Project LIFE 08NAT/LV/000449

„Restoration of Raised Bog Habitats in the Especially Protected Nature Areas of Latvia”

Monitoring of mire management success in nature reserve Melnā ezera Mire

Report

Liene Auniņa
Institute of Biology of University of Latvia
Latvian Fund for Nature

2013

Rīga

Impact of groundwater level rise on vegetation in the nature reserve `Melnais Lake Mire`

Summary

Intensive mire drainage in the past has resulted in significant changes in mire hydrology and vegetation worldwide. Therefore, mire restoration and rehabilitation is of crucial importance in Latvia. In order to stabilize groundwater level in drainage influenced Melnais Lake Mire peat dams have been built during the project „Raised Bogs – LIFE08 NAT/LV/000449". The aim of the study was to evaluate vegetation changes after peat dam construction in the nature reserve `Melnais Lake Mire`. Field sampling was conducted using permanent sample plots *ante* (2010, 2011) and *post* (2012, 2013) dam construction. Vegetation studies were carried out in drainage influenced raised bog (21 sample plots), in cut-over bog (15) and in drainage ditches (7). Six month after dam construction vegetation changes were observed. The vegetation changes continued 16 month after dam construction and they indicated trend towards undisturbed raised bog vegetation. Total sphagnum and *Eriophorum vaginatum* cover continued to increase, but *Calluna vulgaris* cover decreased. However, *Pinus sylvestris* and *Betula pubescens* cover slightly increased. In 2012 amplitude of vegetation changes did not correlate with the distance from the ditch as it also was influenced by mire vegetation structure and species assemblage before dam construction. In areas with severe drainage influence, where shrub and tree layer are well developed, vegetation changes were less significant than in raised bog area with moderate or small drainage influence. In 2013 amplitude of vegetation changes correlated with the distance from the ditch, but still mire vegetation structure and species assemblage before dam construction influenced amplitude of vegetation changes. It can be concluded that dam construction followed by groundwater level rise and stabilization has a positive impact on raised bog restoration. In cut-over bog vegetation cover increased, including *Eriophorum vaginatum*, but in the wooded part in south of it die back of *Calluna vulgaris* took place in 2013. Despite the small increase in groundwater level in cut-over bog, the impact of dam construction cannot be neglected.

Methods

Fifty-four peat dams were constructed during the LIFE project „Raised Bogs – LIFE08 NAT/LV/000449" in January-February 2012. In order to follow vegetation changes field sampling was conducted using permanent sample plots *ante* and *post* dam cosntruction – in 2011 and in 2012, 2013.

Sample plot design

Sample plots in Melnais Lake Mire were established:

1) on two drainage ditches where dam building was proposed;
2) in the raised bog area most likely influenced by dam building;
3) in non-flooded cut-over bog.

Sample plots were established along with the water level monitoring wells and were arranged perpendicularly to ditches where applicable. Each sample plot is a $4m^2$ circle plot and they are allocated in a five sample plots` row using 6m distance between the circle centres (Figure 1). Sample plots in drainage ditches were 2x2m. They were established in order to follow overgrowing of ditches in raised bog. Photo of each sample plot was taken. Centres of sample plots or the left side (on ditches) were marked with the ribbon attached to the tree.

Undamaged part of Cenas tīrelis Mire was used as reference area for natural raised bog vegetation.

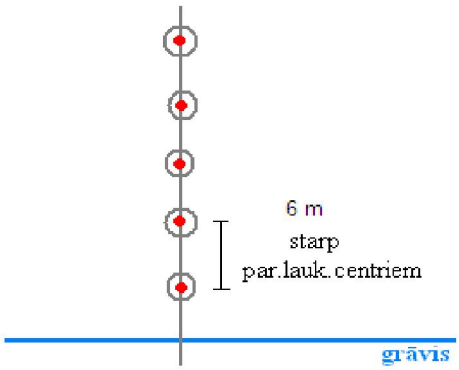

Figure 1. Design of the sample plots` arrangement in Melnais Lake Mire.

Vegetation sampling

All plant species were counted in sample plots and species cover in percentage as well as bare peat, litter cover and open water cover were evaluated.

Nomenclature: vascular plants (Gavrilova & Šulcs 1999), bryophytes – (Āboliņa 2001), lichens – (Piterāns 2001). *Sphagnum flexuosum, S. fallax* and *S. angustifolium* were aggregated into *S. recurvum agg.,* as it is difficult to recognise these species in the field.

