Extraction of peat and the reduction of the concurrent impact on ground and surface water in the Viru-Peipsi sub-basin

S U M M A R Y

Estonia is very rich of bogs and marshes. 1 009 101 ha or 23% of the total territory of Estonia is occupied by wetlands. The total peat reserve in Estonia is 2,37 billion tons. This reserve is divided in to active and passive ones. More than one third of Estonian active peat reserve is located in Viru-Peipsi Basin.

The peat production is very much depending on weather conditions in summer. The big variations in the production demonstrate following figures:
0, 334 million tons in year 1998 (extremely "wet" year);
1, 24 million tons in year 2002 (normal year).
Ida-Viru, Jõgeva and Tartu counties are very rich of big bog areas, and of the peat deposits too. There are very few active peat deposits in Valga, Võru and Põlva counties.

The government of Estonia has established limits of excavation of peat resources for each county to engage for the sustainable use of peat resources. Ida-Viru and Tartu are using approximately 50% of those limits, the other counties use only 10-20% of it. The extraction of the peat has important local impact to the biological diversity of the landscape, and to surface and ground water quality, to the fishery in rivers and lakes, etc.
The most important pollutants are peat dust and nutrients - phosphorus and nitrogen. The peat dust is polluting big sections of rivers- recipients and the main drainage ditches. The load from peat mining is strongest during the preparation period when the water resource in the mires decreases, as well as during heavy downpours of rain in the production period.

The following table reflects the impact of the peat excavation to surface water quality:

	Organic matter (kg/ha)	**N_{TOT} (kg/ha)**	**P_{TOT} (kg/ha)**	**1.1 Suspended solids (kg/ha)**	**1.2 Fe (kg/ha)**
Natural bogs and marshes	100	0,8	0,03	3 – 10	1 – 10
Drainage construction period	600	16,8	0,7	330	-
One year after drainage construction	200	4,8	0,17	87	5,2

Peat dust and excessive leaching of nutrients from peat excavation areas have a negative or even mortal effect to the fish stock in rivers. The valuable species, like grey trout and crayfish are seriously damaged. The number of good spawning areas decreases some years after peat excavation, and the juveniles of trout and crayfish don't stay alive without oxygen and food.

Peat production areas do not have a significant direct negative effect to the big lakes, like Lake Peipsi because their surface area is relatively small compared to the surface area of the lake. Due to the heavy problems concerning the peat transport from big bog areas, the existing peat excavation areas are not located very close to the Lake Peipsi. They have only indirect impact to the lake water quality and lake ecosystems. The impact is bigger in rivers but a part of nutrients can be transported into lake too.

The last chapter of the report is devoted to measures for reduction of pollution loads from peat extraction areas. The restrictions via legislation have been described in second chapter of the report. A lot of technical measures (10) have been analysed. Some of them *e.g.* the drainage with clay pipes or mole draining instead of open ditches can be a part of the preparation of the peat production areas, and their environment protection efficiency is difficult to estimate.
The main advantages of described measures are lower maintenance costs and better working conditions for peat production techniques, the main weakness is the greater risk of fire.
The realistic technical measures are as follows:

Water protection starts from ditches:

sedimentation pockets;
pipe barriers;
sedimentation ponds.
Suspended solids, humus and nutrient load caused by mining can be reduced by means of water protection technique.

A field ditch, with 500 metres/hectare on average, is dug in a peat mining area. A crossing place for working machines is situated at the end of the strips. Water from the field ditches is lead through a so-called bed pipe to a main ditch. A wooden, plastic or metallic pipe barrier is installed at the bed pipe end on the field side, in order to ensure that the tube stays open and to improve the retrieval of the suspended solids from the ditch. The number of pipes in barrier can be more than 2.
The sedimentation pocket is a broader and deeper dug at the end of the ditch where suspended solids moving together with water descends.

Overland-flow, infiltration, chemical treatment:

overland-flow;
soil infiltration;
chemical treatment.

Generally, these methods require that water must be pumped away, a factor that will increase costs. The best site for an overland-flow is an even and very gently sloping peat area in its natural state. These types of areas, nevertheless, are very rare in the surroundings of a production area. In some cases, the lowest part of a planned production area can be used as an overland-flow field in the preparation stage.
Soil infiltration has been researched, especially on mineral soil hillocks inside of the bog area where water is pumped through sprinkler- or perforated tube lines.

