2.7.1.5. Contour diagrams of fluorescence intensity

We used the excitation-emission matrix (EEM) method as pattern recognition technique and as semi-quantitative technique to follow the transport of natural and anthropogenic pollution in hydrologic system (WOLFBEISS 1993).

We scanned the 3D spectra in all background samples. Emission spectra (300 nm to 550 nm, 5 nm intervals) were scanned over the range of excitation wavelengths (300 nm to 500 nm, 5 nm intervals) on the Hitachi-4500 fluorescence spectrophotometer. Slit widths for both excitation and emission monochromators were set at 10 nm.

The comparison with the unchlorinated tap water shows that in all measured samples different organic compounds of unknown origin are present. Namely, we did not have the standards for this compounds and the determination of present compounds will be task for some investigation in the future.

2.7.1.6. Conclusions

The chemical analyses of sediment in the Hubelj, Vipava and Podroteja springs have shown that pollution from the hinterlands is present and that water quality may suffer an abrupt deterioration. The results of microbiological analyses have been shown periodical pollution in the Podroteja, Hubelj and Vipava springs as well.

Investigations of water quality should be followed by appropriate actions. Actions to protect water quality wherever it is still satisfactory and rehabilitation actions where appropriate.

2.7.2. Agricultural threats to pollution of water of Trnovsko-Banjška Planota (B. MATIČIČ)

2.7.2.1. Introduction

The objective has been to determine the relationship between the soil water balance and mineral balance in the Karst region of Trnovsko-Banjška Planota in western part of Slovenia above Vipava valley and to find out if the possible excessive use of fertiliser and/or high intensity of animal husbandry in upland catchment area on Trnovsko-Banjška Planota could affect the quality of drinking water down in Vipava valley.

The altitude of Trnovsko-Banjška Planota is about 800 m. In this region mainly shallow soil types (with depth of 10-50 cm) on limestone are found with low water holding capacity (22-142 mm) and high rate of infiltration.

The amount of precipitation in Trnovsko-Banjška Planota is very high. The average annual value (1951-1980) in meteorological station Otlica was 2457

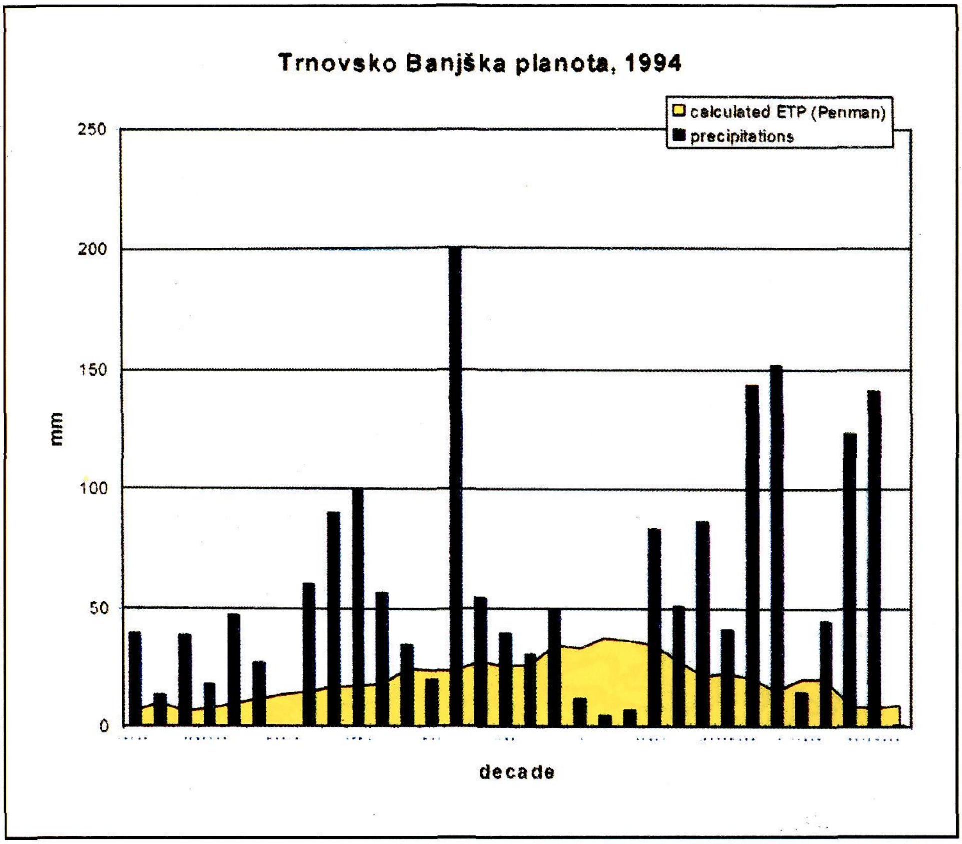

Fig. 2.29: The comparison between evapotranspiration (calculated ETP) and precipitation in the Trnovsko-Banjška Planota for the precipitation station Otlica in the observation year 1994.

mm. The extreme wet year was 1965 with 3233 mm of rain while the extreme dry year was 1973 with 1833 mm of rain (Source: Klimatografija Slovenije, Padavine, HMZ 1989).

