are located at Zvolen. None of these have fish passes, although it is planned to build one at Kozmalovce. These plans however have been postponed many times. Fish passes are essential for maintaining the ecology and migration movements of many fish species.

There are proposals to build more barriers across the Hron and its tributaries. These include a major dam across the Slatina river to the east of Zvolen and 10 or more mini-hydropower schemes on the upper Hron and its tributaries. These have the potential to adversely affect river and flood plain ecology, as well as fish movements, unless adequate measures are included in the schemes. Earlier mini-hydropower schemes have no fish ladders or ineffective ones.

Road building schemes have also affected, and will continue to affect, the Hron river. Thus about two kilometres of the river have been permanently diverted in the construction of the Zarnovica bypass. Proposed road constructions include about 15 km of motorway across the Hron's floodplain in the Ziarska Kotlina area and a motorway from Banska Bystrica to Brezno. These proposals will have major implications for the Hron river and its floodplains, with the possibility of significantly adverse effects on ecology and biodiversity unless appropriate measures are built into the project design.

5.5.2 STATE OF ECOLOGY AND BIODIVERSITY

The Hron basin has, overall, high biodiversity and an extensive system of protected areas intended to maintain and conserve it. Even in non-protected areas, for example forests outside the protected areas system and the more traditional farming systems still found over much of the basin, biodiversity is high and maintained by the prevailing management systems.

The high biodiversity is due to several factors, including the basin's geographical location. About 75% is situated in the mountainous inner western Carpathian region and the remainder in the lowland western Pannonian region. Each area has a distinct fauna and flora - the former with many species typical of mountainous areas and distributed in northern and eastern Europe, and the latter with species typical of southern Europe. Some west Carpathian species reach their southern and/or westernmost distribution limits at the Hron basin, whilst some Pannonian species have their most northerly occurrence.

Over the Hron basin there is a very wide range of ecological conditions due principally to the variation in altitude - ranging from 110 m at the river Hron's junction with the Danube (the

lowest point in Slovakia) to 2046 m in the Nizke Tatry - and therefore climate. This range represents nearly the entire altitude/climate variation in Slovakia, and the Hron basin contains all seven of the country's climate regions ranging from warm/dry to cool/cold. Sturovo, at the mouth of the river Hron, has the highest mean annual temperature in Slovakia (10.4°C). The basin's geology and soils are also very varied with extensive areas of volcanics (eg granites, gneisses, andesites, basalts), limestone, dolomite, clay, sand and loess and soils formed from them.

(1) Species Biodiversity

Biological diversity is the variety of living plant and animal species, the ecosystems in which they live and the genetic information contained in them. The concept can be applied at any scale eg local, regional or national areas. An area has high biodiversity if its numbers of animal and plant species, individuals, and ecosystems, are large compared to the numbers that would occur there in the absence of human influences. Thus human influences often reduce biodiversity and simplify natural, or virgin, ecosystems. Such reductions in biodiversity may be small or very large. Some activities though, for example forest clearance for traditional agricultural practices, may increase biodiversity as witnessed at Pol'ana PLA pasture lands.

The larger protected areas of the Hron basin contain high proportions of Slovakia's vertebrate fauna (Table 5.5-10). This is particularly the case for Muranska Planina National Park which contains 88%, 85% and 81% respectively of Slovakia's mammal, reptile and amphibian species. Some 55% and 49% of Slovakia's birds have been recorded from, respectively, Nizke Tatry National Park and Pol'ana PLA. Thus these protected areas have high vertebrate biodiversity. Important mammal species in the Hron basin include bear, wolf, lynx, wild cat, chamois, otter, marmot, red deer, wild boar.