Chemical treatment is clearly more expensive than other methods in terms of building and operation costs, and therefore the two last mentioned measures should be used in conditions where the high water quality in river recipient is very important.
Volatilisation of the polluted water from the peat excavation fields also seems not very realistic in Estonian climatic conditions.

Peak runoff control as a water protection method

Run-off control dams restrain large water masses caused by sudden heavy rain in field ditches and outlet ditches. Since water leaves the area slowly, erosion diminishes, and the moving peat particles sink down into the drainage networks. The run-off control dams also absorb the nutrients associated with solid particles (*e.g.* phosphorus)

The run-off control method is most effective in new production areas where the ditches are deep and the storage volumes are large. In order to create optimal run-off control and purification efficiency, it is necessary to know the catchment area precisely, as well as the right ditch declinations and dam tube dimensions.
The control dam pipes should be installed slantwise upwards to the flow direction. Thus, any peat floating on the water surface will not get through the dam. During times of low water -flow, all drainage water will leave through the lowest dam pipe. However, when the water rises, the uppermost pipes start to remove water from the drainage network.
The efficiency of run-off control is as follows: suspended solids 90%, phosphorus 20-50%, and nitrogen 13-22 %.

Fig. 1 The run-off control construction

During times of low water flow all drainage waters will run out through the lowest pipe of the dam.

Pollution load from peat extraction areas

	Surface area, ha	**N** $_{TOT}$		**P** $_{TOT}$		**Susp. solids**		**Organic matter**	
		kg/ha year	t/y	kg/ha year	t//	kg/ha year	t/y	kg/ha /y	t/y
Natural bog	6440	0.8	5	0.03	0.2	10	64	100	644
Peat production area without purification	6440	9.3	60	0.3	1.9	80	515	120	773
Peat prod. area+ sedimentat. ponds + run-0ff dambs	6440	8.7	56	0.24	1.5	40	258	110	708

Nutrient load in the sub-basins

	Surface area, ha	**N** $_{TOT}$		**P** $_{TOT}$		**Susp. solids**		**Organic matter**	
		without sediment. basins	with sediment. basins	without sediment. basins	with sediment. basins	without sediment. basins	with sediment. basins	without sediment. basins	with sediment. basins

		t/y	t/y	kg/y	kg/y	tya	t/y	t/y	t/y
Viru sub-basin	**1497**	**13.9**	**13.0**	**449**	**359**	**120**	**60**	**180**	**165**
River basins									
Sõtke	220	2.0	1.9	66	53	18	9	26	24
Vasavere	80	0.7	0.7	24	19	6	3	10	9
Loobu	114	1.1	1.0	34	27	9	5	14	13
Pada	223	2.1	1.9	67	54	18	9	27	25
Kunda	356	3.3	3.1	107	85	28	14	43	39
Gordenka	219	2.0	1.9	66	53	18	9	26	24
Purtse	285	2.7	2.5	86	68	23	11	34	31
Peipsi sub-basin	**4943**	**46.0**	**43.0**	**1483**	**1186**	**395**	**198**	**593**	**544**
River basins									
Mustajõgi	1278	11.9	11.1	383	307	102	51	153	141
Emajõgi	3042	28.3	26.5	913	730	243	122	365	335
sh.Pedja	913	8.5	7.9	274	219	73	37	110	100
Põltsamaa	177	1.6	1.5	53	42	14	7	21	19
Ahja	321	3.0	2.8	96	77	26	13	39	35
Kääpa	172	1.6	1.5	52	41	14	7	21	19
Võhandu	451	4.2	3.9	135	108	36	18	54	50

This table demonstrates the increase of the nutrient load from peat production areas compared with loads from natural bogs. The loads are essential but not crucial to the Lake Peipsi. The efficiency of the sedimentation pockets, sedimentation ponds and run-off control constructions is greater in the reduction of suspended solids and phosphorus loads. It is important because phosphorus is the main limiting factor for eutrophication, and big amounts of suspended solids (peat dust) are dangerous for fish.

The construction costs are about:
for sedimentation basins – 1200 –3000 EEK/ha (100-150 USD/ha);
for sedimentation pockets – 350 –500 EEK/ha (30-40 USD/ha);
run-off regulation constructions – 200-400 EEK/ha (20 –30 USD/ha)
All those measures are recommended to use in integrated way, which means the total cost as 1750 – 3900 EEK/ha, or 140 – 325 USD/ha. The maintenance costs are approximately 10-20% of construction costs.