The amount of precipitation in 1994 (the year of our evaluation of water and mineral balance) was 1822 mm (from Jan.-Nov.); the evapotranspiration in this period was 628 mm (used modified Penman's equation - by DOORENBOS). The evapotranspiration according to this evaluation represents only 40 % of the amount of precipitation (Fig. 2.29). During the period of intensive precipitation, therefore, the processes of leaching of fertilisers can occur.

It has been decided to evaluate regional and farm mineral balance for hilly karstic region of Trnovsko-Banjška Planota in order to identify vulnerability related to the nitrate problems in this less intensive agricultural region.

2.7.2.2. Groundwater and surface waters

The pollution of groundwater and surface waters by nitrates, nitrites, phosphorus and amonium was monitored for the last four years (1991-1994, data base: 'State monitoring of waters').

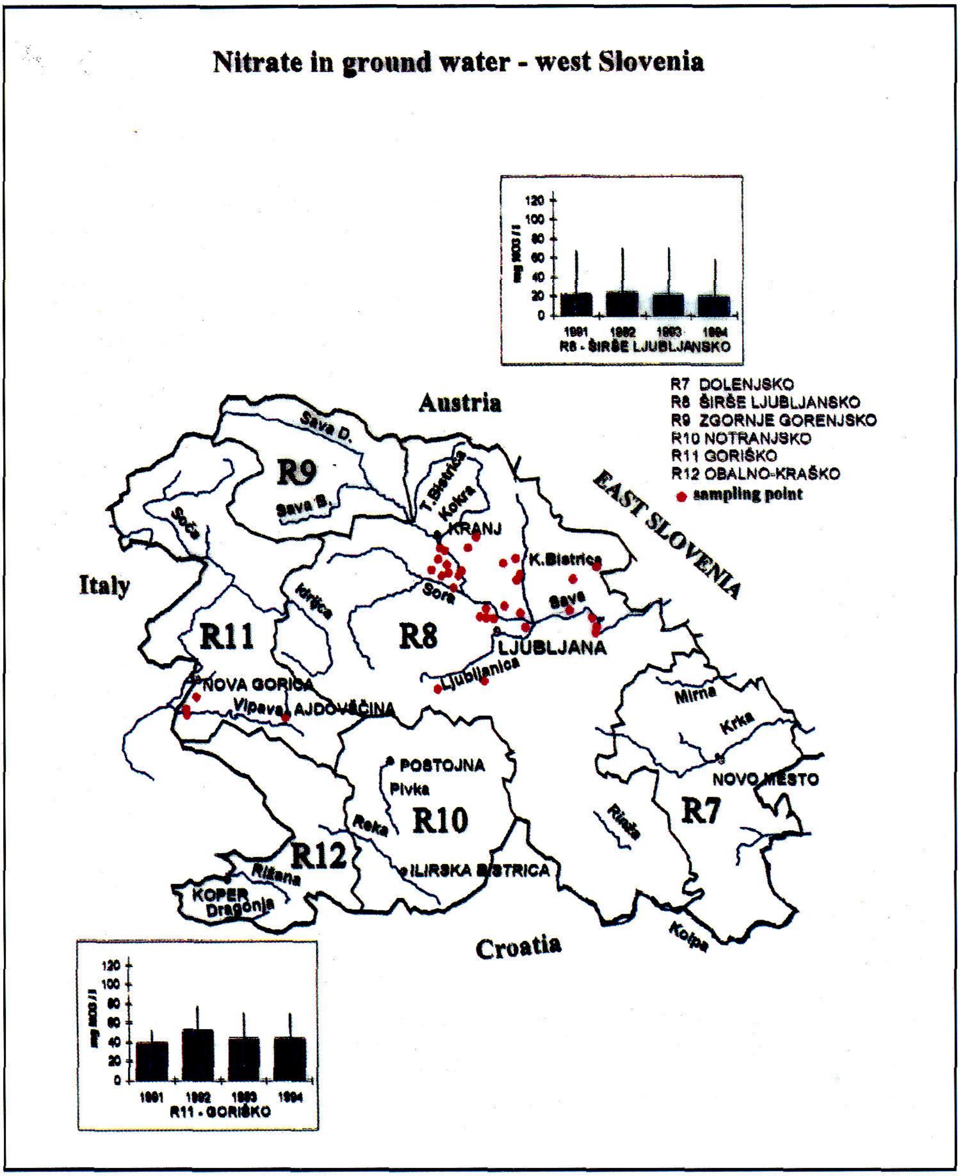

Fig. 2.31: Nitrate in groundwater of west Slovenia: average annual values and extremes.