Table 5.5 - 10 Numbers of Vertebrate Species Occurring in Slovakia and the Hron Basin's Large Protected Areas

Group of Animal	Number of Species Occurring in				
	Slovakia	Muranska Planina NP	Nizke Tatry NP	Pol'ana PLA	Ponitrie PLA
Mammals	85	75	63	37	52
Birds	352	126	192	172	130
Reptiles	20	17	9	9	14
Amphibians	21	17	12	11	10
Fish	75	-	21	18	-

Source: Ref. 4-53, Slovak Environment Agency, National Parks Administration

The situation is less well known for plants. The Muranska Planina National Park has 1 150 species (37%) out of a total of 3 124 higher plants (including ferns) in Slovakia. Nizke Tatry

National Park has about 1 000 species of higher plants, while Vel'ka Fatra has about 1 500 and Pol'ana 1 200 species and sub-species. Further indications of the importance of these large protected areas for biodiversity and nature protection are the numbers of endemic species that occur in them (Map 5.5-3). Thus the Nizke Tatry NP has 50 Carpathian endemic and sub-endemic plant species eg *Campanula carpatica, Soldanella carpatica* and *Dianthus nitidus*. The Muranska Planina NP has 35 endemics and sub-endemics, including *Daphne arbuscula*, found nowhere else in the world.

For invertebrates, relatively few data exist on the biodiversity of various groups (Table 5.5-11). As can be seen however, high numbers of species have been found in the groups and localities studied. It can be reasonably assumed that the protected areas of the Hron basin are major centres of Slovakia's invertebrate biodiversity, and that taken together they contain a very high proportion of the nation's total. Further studies are needed.

Table 5.5 - 11 Occurrence of Selected Invertebrate Groups in Slovakia and Protected Areas of the Hron Basin

Group of Animal	Number of Species Occurring in				
	Slovakia	Ponitrie PLA	Pol'ana PLA (grasslands)	Muranska Planina NP	Vel'ka Fatra PLA
Molluscs	259	126		104	
Spiders	916	364			350
Mayflies	112				
Dragonflies	69				
Orthoptera	122		47		
Heteroptera	787		219		
Beetles	6 498	2 100		450	
Hymenoptera	4 300	651			
Butterflies/moths	3 519	716	456		932
Flies	4 635	763			509

Source: Slovak Environment Agency and National Parks Administration

(2) Ecosystem Biodiversity

The high species diversity in the Hron basin indicates that there is also a high diversity of ecosystems. These can be divided into forest, grassland, aquatic/wetland and agricultural ecosystems. All of them occur in the Hron basin.

In Slovakia as a whole, and probably the Hron basin too, some 40-45% of the forested areas are semi-natural, originating from natural regeneration and with a species composition similar though reduced to that of natural forest. This high proportion is in contrast to most of the rest of Europe, where forests are mainly more highly modified for commercial production. Of the remaining forests in the Hron basin most are also modified for commercial production. However, fragments of natural (virgin) forest still remain (20 000ha in Slovakia) and some are found in the

Hron basin, particularly in the National Nature Reserves located in Nizke Tatry and Muranska Planina NP's and Pol'ana and Vel'ka Fatra PLAs. Most of these areas of natural forest are large enough to be capable of self-regeneration. These areas are of national significance for biodiversity and nature protection, cultural heritage and for scientific study.

Grassland areas can contain a large variety of species and ecosystems. Most of them are the result of deforestation to provide grazing and other agricultural lands. Natural meadows are the most stable grassland ecosystems and occur only in the alpine mountain zone above the upper limits of tree growth (about 1 400-1 550m). In the Hron basin, they are found mainly in the Nizke Tatry NP. Traditionally, alpine grasslands were extended down the mountains by shepherds removing the upper forested (dwarf pine) zones. Such man-made grasslands, particularly if growing on south-facing calcareous soils, have a high biodiversity of flowering plants (up to 90 species per $25m^2$). If grazing pressure is too high, this biodiversity is decreased and if too low the artificially made grasslands will return to forest. Man-made grasslands of high biodiversity occur at Vel'ka Fatra and Pol'ana PLAs and the Muranska Planina NP.

Grasslands may also occur in the floodplains of major rivers where seasonal occurrences of floods and shifting soils can prevent tree growth. However, this type of ecosystem is not widespread in the Hron basin. In the upper Hron the narrowness of the valley bottom and its development for agriculture, roads/railways, industry and urban areas have removed nearly all such grasslands. An exception is the Meandre Hrona NNR. In the lower Hron, intensive agriculture and flood defence works have led to the loss of the floodplain grasslands that existed.