Data analysis

R-programm (R Development Core Team, 2009) were used in data analysis. Euclidian distance between sample units was used as distance measure. Sample plots and transects were analysed *anti* and *post* dam construction using data from 2011, 2012 and 2013.

Results and discussion

Vegetation changes after dam construction

Raised bog

Dam construction took place in January-February 2012. Fifty-four dams were constructed. Groundwater level rise for about 20 cm in average was recorded after dam construction in southern part of Melnais Lake Mire. Amplitude of ground-water level changes has significantly decreased from 20-65 cm to 10-25 cm within period observed. The most significant changes took place within 10 m zone from ditch. Correlation between ground-water level changes and amount of precipitation and mire structure was found (Dēliņa 2013). Vegetation changes in Melnais Lake Mire continued in 2013. Total sphagnum cover increased in all four transects beeing the most expressed in Transects 1, 3 and 4. Transect 2, representing the most drainage influenced part of the study area, had the smallest sphagnum cover increase in compariosn with the rest of transects. Increase of sphagnum cover took place within 50m zone from drainage ditch. There was a strong correlation between distance from a ditch and amplitude of sphagnum increase in Transects 1, 3 and 4, but it was non-significant in Transect 2. Changes of *Calluna vulgaris* cover correlated with the distance from ditch in all transects in 2013. Decrease in *Calluna vulgaris* cover was recorded as they die back in conditions of excess water. *Calluna vulgaris* cover next to drainage ditches has decreased more than eight times in comparison to 2011. Moreover, it took place in bog parts where vegetation changes were not recorded in 2012 (Transects 2, 3 and 4) (Figure 2, 4 and 6, Table 1). Tree and shrub cover slightly increased (Figure 2).