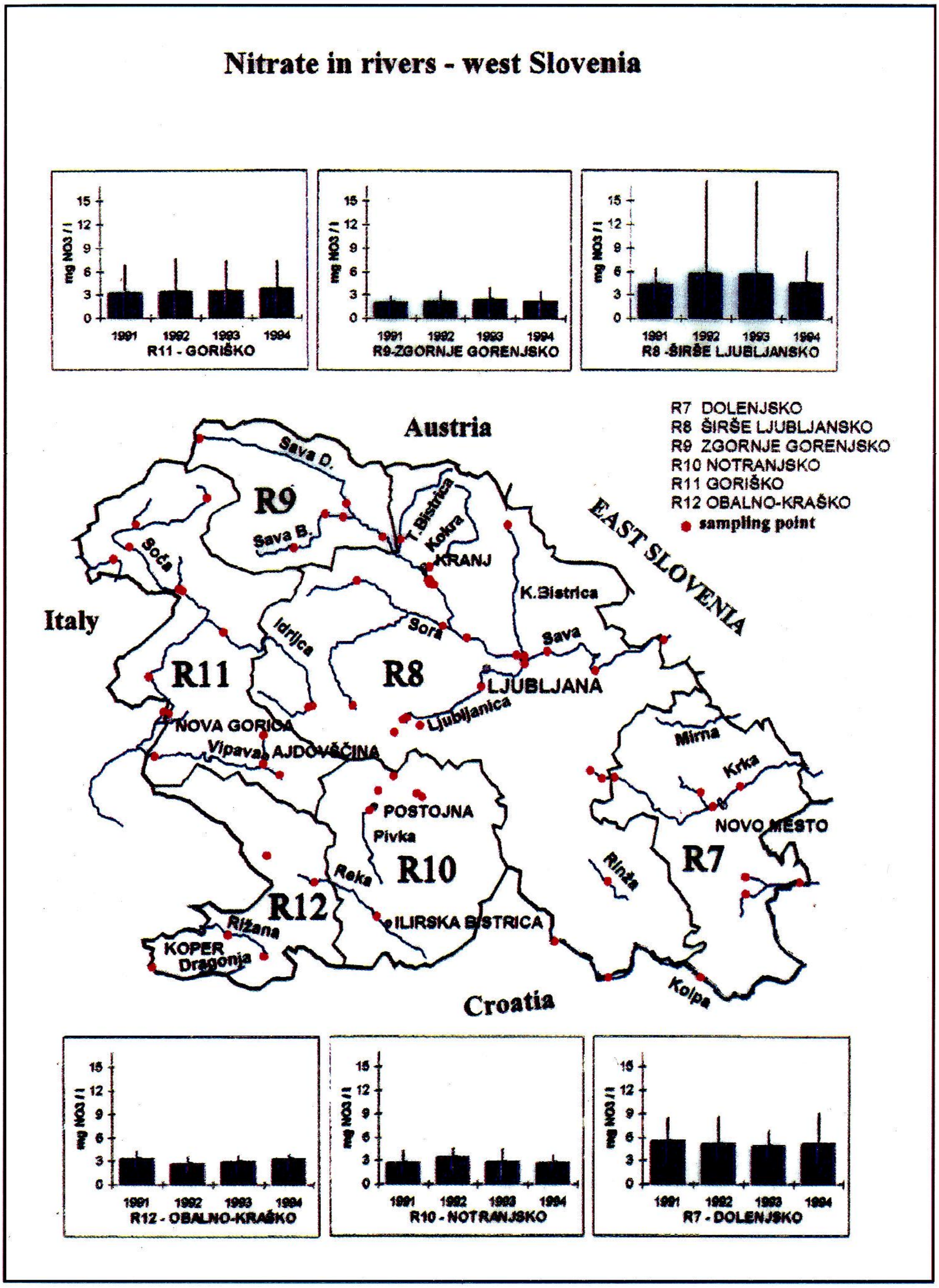

Fig. 2.30: Nitrate in the rivers grouped according to the region in west Slovenia: average annual values and extremes.

Nitrate in groundwater (1991-1994) for western part of Slovenia, where karst prevails, is presented on Figure 2.31. Average annual values for nitrate concentration (in mg/l) in the region of Gorica was 39,08 in 1991 (maximal value: 51,36 mg/l), 51,70 in 1992 (maximal value: 76,61 mg/l), 43,84 in 1993 (maximal value: 69,08 mg/l) and 44,06 in 1994 when the maximal value of NO_3 was 67,97 mg/l. (The average ammonium concentration in mg/l in this region was 0,01-1991, 0,02-1992, 0,04-1993, 0,02-1994. The average NO_2 concentration was 0,02-1991, 0,01-1992, 0,01-1993 and 0,01-1994. The average P_2O_5 concentration was 0,07-1991, 0,06-1992 no data for 1993 and 1994).

Nitrate in rivers for this region is presented on Figure 2.30. The average concentration of NO_3 in mg/l varied between 3,28 and 3,81 (maximal value was observed in 1992 being 7,53 mg/l).

2.7.2.3. Nitrogen balance at regional and farm level

For mineral balance the main agricultural crops that occupy 92 % of arable land have been taken into evaluation. Nitrogen, phosphate and potash supply was calculated by the number of livestocks in the region and at each farm and the nitrogen, phosphate and potash content of liquid manure as well as the statistical data on trade of mineral fertilisers were taken into evaluation. Two nitrogen balances have been evaluated:

GROSS-BALANCE taking into consideration nitrogen input from mineral fertiliser and animal wastes, minus nitrogen uptake by harvested crops (as being output).