Aquatic and wetland habitats occur in the Hron basin, from slow-flowing lowland rivers, particularly below the Hron Gate, to fast-flowing alpine streams and marshy areas associated with fields of melting snow in the high mountains. Standing waters are found only in reservoirs and lowland oxbows of the Hron river. Marshy areas, with standing growths of reed are not common. The best example is the Parizske Mociare NNR. Elsewhere, only small isolated reed patches occur. Alder trees and groves, along with willows, typically grow along the banks of the Hron river and its tributaries, though in some areas they are replaced by introduced Canadian poplars or are treeless. Other wetland habitats include peat bogs in the higher mountainous areas, where they act as refuges for relic arctic flora and fauna, and spring areas which occur throughout the Hron basin.

Agricultural areas occupy about 45% of the Hron basin. These include ploughed land, grasslands, pasture, vineyards, gardens and orchards. Ploughed lands occur mainly in the alluvial

lowlands below the Hron Gate and represent the most changed ecosystems of the Hron basin. Thus the Okres of Levice and Nove Zamky have 74% and 80% respectively of agricultural lands. The Okres of Banska Bystrica Kraj, in the middle and upper Hron basin, have a combined average of about 35% agricultural land. Grasslands and pastures, particularly in the lower Hron, are usually intensively managed by over-fertilizing and using hybrid seed mixes for restoration. Consequently, their biodiversity is reduced. Vineyards, allotments and orchards cover only small areas but represent islands and refuges of higher biodiversity surrounded by intensively farmed agricultural lands. Ploughed lands have the lowest biodiversity.

The institute of Landscape Ecology of the Slovak Academy of Sciences is undertaking a study to map all biotopes in Slovakia. Information about biotopes in the Hron basin were not available in time for inclusion in this report. When available, the information will be very useful for environmental planning and management.

(3) Species of Conservation Significance

The total identified flora and fauna of Slovakia is around 11 270 plant species (including algae and fungi), over 28 800 animal species (including invertebrates), and about 1 000 species of Protozoa. The actual numbers occurring, particularly amongst micro-organisms and invertebrates will be much higher. About 40 000 animal species are believed to occur in the country for example.

As a result of many activities and for many reasons, large numbers of Slovakia's animal and plant species have become rare or endangered (Table 5.5-12) and a few have become extinct. These are the species of greatest conservation significance. The proportions of endangered species varies from group to group. Thus the survival of all species of reptiles and amphibians is threatened to a greater or lesser extent. Similarly, about two thirds of mammals and fish and one third of birds are threatened. Threatened mammals (all found in the Hron basin) include wolf, wild cat, otter, lynx, ermine, chamois, bear, alpine shrew and several species of each of mice, voles and bats. Threatened species of birds found in the Hron basin include (amongst others) the peregrine falcon and other birds of prey, capercaillie, corncrake and ring ouzel. (Ref. 4-24)

Table 5.5 - 12
Numbers of Animals and Plants in Selected Groups
and the Proportions Under Threat of Survival

Group	Species in Slovakia	% Threatened*
Mammals	85	65
Birds	352	32
Reptiles	20	100
Amphibians	20	100
Fish	78	45
Invertebrates	>28 800	18
Crustacea	383	25
Mayflies	112	39
Dragonflies	69	68
Beetles	6 498	23
Butterflies/moths	3 519	33
Fleas	90	39
Higher plants	3124	36
Mosses/liverworts	902	60
Lichens	1493	39

*IUCN categories Extinct, Endangered, Vulnerable, Rare, Indeterminate and Insufficient Information.
Source: Ref. 4-39

There is no complete listing of fauna and flora occurring in the Hron basin or of the species under threat. However, the proportions can be taken to be at least equal to those for the country as a whole (Table 5.5-12). In all likelihood, the proportions will be higher, since the Level II to Level V protected areas are usually centres of biodiversity and refuges for species that are uncommon or absent outside them. In the Nizke Tatry NP for example, there are 21 species of fish occurring and 14 (67%) belong to one or other IUCN threatened category. Of the 51 mammal species regularly reported, 43 (84%) are threatened.

The numbers and proportions of threatened species in the Hron basin are therefore high. The protected areas, especially the protected landscape areas, national parks, nature reserves and national reserves, are centres of biodiversity and important for nature protection.

