LIFE project LIFE CCM DE/15/000138
LIFE Peat Restore

«Reduction of CO_2 emissions by restoring degraded peatlands in Northern European Lowland»

State of the project sites and consequences for project implementation – results of field surveys.

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LIFE15 CCM/DE/000138
LIFE project «Reduction of CO_2 emissions by restoring degraded peatlands in Northern European
Lowland»

Description of the project sites

The German project area is called Biesenthaler Becken (Biesenthal Basin) and is located in the federal state of Brandenburg, in the administrative district Barnim, ca. 30 km north of Berlin. The territory covers a total area of about 990 ha, that was declared as nature reserve in 1999. Additionally, approximately 960 ha are also designated as NATURA 2000 sites.

Due to complex glacial and post-glacial processes the Biesenthal Basin features diverse geomorphological patterns, resulting today in various biotope types and vegetation forms on a relatively limited area with forests and grasslands on mineral soils and in the depressions with lakes and secondary peatland vegetation like alder forests, willow shrubberies, sedges and rushes reeds or wet meadows (see detailed descriptions in previous reports).

With the long-term annual averages of air temperature and precipitation (1961-2010) amounting to 8.9 °C and 520 mm, respectively, the climate is classified as moist-continental.

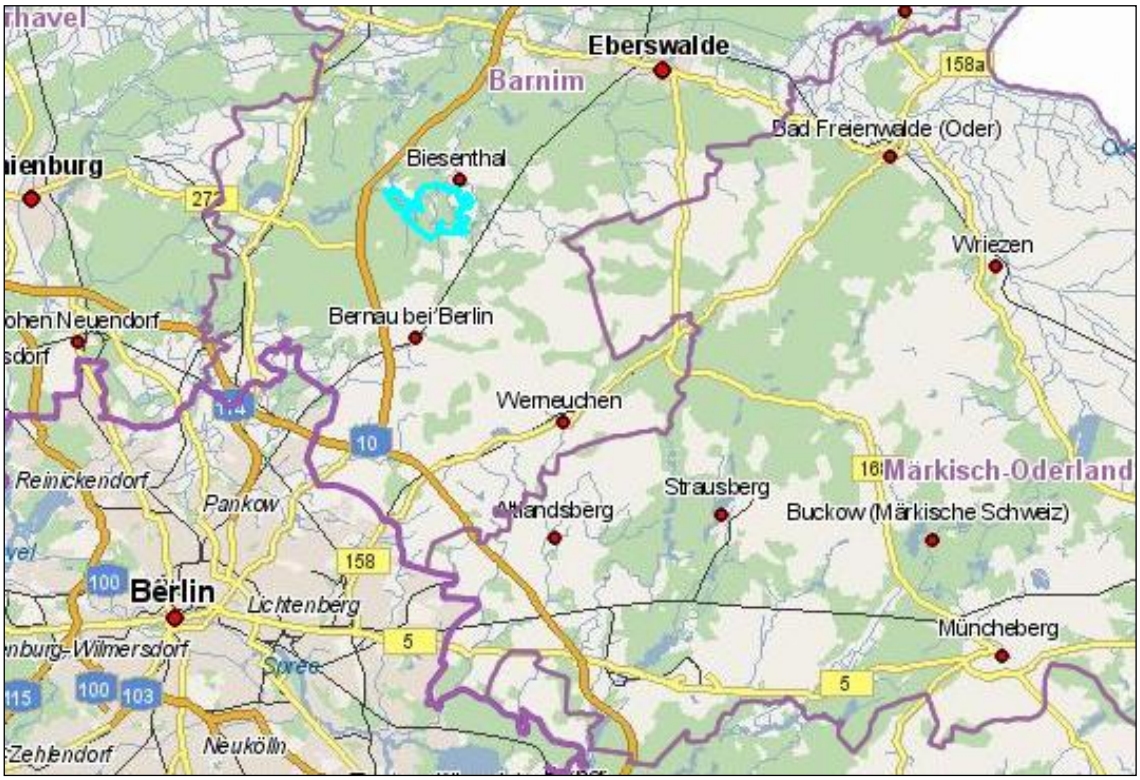

Figure 1: Location of the German Project area Biesenthal Basin (protected area light blue borders, source: "Landesamt für Umwelt Brandenburg"; https://www.govdata.de/dl-de/by-2-0; dl-de-by-2.0; Basic Geo Data: OpenStreetMap).