NET-BALANCE taking into consideration mineral fertiliser, animal wastes and deposition from the atmosphere as input and nitrogen uptake by harvested crops and ammonia losses to the atmosphere as output.

The evaluation has been done using normative approach and methodology that has been used in EU countries.

Agriculture on Trnovsko-Banjška plateau is extensive, animal husbandry is prevailing. Landuse, yields, use of mineral fertilisers and livestock population on selected farms is presented in Tables 2.19 and 2.20.

Surface mineral balance was evaluated for 534 ha of arable land in region Dol-Otlica on Trnovsko-Banjška Planota, for 16.145 ha of arable land in Ajdovščina community (Dol-Otlica is part of Ajdovščina community).

Nitrogen balance on farm level (for 16 farms on Trnovsko-Banjška Planota) was evaluated for detecting possible point polluters in this region.

2.7.2.4. Nitrogen surpluses as possible source of water pollution

Average net-balance nitrogen surplus for Slovenia is about 56 kg N/ha. Higher values that can be considered vulnerable for the pollution of groundwater and surface waters can be found in regions with high intensity of animal husbandry in eastern part of Slovenia.

Average low nitrogen surpluses on regional level are found in Western part of Slovenia where less intensive agriculture prevails. Average net-balance nitrogen surplus for Ajdovščina and Dol-Otlica on regional level was 36 kg N/ha; this value can not be considered as possible non-point source of pollution of groundwater and surface waters. Livestock density in Dol-Otlica is 0,81 LU/ha (Livestock unit per ha). The high nitrogen surpluses can be caused by higher animal production. In Dol-Otlica the average yields and uptake by crops are low; stocking rate over 2,1 LU/ha can cause net-balance surplus over 100 kg/ha what can be considered vulnerable for groundwater and surface waters (Tab. 2.19 and 2.20).

The average nitrogen net-balance surplus on selected farms has been 36 kg N/ha and is varying between 13 and 87 kg N/ha (Fig. 2.32 and 2.33). On average nitrogen input from mineral fertiliser was observed very low - 11 kg/ha, while nitrogen input from organic manure was 72 kg/ha (Tab. 2.21). Livestock density in selected farms was between 0,4 to 2 LU/ha. The average phosphate surplus was found 27 kg/ha and the average potash surplus was 57 kg/ha (Tab. 2.22 and Fig. 2.34 and 2.35).

Tab. 2.19: Structure of livestock on farms in the karst region, Slovenia, 1994.

	livestock	% of total livestock					LU/ha			
Region	**units**	**Cattle**	**Pigs**	**Poultry**	**Sheep**	**Other**	**UAA**	**kg N/ha**	**kg P/ha**	**kg K/ha**
SLOVENIA 1991	**748836**	**58.4**	**16.6**	**22.7**	**0.4**	**1.9**	**1.26**	**89.82**	**50.80**	**92.05**
SLOVENIA 1994	**649916**	**62.6**	**16.0**	**19.6**	**0.3**	**1.6**	**1.10**	**77.51**	**42.34**	**76.47**
farm 7	12.3	84.8	4.9	0.5		9.8	0.94	66.18	28.96	82.88
farm 13	11.1	93.7	5.4	0.9			1.05	74.91	33.36	96.60
farm 16	10.3	81.4	5.8	1.2		11.6	1.98	139.25	61.54	169.23
farm 14	16.3	88.2	3.7	0.7		7.4	1.42	99.49	43.48	128.70
farm 3	12.4	93.7	4.8	1.5			0.77	55.58	24.66	61.22
farm 2	7.3	87.7	12.3				1.04	76.71	35.14	91.14
farm 4	10.3	94.2	5.8				0.76	54.67	24.22	72.44
farm 9	6.3	90.5	9.5				1.05	76.33	34.50	96.33
farm 6	11.0	94.5	5.5				0.91	65.12	28.76	84.30
farm 10	3.6	83.3	16.7				1.03	76.57	36.00	96.00
farm 8	4.6	87.0	13.0				1.02	75.11	34.67	96.89
farm 15	6.0	100.0					2.01	140.94	60.40	201.34
farm 1	3.0	90.0	10.0				0.40	29.20	13.20	34.67
farm 5	6.3	90.5	9.5				0.75	54.20	24.50	68.40
farm 11	8.6	93.0	7.0				1.23	88.29	39.43	119.43
farm 12	11.0	94.5	5.5				1.10	78.80	34.80	102.00
AVERAGE*	**8.8**	**90.4**	**8.0**	**0.9**		**9.6**	**1.01**	**72.33**	**32.16**	**91.63**

* average for all 16 farms

Tab. 2.20: Land use and yields on farms in the karst region, Slovenia, 1994.