There is little regular monitoring of fauna and flora, due to insufficient financial and staff resources at the Slovak Environment Agency and National Parks Administration. Improvements or decline in the numbers of nearly all species will therefore be unrecorded.

(4) Forests

Forests cover about 41% of Slovakia and 47% of the Hron basin. They are unevenly distributed, with a higher proportion occurring in the middle and upper basin (about 70% forest cover) whilst less than 20% of the lower basin (south of the Hron Gate) is forested. Extensive areas of the lower Hron have no forests at all and few trees.

The various forest categories in Slovakia are well represented in the Hron basin (Table 5.5-13). Thus the Hron basin (5 465 km^2) occupies 11.1% of Slovakia but contains all eight of the forest zones and 21% of its forest regions (Map 5.5-4). Forest zones (with dominant species forming 60-100% of the trees) represent the eight categories of naturally occurring forest ecosystems of Slovakia's climate - altitude zones, and are further subdivided into regions and sub-regions. Besides the dominant tree species (in mixed-age stands) these natural forest ecosystems (Map 5.5-5) would typically have characteristic assemblages of shrubs, herbs, lichens, mosses, fungi, vertebrates and invertebrates.

Table 5.5 - 13 Forest Categories in Slovakia and the Hron Basin

Category		Number in Slovakia	Number (%) in Hron Basin
1) Forest Zone and area (ha)		8	8 (100)
Oak (171) Beech-Oak (38 093) Oak-Beech (66 073) Beech (49 402)	Fir-Beech (66 978) Spruce-Fir-Beech (23 334) Spruce (5 988) Mountain Pine (1 972)		
2) Forest Region		47	10 (21)
3) Forest Sub-Region		46	11 (24)

Source: Forestry Research Institute, Zvolen, 1998

These natural forest categories now have limited distribution in the Hron basin, having been modified to a greater or lesser extent by planted and managed forests of various types and agriculture (Table 5.5-14). Thus the forests of the Hron basin are now dominated by spruce (17.1%), beech (23.3%) and oak (10.9%) forests, which are also major components of the mixed species category of forest. In particular, spruce forests are now more widespread (45 618 ha), because of planting, than they would be under natural circumstances (5 988 ha). This is due to earlier forestry policies which favoured this species for commercial plantations.

Table 5.5 - 14 Forest Types of the Hron Basin

Forest Type	Area in the Hron Basin (ha)
Conifers	
Spruce	45 618
Fir	6 036
Pine	3 235
Larch	1 759
Mountain pine	1 292
	57 940
Broadleaved	
Beech	62 174
Oak	29 021
Hornbeam	8 930
Acacia	1 677
	101 802
Mixed	106 638

Source: Forestry Research Institute, Zvolen, 1998

These planted forests generally will have lower biodiversity than naturally-occurring ones and a simpler forest structure with reduced understorey and ground layer vegetation. However, no detailed studies have been done in Slovakia to compare overall biodiversity of natural and planted forests.

The forests of the Hron basin are classified into three main categories - commercial, protection and special purpose (Table 5.5-15 and Figure 5.5-6). Commercial forests are managed for sustained production of high quality timber whilst simultaneously fulfilling other roles. Special purpose forests are managed to fulfil specific social and ecological needs, such as protection around water supply sources and mineral springs, forest parks and suburban forests, forest in certified game reserves and pheasantries, parts of forests in national parks and protected landscape areas, forests affected by air pollution and forests for research and education.

The functions of protection forests arise mainly from their location in environmentally sensitive areas. Their management is aimed at maintaining and improving their role in erosion control, soil protection, avalanche control, water management etc. Protection forests are located on unfavourable sites such as mantle rocks, ravines, ridges, deep peatlands and in the high altitude zones of dwarf pine and upper tree layers to provide protection for forests and lands at lower altitudes. Commercial forests make up 77.1% of the Hron basin's forested lands whilst protection and special purpose forests make up 13.6% and 9.3% respectively.