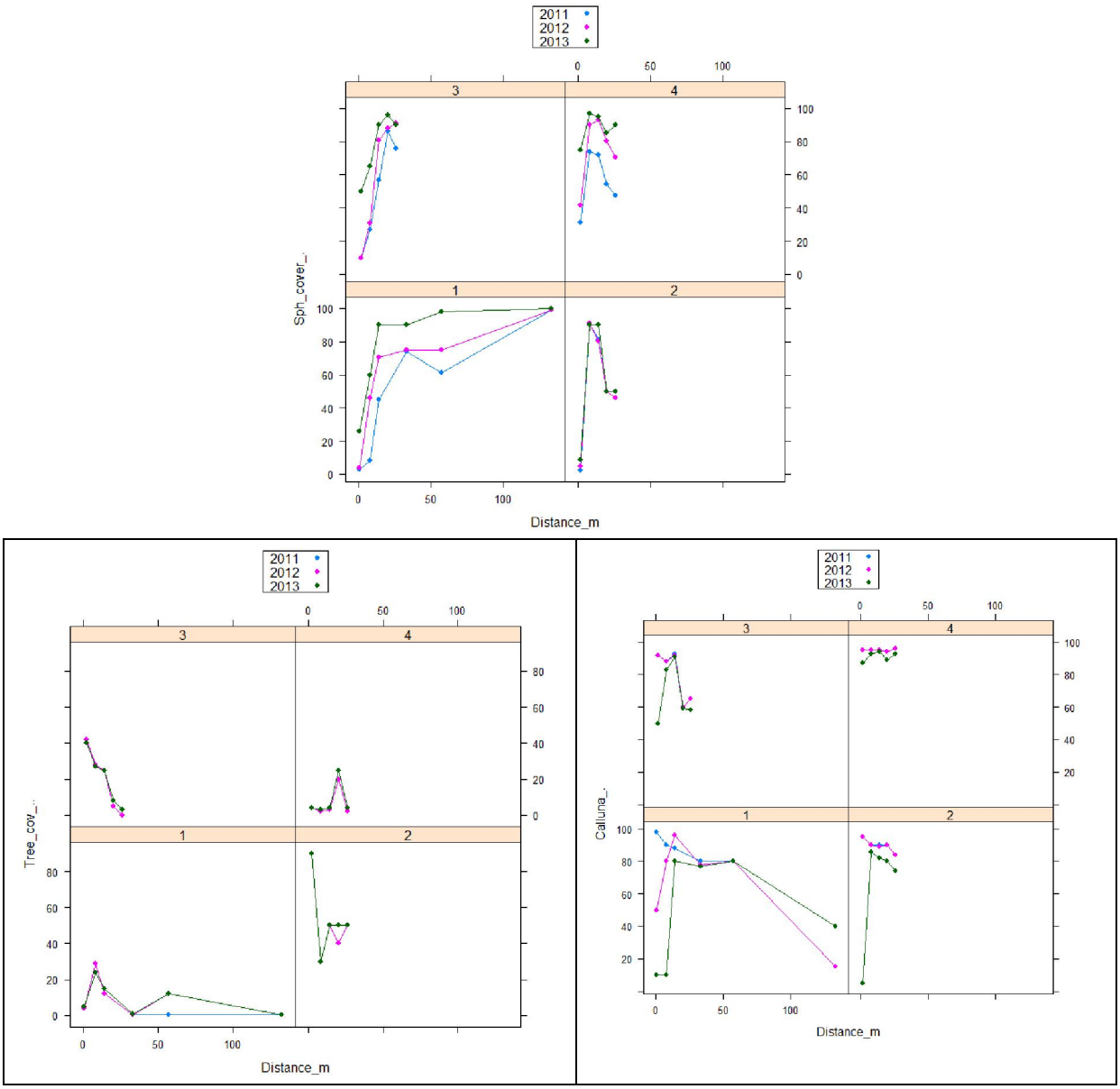

Figure 2
Changes in total sphagnum, *Calluna vulgaris* and tree and shrub cover, %, in raised bog part of Melnais Lake Mire depending from the distance from drainage ditch in 2011-2013.
Legends: 1,2,3,4 – Transects 1. ,2., 3., and 4.

Rhynchospora alba cover increased in Transects 1 and 3, and was recorded in one sample plot for the first time (Figure 3).

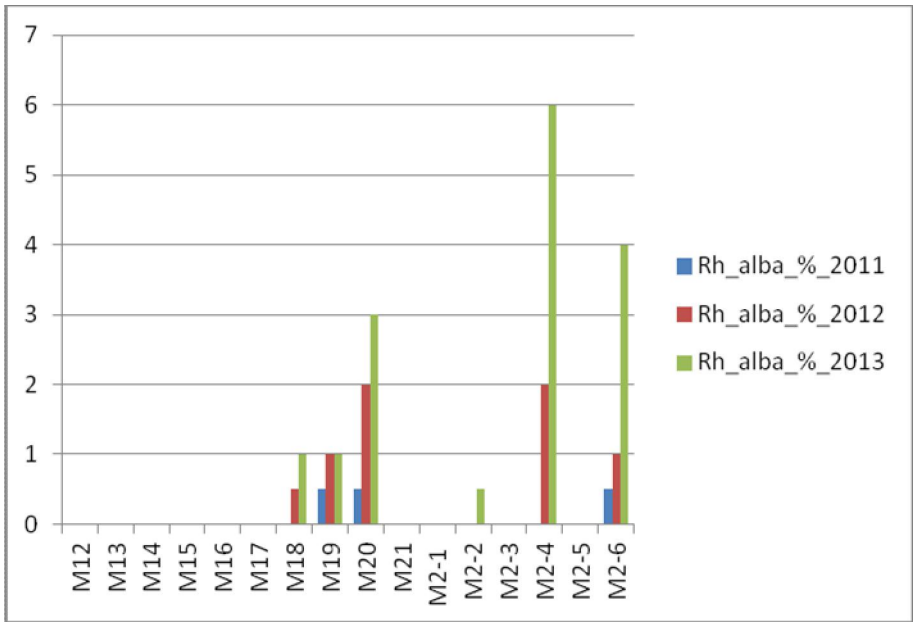

Figure 3
Chnages of *Rhynchospora alba* cover, %, in 2011-2013 in sample plots of Transects 1 and 2.