Region	Arable and grassland (ha)	Arable land (%)	Grass land (%)	% of arable land					Yields t/ha				
				Cereals	Potatoes	Sugar beets	Fodder maize	Green fodder	Cereals	Potatoes	Sugar beets	Fodder maize	Grassland
SLOVENIA 1991	**569411**	**39.0**	**61.0**	**53.8**	**13.8**	**1.7**	**15.4**	**15.3**	**4.7**	**13.8**	**45.1**	**35.6**	**4.1**
farm 7	13.0	0.2	99.8		66.7		33.3			18.0		15.0	2.5
farm 13	10.6	2.8	97.2		100.0					18.0			2.5
farm 16	5.0	4.0	96.0		100.0					16.0			2.7
farm 14	11.5	13.0	87.0		33.3			66.7		19.0			2.8
farm 3	10.0	19.0	81.0	10.5	10.5			89.5	3.0	18.0			2.7
farm 2	7.0	28.6	71.4		25.0			75.0		17.0			2.8
farm 4	7.5	1.3	98.7		100.0					16.0			2.8
farm 9	6.0	16.7	83.3		100.0					15.0			2.7
farm 6	12.0	0.8	99.2		50.0					15.0			2.7
farm 10	3.5	2.9	97.1		100.0					15.0			2.6
farm 8	4.5	2.2	97.8		100.0					15.0			2.7
farm 15	3.0	2.7	97.3		100.0					15.0			2.5
farm 1	7.5	1.3	98.7		100.0					15.0			2.5
farm 5	8.5	0.6	99.4		100.0					15.0			2.5
farm 11	7.0	11.4	88.6		62.5		37.5			16.0		15.0	2.7
farm 12	10.0	5.0	95.0		100.0					16.0			2.7
AVERAGE*	**7.9**	**7.0**	**93.0**	**10.5**	**78.0**		**35.4**	**77.0**	**3.0**	**16.2**		**15.0**	**2.7**

* average for all 16 farms

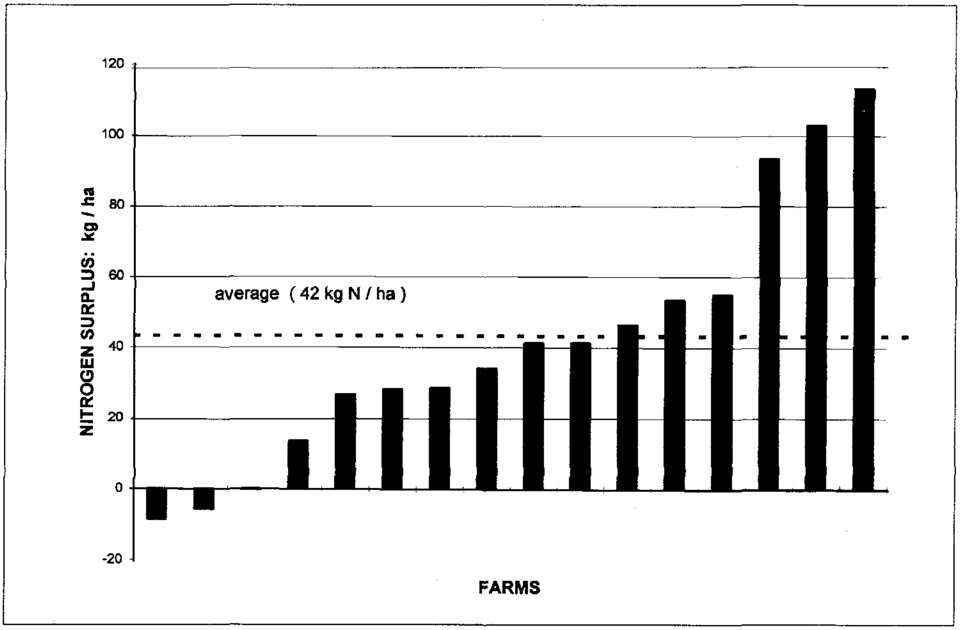

Fig. 2.32: Gross nitrogen balance, farm level, Trnovsko-Banjška Planota.