Table 5.5 - 15 Categories, Roles and Functions of the Forests of the Hron Basin

Forest Category	Forest Role	Forest Function	Area (ha)
Commercial	Wood production	Wood production	191,817
Protection	Environmental	Erosion control	19,774
		Water management	11,571
		Avalanche control	761
		River protection	658
		Anti-deflation	1034
Special Purpose	Ecological/social	Water protection	127
		Recreational	1791
		Health resort	1042
		Nature protection	3208
		Emission control	13,013
		Game management	260
		Education, research	3572

Source: Lesné oblasti Slovenska, Lesoprojekt

Forests in the Hron basin are owned by a variety of organisations (Table 5.5-16). The government is the largest owner, but under present policies of returning nationalised forests to previous owners, its share will decrease. The government however remains responsible for the proper management of all forests in accordance with the standards and practices laid down in legislation (Act No 100/1997 *On the Management in Forests and State Administration of Forestry*) and prevailing government policies as developed by the Forestry Section of the Ministry of Agriculture, Food, Forestry and Water Management.

Table 5.5 - 16 Forest Ownership in the Hron Basin

Forest Category	**Area (ha)**
Government (state)	151,583
Individual private owners	11,961
Joint owners	28,537
Towns and villages	37,775
Churches	19,973
Agricultural cooperatives	704
Others	7,582

Source: Lesné oblasti Slovenska, Lesoprojekt

The principal tool by which forests are managed is the forestry management plan (FMP). All of Slovakia's forested lands are divided into forest management units (averaging about 1 000 ha) and for each a 10-year FMP is prepared and implemented. The FMPs are normally prepared by the Forest Management Institute (Lesoprojekt) based in Zvolen. FMPs are very detailed and specify all the forestry objectives and activities to be undertaken in their areas. They include all required management measures eg maximum volumes and locations of fellings, thinning activities, silvicultural systems and allowable composition of new plantings and regenerated trees.

FMPs are prepared and reviewed following a detailed study and consultation process over a 2-year period. The studies investigate a wide range of soil, air quality, biological and tree condition factors in each of the 47 forest regions (10 in the Hron basin). These determine the prevailing environmental conditions and allow preparation of the most appropriate management measures for the duration of the FMP. For each forest region the Forestry Research Institute has prepared the basic forestry management model. These include guidelines for planting methods and species composition, tending, logging and transportation and site management techniques by clearfelling, selection or shelterwood systems of logging and regeneration.

Draft FMPs are reviewed by the state's Regional Forestry Authorities (RFA) based in Kraj offices and Forest Authorities (FA) from the Okres office. Other relevant stakeholder agencies (eg National Parks, Slovak Environment Agency) also review the FMPs. Much forested land is managed by these two agencies - all Level II to Level V protected areas. So far as possible the comments of consultees are incorporated into the FMP, but where agreement cannot be reached the RFA is the final arbitrator. The RFA approves the FMP whilst the FA closely monitors its implementation.

(5) Protected Areas

The principal way of protecting nature and biodiversity is via the establishment and good management of protected areas. These are designated and declared according to the specifications of Act No. 287/1994: *On Nature and Landscape Protection*. The Act recognises five levels of protection, with the degree of protection increasing with each level. The five levels are described in Table 5.5-17.

All categories of protected areas occur in the Hron basin (Map 5.5-7), and these are summarised and compared with national numbers in Table 5.5-18. The most important protected areas are the four protected landscape areas of Vel'ka Fatra, Stiavnicke Vrchy, Pol'ana and Ponitrie and the three national parks of Nizke Tatry, Slovensky Raj and Muranska Planina. Of these seven major areas, only Pol'ana PLA lies completely within the Hron basin (Table 5.5-19). One area (Slovensky Raj NP) has an insignificant proportion (1.5%) whilst only 11.1% and 17.8% respectively of Vel'ka Fatra PLA and Ponitrie PLA are in the Hron Basin.