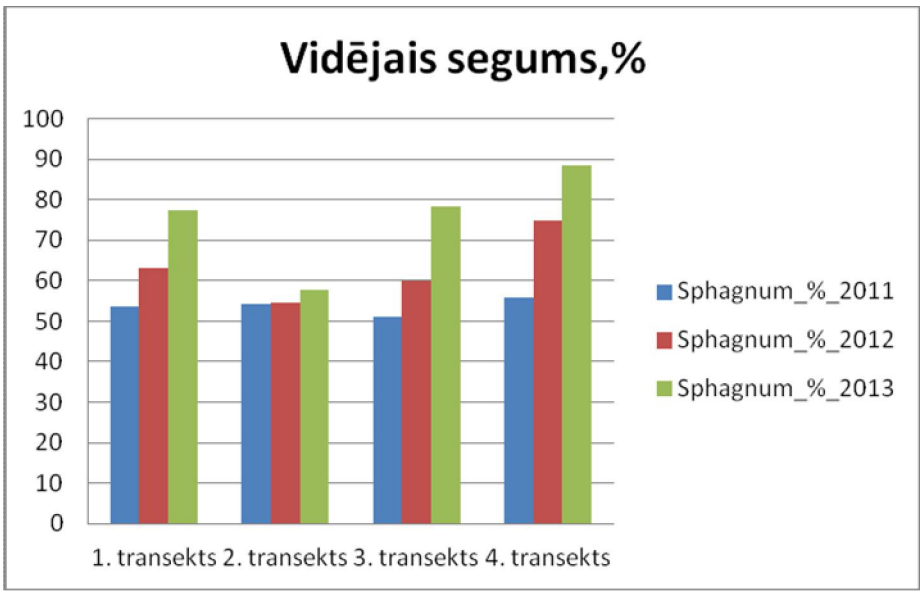

Figure 4
Changes of sphagnum mean cover, %, in Transects 1-4 in 2011-2013.

In all four raised bog transects *Eriophorum vaginatum* cover increased changes being the most expressed in Transects 1 and 2 (Figure 4). Increase was mainly caused by more vigorous growth of already existing *Eriophorum vaginatum* tussocks. *Rubus chamaemorus* and *Andromeda polifolia* cover increased in Transects 1 and 2. Species diversity slightly increased in ten sample plots. Species characteristic for natural raised bogs such as *Cladopodiella fluitans, Sphagnum tenellum, Sph. magellanicum, Kurzia pauciflora* and *Mylia anomala* as well as species indicating more dry conditions, e.g. *Dicranum polysetum, Pleurozium schreberii* were recorded there.

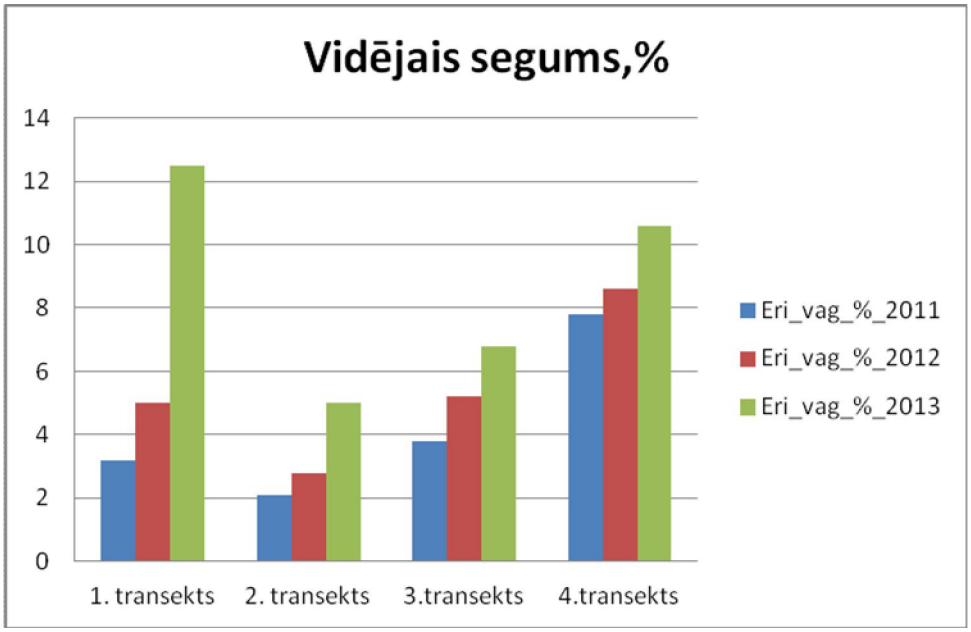

Figure 5
Changes in *Eriophorum vaginatum* mean cover, %, in Transects 1-4 in Melnais Lake Mire 2011-2013.