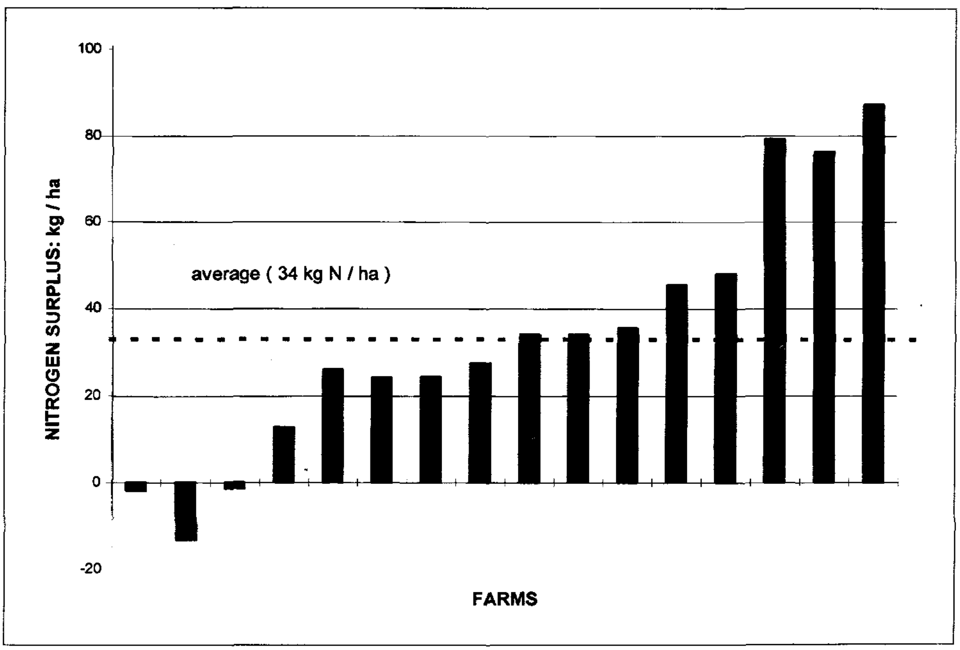

Fig. 2.33: Net nitrogen balance, farm level, Trnovsko-Banjška Planota.

Tab. 2.21: Nitrogen balance, farm level, Trnovsko Banjška planota.

	INPUT				OUTPUT	BALANCES	
	1	2,1	2,2	2,3	3	4,1	4,2
	Nitrogen	Nitrogen from agric. production			Nitrogen	Nitrogen balances	
	from the atmosphere	Mineral fertilizer	Liquid manure	Total N supplay	uptake	Gross balance	Net balance
Region	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha
SLOVENIA 1991	15.5	47.2	89.8	137.0	70.8	66.3	56.3
SLOVENIA 1992	15.5	43.5	81.1	124.6	53.3	71.3	62.5
SLOVENIA 1993	15.5	57.3	81.9	139.2	52.1	87.1	78.1
SLOVENIA 1994	15.5	60.7	77.5	138.3	91.0	47.2	39.5
farm 7	15.5	0.0	66.2	66.2	37.5	28.6	24.3
farm 13	15.5	18.4	74.9	93.3	38.2	55.1	48.1
farm 16	15.5	15.4	139.3	154.6	41.1	113.5	87.2
farm 14	15.5	53.0	99.5	152.5	59.0	93.6	79.2
farm 3	15.5	13.1	55.6	68.7	69.0	-0.3	-1.4
farm 2	15.5	0.0	76.7	76.7	82.5	-5.8	-13.3
farm 4	15.5	1.1	54.7	55.8	42.2	13.6	12.7
farm 9	15.5	7.5	76.3	83.8	42.5	41.3	33.9
farm 6	15.5	3.7	65.1	68.8	40.6	28.2	24.2
farm 10	15.5	4.3	76.6	80.9	39.4	41.5	34.0
farm 8	15.5	0.0	75.1	75.1	40.8	34.3	27.3
farm 15	15.5	0.0	140.9	140.9	37.9	103.0	76.3
farm 1	15.5	0.0	29.2	29.2	37.7	-8.5	-1.8
farm 5	15.5	10.2	54.2	64.4	37.6	26.8	26.0
farm 11	15.5	0.0	88.3	88.3	41.8	46.5	35.5
farm 12	15.5	16.0	78.8	94.8	41.3	53.5	45.4
AVERAGE*	15.5	10.5	72.3	82.9	47.0	35.9	29.7

* average for all 16 farms; column 2.3 = 2.1 + 2.2; col. 4.1 = 2.1 + 2.2 - 3; col. 4.2 = 1 + 2.1 +2.2*0.7 -3

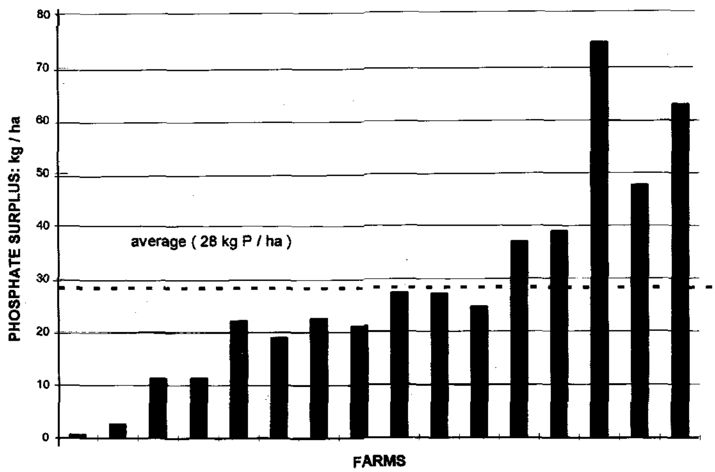

Fig. 2.34: Phosphate balance, farm level, Trnovsko-Banjška Planota.

Tab. 2.22: Phosphate and potash balance, farm level, Trnovsko Banjška planota.