Table 5.5 - 17 Level of Territorial Protection of Nature and Landscape

Protection Level	Name	Type of Area and Protection
I	-	Country-wide except for Levels II-V. Regulation of 15 specified activities and other preventive measures.
II	Protected Landscape Area and National Park buffer zones	Large area, usually more than 1 000 ha, with fragmented ecosystems which are significant for conservation of biological diversity and ecological stability, with characteristic landscape features or specific forms of historical settlements. Regulation of a further 14 specified activities.
III	National Park core zones	Large area, usually more than 1 000 ha, with mainly ecosystems substantially unaffected by human activities, or with unique and natural landscape structures that form national biocentres and the most significant natural heritage in which nature protection is a higher priority than other activities. Regulation of a further 12 specified activities.
IV	Protected Site	Small area, usually up to 1 000 ha, representing mainly biocorridors, inter-active elements, or biocentres of local or regional importance. Prohibition of a further 15 specified activities.
V	Nature Reserve and National Nature Reserve	Small area, usually up to 1 000 ha, of mainly original or those ecosystems not generally affected by human activity and biocentres of national importance. Prohibition of a further 18 specified activities
V	Nature Monument and National Nature Monument	Point, linear or other smaller ecosystems usually smaller than 50 ha with scientific, cultural, ecological, aesthetic or landscape significance, especially outcrops, rock formations, stone seas, narrow valleys, dunes, sections of streams, springs, sinks or lakes.

Source: Act 287/1994 *On Nature and Landscape Protection*

Table 5.5 - 18 Occurrence of Protected Areas in the Hron Basin and Slovakia

Type of Protected Area (and Level)	Number in Hron Basin	Number in Slovakia	Area in Hron Basin (km^2)	Area in Slovakia (km^2)
Protected Landscape (II)	4	16	399	6 100
National Parks (III)	3	7	1137	4 813
Protected Sites (IV)	20	260	3.4	67
Nature Reserve (V)	42	345	15.8	142
National Nature Reserve (V)	33	231	74.1	853
Nature Monument (V)	25	217	1.5	16
National Nature Monument (V)	6	45	3.8	0.8
Totals	133	1 121	1 634.6	11 991.8

Areas include buffer zones where present for Levels III, IV and V
Source: Slovak Environment Agency, Banska Bystrica

Table 5.5 - 19 Proportions of Protected Landscape Areas and National Parks Occurring in the Hron Basin

Protected Area	Area in Hron Basin (km^2)	Total Area (km^2)	Proportion in Hron Basin (%)
Vel'ka Fatra PLA	67	606	11.1
Stiavnicke Vrchy PLA	553	776	71.3
Pol'ana PLA	201	201	100
Ponitrie PLA	67	377	17.8
Nizke Tatry NP	840	1 830	45.9
Slovensky Raj NP	5	328	1.5
Muranska Planina NP	293	420	69.8

Source: Slovak Environment Agency, Banska Bystrica, 1998

Overall however, the Hron basin has a high occurrence of protected areas and 30% of it belongs in protected levels II-V. All types of protected area (except Protected Sites, 7.7% of national total) occur in numbers and area (km^2) greater than those expected as a proportion of the Hron basin's area to Slovakia's total area (11.1%). In total, the Hron basin has 133 protected areas completely or partially within it out of the 1 121 occurring in Slovakia. National Parks are particularly well represented, with an area of 1 137 km^2 in the Basin, some 21% of its total. This will increase within a year or two when Vel'ka Fatra PLA becomes a national park.

The distribution of protected areas within the Hron basin is very uneven. Out of the total 133 Level II - Level V sites, only 19 (14.3%) occur in the lowlands below the Hron Gate. This area has no national parks, PLAs or National Nature Monuments, reflecting the generally low conservation value of this part of the Hron basin. The only protected areas are eight Protected Sites, five Nature Reserves, four National Nature Reserves and two Nature Monuments. In total, these amount to about 11.4 km^2, only 0.7% of the total area of protected areas in the Hron basin. Thus in the middle and upper basin (4 158 km^2) there are some 114 protected areas with a total area of 1 623.2 km^2 - about 40% of this part of the Hron basin, indicating its extremely high conservation and landscape values.

Four of the nationally protected areas of the Hron basin belong also to one or more international wildlife conservation categories. These are the Pol'ana PLA (Biosphere Reserve and Important Bird Area), Parizske Mociare National Nature Reserve (Ramsar Site and Important Bird Area) and Vel'ka Fatra PLA and Nizke Tatry National Park (Important Bird Areas). These sites are therefore recognised as being of European and international importance for wildlife, especially bird protection.