Three drained peatland areas were selected as project sites for restoration measures (Fig. 1). Location BB-1 covers an area of around 10.5 ha. It is situated in the west of a mineral sandy plateau called „Heideberg“, and is crossed by the small river “Pfauenfließ”. Location BB-2 has an area of approximately 3.5 ha and is situated between the two lakes „Plötzensee“ and „Hellsee“, crossed by the artificial water course “Plötzenseefließ”. Location BB-3 is situated in a drainless depression west of lake „Plötzensee“ and takes up around 0.7 ha (Fig. 1).

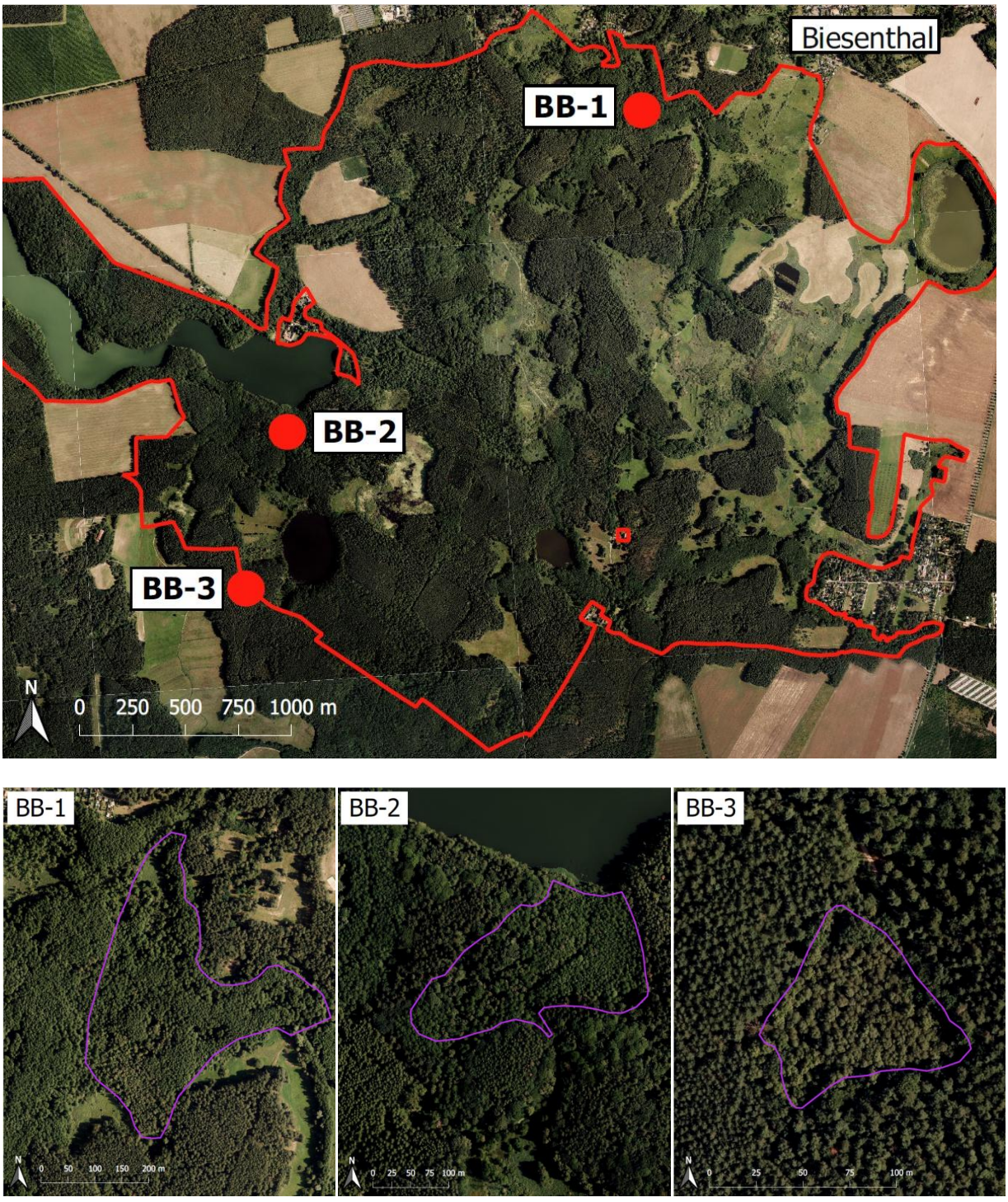

Figure 2: German project area (red, protected area Biesenthal Basin, source: "Landesamt für Umwelt Brandenburg"; https://www.govdata.de/dl-de/by-2-0; dl-de-by-2.0) and location of the three project sites, details in pink (Basic Geo Data: © GeoBasis-DE/LGB 2018).

Summarised description of data collection and results

Table 1: Data collection on and first results of the project sites in the Biesenthal Basin.

Site	**N vegetation monitoring / forest inventory plots 2018**	**N Vascular plant + moss species**	**Vegetation unit from mapping 2017**	**GEST** (Greenhouse gas Emission Site Types)	**Area (ha)**	**Water level, cm (mean, min, max)**	**Trophic level & base richness**	**N Soil profiles / peat stratigraphy drills**	**Peat depth, m (mean/ min/ max)**	**Ground water wells /gauge staff**	**GHG measu-rement sites**
BB-1 – "Alder Forest on the Pfauenfließ" 7 vegetation units, total 10.386 ha	4/ 5	81	Forbs-Carex acut.-Alnus glut. Forest & Carex acut.-Salix cin.shrubbery	Moist Forests and shrubberies (Meso- and eutrophic peatlands)	4.795	3+	eu-thropic	5	3/ 1/ 5	3/ 2	0