	PHOSPHATE				POTASH			
	1,1	1,2	2	3	1,1	1,2	2	3
Region	Mineral fertilizer kg/ha	Liquid manure kg/ha	Uptake kg/ha	Balance kg/ha	Mineral fertilizer kg/ha	Liquid manure kg/ha	Uptake kg/ha	Balance kg/ha
SLOVENIA 1991	35.5	89.8	29.8	95.5	55.8	89.8	74.0	71.7
SLOVENIA 1992	36.4	81.1	22.5	95.0	56.6	81.1	54.8	83.0
SLOVENIA 1993	48.7	81.9	22.4	108.1	75.6	81.9	52.8	104.8
SLOVENIA 1994	42.0	77.5	37.7	81.8	66.8	77.5	97.8	46.5
farm 7	6.2	29.0	12.5	22.6	0.0	82.9	45.1	37.8
farm 13	18.4	33.4	12.9	38.9	18.4	96.6	46.8	68.2
farm 16	15.4	61.5	13.9	63.1	50.0	169.2	50.5	168.7
farm 14	53.0	43.5	21.8	74.7	60.0	128.7	72.3	116.4
farm 3	13.1	24.7	26.6	11.2	24.4	61.2	82.4	3.2
farm 2	0.0	35.1	32.6	2.6	0.0	91.1	101.1	-10.0
farm 4	1.1	24.2	14.1	11.2	1.1	72.4	51.0	22.5
farm 9	7.5	34.5	14.8	27.3	7.5	96.3	55.5	48.3
farm 6	3.7	28.8	13.6	18.9	3.7	84.3	48.9	39.1
farm 10	4.3	36.0	13.2	27.1	4.3	96.0	48.0	52.3
farm 8	0.0	34.7	13.7	21.0	0.0	96.9	49.5	47.4
farm 15	0.0	60.4	12.7	47.7	0.0	201.3	46.2	155.1
farm 1	0.0	13.2	12.6	0.6	0.0	34.7	45.6	-10.9
farm 5	10.2	24.5	12.6	22.1	3.6	68.4	45.3	26.7
farm 11	0.0	39.4	14.8	24.6	0.0	119.4	52.7	66.8
farm 12	16.0	34.8	13.9	36.9	52.0	102.0	51.0	103.0
AVERAGE*	11.1	32.2	16.6	26.6	15.9	91.6	57.2	50.3

* average for all 16 farms — column 3 = 1.1 + 1.2 - 2

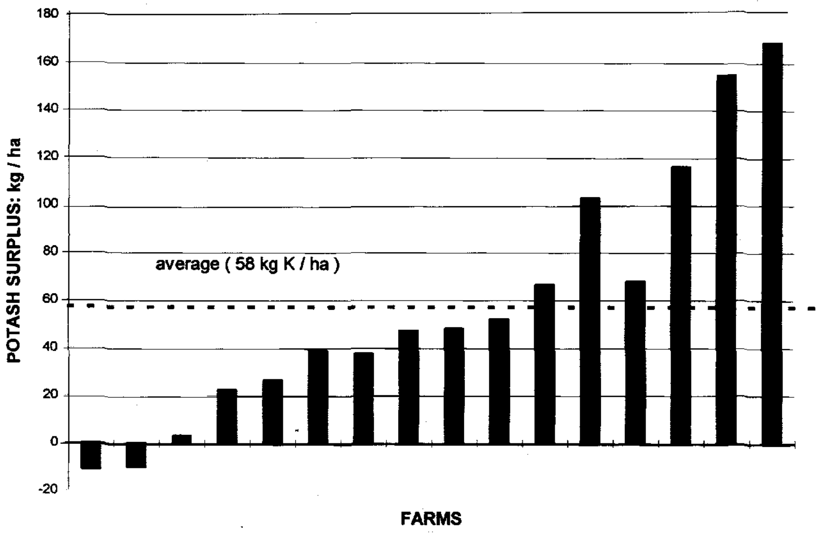

Fig. 2.35: Potash balance, farm level, Trnovsko-Banjška Planota.

Taking into consideration all the evaluated average data it could be concluded that the region Trnovsko-Banjška Planota can not be identified as vulnerable for nitrogen leaching into the groundwater. But in these regions with limited growing conditions for agricultural crops (climate, soil depth) just small increase in livestock density can cause nitrogen surpluses over 100 kg N/ha. For this reason the restrictions regarding application of chemical fertiliser and manure on hilly and karst regions have to be more rigorous than in plains. On the other hand it was found out that in many cases dung yards and cesspools on farms are not built and/or are poorly built. In this case liquid manure can cause serious problem as being point polluter of groundwater.

2.7.2.5. National nitrate policies

There are several regulations in force in Slovenia that are supposed to control water and food quality in connection to nitrates.

Slovenian legislation is quite strict as far as standards on drinking water, food quality or quality of agricultural products is concerned regarding nitrate (as well as other chemical elements or toxic substances). According to EU Nitrate Directive the maximum standard for nitrate in drinking water (according to adopted value by WHO) is 50 mg NO_3/l of water. (SOREN & BOIE 1994). Slovenian legislation on the other hand has set up standard of maximum nitrate content in drinking water being 44 mg NO_3/l of water.

Bottled water is not supposed to contain any NO_2, while regular water is allowed to contain up to 0,005 mg/l of NO_2^- N under regular conditions and not more than 0,05 mg/l of NO_2^- N in irregular conditions. And if our Slovenian legislation, which almost entirely corresponds to Nitrate Directive and Code of Good Agricultural Practice, is followed and obeyed, there should be no fear in future to expect the agriculture to be polluter of ground water and surface waters.