Biosphere reserves, declared under UNESCO's Man and Biosphere programme are areas of international significance for their wildlife, socio-economic and cultural values. Human impacts are low and agricultural activities in particular are carried out by traditional methods that encourage harmony and sustainability between man and the environment. In Pol'ana the fauna and flora of the pasture lands have considerable biodiversity value and are maintained by low levels of grazing and nutrient inputs. There are three other biosphere reserves in Slovakia - Slovak karst PLA, Vychodne Karpaty PLA and Tatry National Park.

Ramsar sites are declared under the *Convention on Wetlands of International Importance, Especially as Waterfowl Habitats*. The Parizske Mociare National Nature Reserve is one of seven Ramsar sites in Slovakia. It has 37 species of breeding water bird, 71 other species of birds and other interesting fauna and flora.

Important Bird Areas (IBAs) are sites declared as Special Protection Areas under the European Community Directive 79/409 *On the Conservation of Wild Birds*. The Directive is intended to safeguard the habitats of migratory birds and birds generally under threat of decline or extinction. There are 18 IBAs in Slovakia, including the four in the Hron basin.

The available financial and staff resources for the Hron basin's protected areas are insufficient to properly plan for and carry out fully effective management.

(6) Territorial System of Ecological Stability (USES)

The USES is an hierarchically arranged, interconnected network of ecosystems planned to protect and develop biological and landscape diversity. It is based on a system of biocentres (ecosystems with high biodiversity) connected by biocorridors (linear ecosystems) and of interactive elements (ecosystems connected to biocentres or biocorridors). The network is intended to identify key areas whose conservation and management is essential for maintaining good ecological conditions.

The USES network is applied at national, regional and local levels. The national level network (S-USES) was prepared at scales of 1:200 000 and 1:500 000 and approved by Government in 1992 as *The General Plan of the Supraregional Territorial System of Ecological Stability*. This was based mainly on the existing system of national parks, PLAs and major river corridors and contains many parts of the Hron basin (Table 5.5-20). Many parts of the Hron basin are also recognised as nature development areas of potential core value and as biocorridors. These need to be developed and strengthened in order to enable the S-USES network to function properly.

Additionally, the lower half of the Hron river is a major route for birds migrating between north and south Europe (Map 5.5-8). All of these S-USES components emphasise the importance of the Hron basin for both Europe's and Slovakia's biodiversity.

Table 5.5 - 20 Hron Basin Core Areas of the Supraregional Territorial System of Ecological Stability

Core Areas of European Importance	Core Areas of National Importance	River Biocorridors
Pol'ana PLA	Parizske Marshes	Hron
Sitnianske Highlands	Pohronsky Inovec	Slatina
Muranska Planina NP	Vtadnik	Sikenica
Slovensky Raj NP	Kremnicke Hills	
Vel'ka Fatra PLA		
Dumbierske Low Tatry		
Kral'ovohol'ske Low Tatry		

At regional (Okres) level (R-USES) and local (municipal/obed) level (M-USES) the plans are prepared following the directions and authority of Act No 287/1994 *On Nature and Landscape Protection*. Between 1993 and 1995 R-USES plans and maps (1:50 000) were prepared for the Okres of the Hron basin. Their chief objective is to provide strategy documents at the Okres level by their incorporation into development plans for the area. The Hron basin's R-USES plans are currently being updated by the Slovak Environment Agency. Plans and maps prepared at the Okres level are combined to form an integrated plan for the Kraj.

Few (about 10) M-USES have been prepared in the Hron basin. A new and very detailed methodology is currently being prepared by the MoE. This describes in considerable detail how the M-USES objectives are the same as R-USES, but are prepared at a scale of 1:5 000 or 1:10 000 for use at the local level. The methodology also stresses the importance of identifying areas requiring restoration and revitalisation by, for example, tree planting.

The M-USES plans are chiefly concerned with Level I lands - all those areas outside the more strongly protected Levels II-V. Thus they are chiefly concerned with ecological priorities at the local (cadastre, obed, municipal) level. It is at such levels that the USES concept can most readily be applied. This is done by, for example, changing land uses, avoiding damaging developments and implementing various works to reduce environmental problems and promote ecological stability.

(7) Hunting

Hunting is a traditional and popular recreational activity in the Hron basin and Slovakia in general. The Hron region is considered one of the best hunting areas in Slovakia with good

populations of large trophy animals. The upper Hron is particularly noted for capercaillie (*Tetrao urogellus)*, the middle Hron for roe deer and wild boar, and the lower Hron (Levice to the Danube) for roe deer, brown hare and pheasant. The numbers of small game in agricultural areas has decreased rapidly in recent years due mainly to intensive agricultural practices.