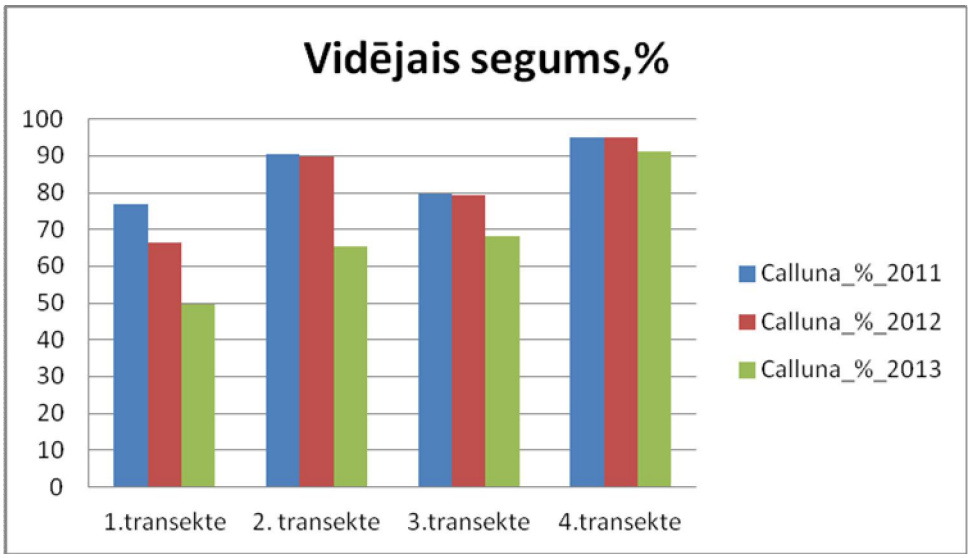

Figure 6
Changes in *Calluna vulgaris* mean cover, %, in Transects 1-4 in Melnais Lake Mire 2011-2013.

Drainage ditches
Vegatation changes took place in both studied drainage ditches. Significant increase of *Utricularia minor* cover took place in Ditch 1. Sphagnum cover increased in both ditches and it reaches 100% in Ditch 2 (Figure 7). Overgrowing of drainage ditches after dam construction was recorded also elswhere (Ķuze & Priede 2008, Salmiņa & Bambe 2008, Lanti et al. 2006) and it is considered to be positive effect in terms of bog restoration (Lanti et al. 2006).

A

B

C

Figure 7
Vegetation changes in Ditch 2 after dam construction in Melnais Lake Mire in 2012 (A – view on sample plot MG6 in 2010, B – 2012, C – 2013)

Cut-over bog

Four dams were built in this area in order to stabilize groundwater level in drainage influenced raised bog avoiding significant increase of groundwater level in cut-over bog.

Table 1
Vegetation structure in Melnais Lake Mire *anti* and *post* dam cosntruction

	Mean tree&shrub cover,%		Mean Calluna vulgaris cover,%		Mean herb cover,%		Mean sphagnum cover,%		Mean brown moss cover,%	
	2011	2013	2011	2013	2011	2013	2011	2013	2011	2013
Transect 1	9.3	11.4	76.8	49.5	4.3	16.8	53.6	77.3	0.25	0
Transect 2	52	54	90.4	65.4	6.8	13.8	54.3	57.6	0.6	1.3
Transect 3	20	20.6	79.6	68.2	10.4	17.7	51.2	78.2	1.3	1.2
Transect 4	7.4	8	95	91.2	6.2	18	55.7	88.6	1.2	1.2
Transect 5	10.6	20.8	0.5	0	34.3	36.7	0	0.4	0.3	0.8
Transect 6	13.2	20.6	19.8	19.6	25	34	0	0	2.7	4.5
Wooded part _S	47.5	55	38	26	25	26	0	0	0.8	3.5
Wooded part_N	56.5	79.5	4	9	12.5	31	0	0	0.8	1
Temporary flooded cut-over bog	2.5	7.3	0.2	0.8	10.7	21.2	0	0	0.1	0.8

There was a tendency of overgrowing of cut-over bog (Table 1; Transects 5, 6, Wooded part N and S). *Eriophorum vaginatum* cover increased in 2013 being the most distinctive in temporary flooded part of cut-over bog (Figure 8, 9). Die back of *Calluna vulgaris* was recorded in wooded part in south of cut-over bog. However, ground-water level has only slightly increased in this part of nature reserve (Dēliņa 2013).