The most important regulation regarding expected processes of change in agriculture is supposed to be The Regulation on animal excrement's management. This regulation gives different norms. The most important are the following:

a) The highest quantity of manure allowed to be used on agricultural land as well as limitations for the use of the manure in specific soil conditions:
   - The maximal allowed intensity of raising animals is 3 LU/ha for cattle or 2 LU/h for pigs and poultry.
   - Application of organic manure is not allowed during winter time on frozen soil.
   - Application of organic fertiliser is not allowed on soil saturated with water.
   - Application of organic fertiliser is not allowed in temporarily flooded areas.

- Application of organic fertiliser is not allowed near water streams (10 m away from the stream) and in the depressions where there is no run-off of water.
- It is not allowed to apply liquid manure on bare soil in the period from Nov. 15 till Feb. 15.
- Application of organic fertilisers on water aquifer protected areas has to be done in agreement with the local regulations valid for those areas.
- In the vicinity of spring water and in underground water pumping areas waste water can not be drained to spring water or underground water in any case.

b) The highest quantity of N, P_2O_5, and K_2O allowed to be used per hectare is 210 kg N, 120 kg P_2O_5 and 300 kg K_2O.

c) Animal wastes should be stored in a suitable arranged dung yards and cesspools. Dung yards and cesspools are supposed to be arranged in the way that there is no danger of leaking through and pouring over the underground water.

d) It is set up 5 years grace period needed for the adjustment of farms to these regulations as follows:
- the adjustment of the number of animals (LU) according to the area of land available on the farm,
- possible rent of additional land according to the contract, the construction of necessary dung yards and cesspools for hard and liquid manure according to the restrictions.

The extension service is obliged to take care of the transfer of necessary knowledge to the farmers. The control over implementation of mentioned regulations is supposed to be done by agricultural inspection, belonging to Ministry of agriculture.

2.7.2.6. Conclusions

Nitrate leaching into ground water and surface waters influenced by agricultural production is supposed to be a problem in the karstic region of eastern Slovenia - Trnovsko-Banjška Planota under certain conditions; point source pollution due to the lack of dung yards and/or cesspools or higher concentration of animals per ha can cause the problem with nitrate pollution in the groundwater. Therefore a nitrate policy is being in the phase of preparation in order to reduce mineral surpluses in agriculture and to meet the standards of nitrate in drinking water.

Mineral balances at national, regional and farm level were calculated based on the 'corrected normative approach'. In Ajdovščina community and Trnovsko-Banjška Planota region the nitrogen net-balance surplus is less than 36 kg N/ha while average net-balance surplus for Slovenia is about 56 kg N/ha.

In Trnovsko-Banjška Planota the average yields and uptake by crops are low and therefore non-point source pollution caused by mineral fertilisation in this region is not considered a serious problem. The high nitrogen surpluses can be caused by high animal density per ha. The stocking rate over 2,1 LU/ha can cause net-balance surplus over 100 kg N/ha; in this case organic fertilisation can be considered a serious pollution source

The average net nitrogen surplus in private farms in other parts of Slovenia is 46 kg/ha. It is a little bit higher than Slovenian average in 1994 (40 kg/ha). While in state farms is nearly three times higher than Slovenian average - 117 kg/ha.

In the Karst region of Trnovsko-Banjška Planota with limited growing conditions for crops (climate, soil depth, shallow soil) just small increase of livestock density can cause considerable nitrogen surplus. For that reason the restrictions for the application of chemical fertiliser and manure on hilly karstic regions had to be more rigorous than in plains.

Slovenian legislation intends to level this situation with quite strict regulations which are in agreement with EC Nitrate Directive and Code of Good Agricultural Practice.

2.8. FAUNA IN SELECTED KARST SPRINGS FROM THE TRNOVSKO-BANJŠKA PLANOTA (A. BRANCELJ)

2.8.1. Introduction

Copepoda is one of the most diverse and widespread group of so called "lower crabs - Entomostraca". Their body size usually ranges between 0.5 and 3 mm (HUYS & BOXSHALL 1991; EINSLE 1993). In inland waters they occupy very diverse of habitats, particularly taxa from groups Cyclopoida and Harpacticoida. They inhabit all types of permanent waters as well as some perennial ones (as for example puddles). They are very common members of subterranean communitus in sinking rivers, springs and percolating water. In sinking river abundance and number of epigeic species decline along the river, but number of subterranean taxa increase (BRANCELJ 1986). In percolating waters prevail stygobitic taxa, also in rare occasions some epigeic taxa are found there. This happens when thickness of ceiling is small and epigeic water bodies are in a vicinity. There is a lot of endemits among subterranean taxa, especially in that inhabiting percolating waters (SKET & BRANCELJ 1992). In some springs beside specimens of Copepoda, Ostracoda, Amphipoda, Ephemeroptera, Plecoptera and Coleoptera are present, too.

In the area of the "Karsthydrogeological Investigations in SW-Slovenia" within the framework of the ATH-project we made in 1993 a preliminary analysis of copepod fauna in four springs. No similar work has been carried