There are about 49 000 regular hunters in Slovakia, mostly operating through the Slovak Hunters Union. Virtually the whole of the Hron basin (as well as Slovakia) is divided into hunting grounds, ranging in size from less than 500 ha to more than 10 000 ha, with the majority between 1 000 ha and 2 500 ha (Table 5.5-21). Each hunting ground is managed by a local hunters' association, which prepares the rules and sets annual quotas for most species. Hunting is allowed in national parks, though it may be prohibited in some parts. Hunters' associations generally work in close cooperation with the National Park Administration over such issues as setting quotas. Hunting is mostly under the control of the Ministry of Agriculture Food, Forestry and Water Management (Forest Research Institute). There is a special commission for regulating the hunting of protected species, which is under the control of the Ministry of Environment.

Table 5.5 - 21 Distribution of Hunting Grounds in the Hron Basin

Okres	Number	Type and Area of Hunting Ground (ha)				
		Agricultural	Forest	Water	Others	Total
Banska Bystrica	20	25,061	42,303	0	7	67,371
Banska Stiavnica	10	8,800	13,328	0	0	22,128
Brezno	28	30,277	92,841	391	3	123,512
Detva	13	22,951	24,542	60	3,263	50,716
Levice	67	110,289	32,611	830	1,762	145,492
Zvolen	25	27,848	30,876	123	6,610	65,457
Zarnovica	14	11,427	25,986	26	0	37,439
Ziar nad Hronom	19	21,362	29,535	273	0	51,170
TOTAL	196	258,015	292,022	1,703	11,645	563,285

Source: Forestry Research Institute, Zvolen, 1998

Besides being a pleasant activity for many, hunting can also assist in maintaining a balance between species and their environment. With the many pressures on the use of forest and agricultural lands today, balances must be maintained between them. Hunting, for most species at least, can keep animal populations at levels where they do not damage the environment (eg deer damage to young trees or crops). To maintain animals at such levels however, it is necessary to know the population size, reproductive increases and the environmental carrying capacity and therefore the numbers of animals that can be hunted. The numbers of animals shot in the Hron basin in 1996 are given in Table 5.5-22.

Table 5.5 - 22 - Numbers of Game Stock and Hunted Game in the Hron Basin, 1996

District	B.Bystrica		B.Stiavni		Brezno		Detva		Levice		Zvolen		Zarnovica		Ziar/Hronom		Total	
Game	GS	HG	GS	HG	GS	HG	GS	HG	GS	HG	GS	HG	GS	HG	GS	HG	GS	HG
Hoofed game																		
Red deer	1 029	364	231	86	1569	440	280	89	778	382	590	256	268	125	465	229	5 211	1 970
Fallow deer	0	0	20	0	0	0	21	4	192	35	270	76	11	5	0	0	520	120
Mouflon	0	0	75	18	0	0	49	15	329	190	272	16	182	59	0	0	727	298
Roe deer	942	245	491	54	695	79	552	100	3 415	853	1118	240	528	77	690	177	8 431	1 825
Wild boar	248	197	184	75	180	62	204	92	596	243	504	367	164	86	247	173	2 327	1 295
Small game																		
Brown hare	398	23	84	0	238	2	182	2	11724	1 038	205	0	75	10	249	0	13 155	1 075
Pheasant	25	0	58	0	0	0	70	0	8 308	22 277	152	0	52	9	161	0	8 826	22 286
Wild duck		55		0		14		4		500		115		0		18		706
Carnivora																		
Brown bear	143	5	11	0	171	6	13	0	1	2	21	1	0	0	25	1	385	15
Wolf	32	0	0	0	154	0	5	0	0	0	1	0	0	0	0	0	192	0
Lynx	49	2	7	0	93	0	15	0	0	0	9	1	1	0	7	0	181	3
Wild cat	32	1	10	0	50	0	9	0	64	1	32	0	8	0	10	0	215	2

GS : Estimated Game Stock
HG: Hunted Game
Source: Forest Research Institute, Zvolen