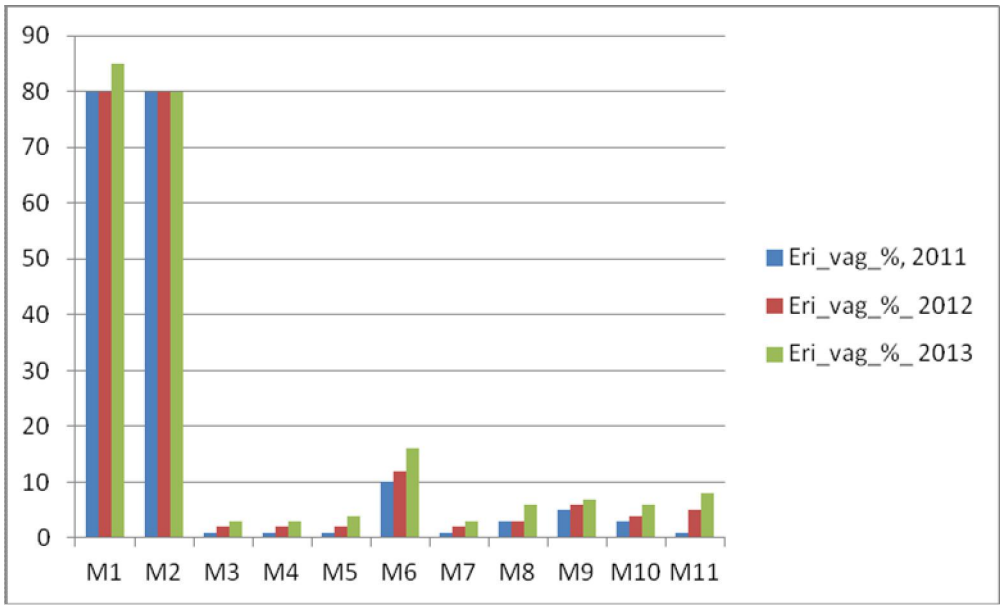

Figure 8
Changes in *Calluna vulgaris* cover, %, in Transects 5 and 6 in Melnais Lake Mire in 2011-2013.

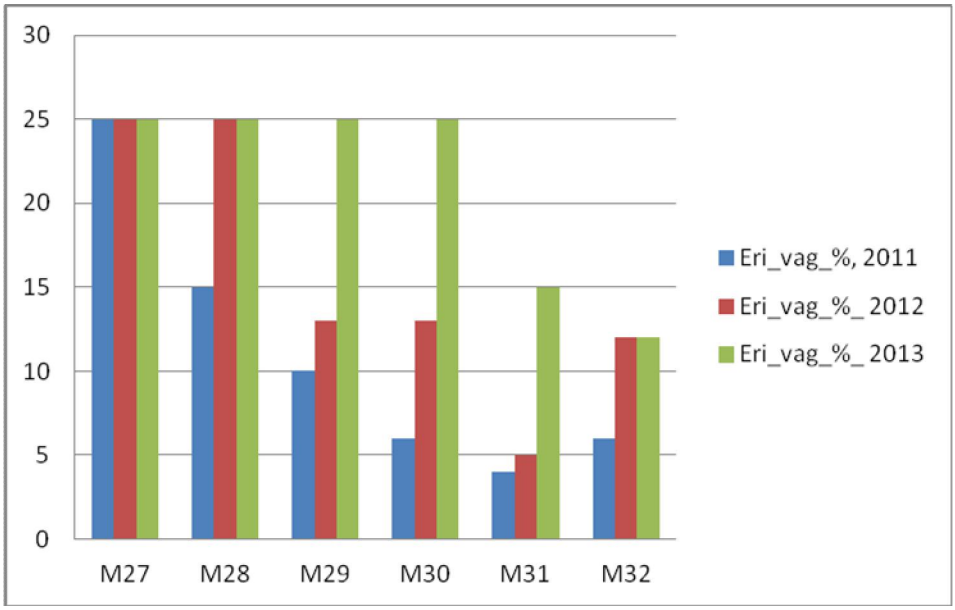

Figure 9
Changes in *Eriophorum vaginatum* cover, %, in periodically flooded part of cut-over bog in Melnais Lake Mire in 2011-2013.

Study showed fast and significant sphagnum response to groundwater level stabilization in drainage influenced raised bog and it contradicts to the first results from Vasenieku, Cenas tīrelis and Klāņi Mire (Salmiņa & Bambe 2008). However, in all raised bogs as well as in Ķemeru tīrelis Mire extensive die back of *Calluna vulgaris* was observed in 1–2m zone along drainage ditches and sphagnum colonization in drainage ditches was recorded (Salmiņa & Bambe 2008, Ķuze & Priede 2008). After dam construction *Eriophorum vaginatum* cover increased in Melnais Lake Mire like in Vasenieku and Cena Mire. Despite the vegetation changes observed, raised bog vegetation in Melnais Lake Mire still differs from natural bog vegetation in Cenas tīreļa Mire. High pine and heather cover and medium sphagnum cover indicated that. However, succession trend towards natural raised bog vegetation is obvious (Figure 10). Studies prove, that it can take several years after dam construction untill groundwater level reaches its equilibrium (Ruseckas&Grigaliūnas 2008). Consequently, we expect further vegetation changes in Melnais Lake Mire. Rapid establishment of *Rhynchospora alba* and *Sphagnum cuspidatum* in transects was favoured by presence of these species in adjacent area. Importance of species diaspore in restoration of raised bog vegetation was already stressed by different authors, e.g. Poschold (1995), Money & Wheeler (1999).

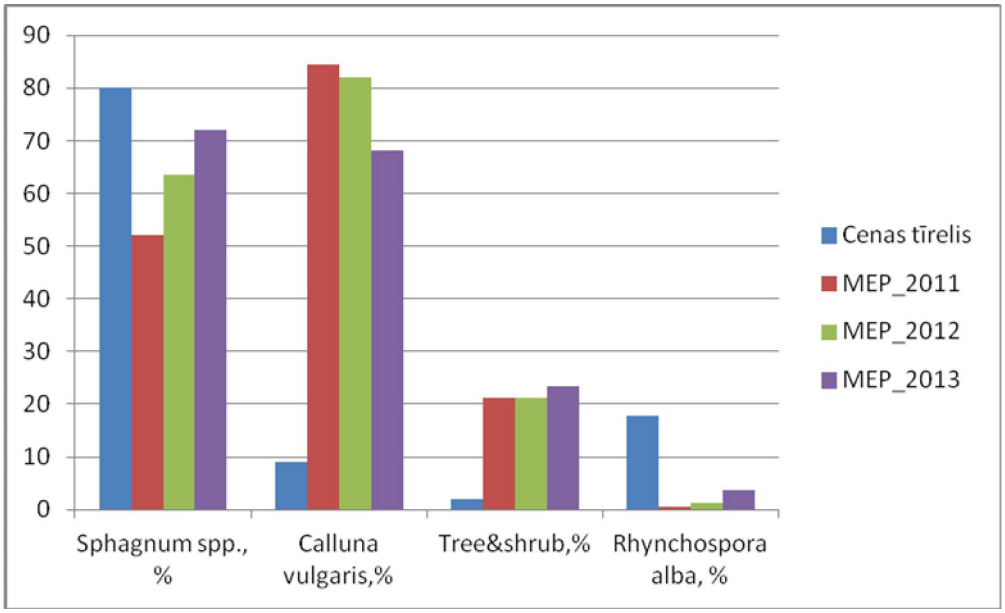

Figure 10
Comparision of main vegetation parameters of undisturbed raised bog (Cenas tīrelis Mire) and drainage influenced raised bog area in Melnais Lake Mire in 2011-2013. Central part of Cenas tīreļa Mire is a reference area for Melnais Lake Mire. Mean species cover, %, is presented.

Conclusions

The construction of peat dams in Melnais Lake Mire has an impact on drainage influenced raised bog vegetation. The observed vegetation changes indicated trend towards undisturbed raised bog vegetation. Increase of bog pool and hollow species cover, such as *Rhynchospora alba* and *Eriophorum vaginatum* as well as total sphagnum cover increase and die back of *Calluna vulgaris* indicated it. In 2013 amplitude of vegetation changes correlated with the distance from the ditch, being the most distinct next to ditches. Still mire vegetation structure and species assemblage before dam construction influenced amplitude of vegetation changes. It can be concluded that dam construction followed by groundwater level rise and stabilization has positive impact on raised bog restoration. In cut-over bog vegetation cover increased, including *Eriophorum vaginatum*, but in the wooded part in south of it die back of *Calluna vulgaris* took place in 2013. Despite the small increase in groundwater level in cut-over bog, the impact of dam construction cannot be neglected. Nevertheless, vegetation response to groundwater level changes should be evaluated on a long-term basis in order to draw final conclusions on management effect.

Acknowledgments
I owe thanks to Baiba Strazdiņa for preparation of cartographic materials and to Ainārs Auniņš for help at data analysis during the project.

References

Āboliņa A. 2001. Latvijas sūnaugu saraksts. Latvijas Veģetācija 3: 47 – 87.
Gavrilova G., Šulcs V. 1999. Latvijas vaskulāro augu flora. Zinātne, Rīga. 135 lpp.
Goodyear J. & Sliva J. 2000. Vegetation patterns on degraded raised bogs: a contribution towards restoration. Proceedings IAVS Symposium, Uppsala, pp. 282 – 285
Ķuze J. & Priede A. 2008. Ūdens līmeņa paaugstināšana meliorācijas ietekmētajās ķemeru tīreļa daļā: paņēmieni un pirmie rezultāti. Grām. Pakalne M. (red.) Purvu aizsardzība un apsaimniekošana īpaši aizsargājamās dabas teritorijās Latvijā. Jelgavas tipogrāfija, Rīga, 131. – 141.
Lanti V., Mach J., Holcova V. 2006. The effect of dam construction on the restoration succession of spruce mires in the Giant Mountains (Czech Republik).Annales Botanici fennici 43:260-268
Money R. P & Wheeler B. D. 1999. Some critical questions concerning the restorability of damaged raised bogs. Applied Vegetation Science, 2, 107 – 116.
Piterāns A. 2001. Latvijas ķērpju konteksts. Latvijas Veģetācija 3:5 – 46.
Poschlod P. 1995. Diaspore rain and diaspore bank in raised bogs and its implications for the restoration of peat mined sites. In: Wheeler, B.D., Shaw S. C., Fojt W. J. & Robertson R. A. (eds). Restoration of temperate wetlands, pp. 471– 494. John Wiley and Sons, Chichester.
Poulin M., Rochefort L., Desrochers A. 1999**.** Conservation of bog plant species assemblages: assessing the role of natural remnants in mined sites. Applied Vegetation Science 2: 169 – 180
Price J. S., Heathwaite A. L. & Baird A. J. 2003.Hydrological processes in banadoned and restored peatlands: An overview of management approaches. Wetlands Ecology and Management 11: 65– 83
R Development Core Team, 2009. A language and environment for statistical computing. The R Foundation for Statistical Computing. Pieejams <http://www.R-project.org (aplūkots 12.04.2013)
Ruseckas J., Grigaliūnas V. 2008. Effect of drain-blocking and meteorological factors on groundwater table fluctuations in Kamanos Mire. Journal of Environmental engineering and landscape managemnet, 16(4): 168-177
Salmiņa L., Bambe B. 2008. Apsaimniekošanas ietekme uz purvu veģetāciju. Grām. Pakalne M. (red.) Purvu aizsardzība un apsaimniekošana īpaši aizsargājamās dabas teritorijās Latvijā. Jelgavas tipogrāfija, Rīga, 152. – 157.
Sliva J., Pfadenhauer J. 1999. Restoration of cut-over raised bogs in southern Germany: a comparison of methods. Applied Vegetation Science 2 (1): 137– 148
Wheeler B. D. & Shaw S. C. 1995. Restoration of damaged peatlands – with particular reference to lowland raised bogs affected by peat extraction. HMSO, London.

Unpublished sources

Dēliņa A., Ģederts P. 2013. Hidroloģiskie pētījumi Melnā ezera, Rožu, Aklajā un Aizkraukles purvā un mežos. Projekta atskaite.

Annexes

Annex 1. Location of sample plots, dams and groundwater level wells in Melnā ezera Mire
Annex 1. Field data forms for monitoring of vegetation changes in the Melnā ezera Mire Nature Reserve
Annex 2. Photos of the sample plots in the Melnā ezera Mire Nature Reserve (2013)