			Carex acut.-Alnus glut. Forest	Very moist Forests and shrubberies (Meso- and eutrophic peatlands)	3.584	4+	eu-thropic				
			Carex acut.-Sphagnum-Alnus glut. Forest & Carex acut.-Betula pub.-Pinus syl. Forest	Wet Forests and shrubberies (Meso- and eutrophic peatlands)	2.007	5+ & 4+	meso-trophic-acid				
			Carex acut.-Phragmites aust. reed	Very moist Meadows, forbs and small sedge reeds	0.16	4+	eu-thropic				
			Carex acut.-Urtica dioi. Forb	Moist reeds and (forb) meadows	0.053	3+	eu-thropic				

Site	**N vegetation monitoring / forest inventory plots 2018**	**N Vascular plant + moss species**	**Vegetation unit from mapping 2017**	**GEST** (Greenhouse gas Emission Site Types)	**Area (ha)**	**Water level, cm (mean, min, max)**	**Trophic level & base richness**	**N Soil profiles / peat stratigraphy drills**	**Peat depth, m (mean/ min/ max)**	**Ground water wells /gauge staff**	**GHG measu-rement sites**
BB-2 – "Alder Forest on the Plötzenseefließ" 6 vegetation units, 3.417 ha	2/ 5	55	Fagus sylv. Forest with pine and spruce & Spruce forest with Fagus sylv.	Dry Forests and shrubberies (Meso- and eutrophic peatlands)	0.552		-	5	2.13/ 1.40/ 3.00	2/ 2	1 with 3 chambers
			Athyrium fi-fe.-Alnus glut. Forest & Forbs-Carex acut.-Alnus glut. Forest & Forbs-Salix cin. Shrubbery	Moist Forests and shrubberies (Meso- and eutrophic peatlands)	1.649	3+	eu-thropic				
			Carex acut.-Betula pub.-Alnus glut. Forest	Very moist Forests and shrubberies (Meso- and eutrophic peatlands)	1.768	4+	eu-thropic				
BB-3 – „Birch forest west of the „Plötzenseefließ" 1 vegetation unit, 0.649 ha	1/ 1	18	Molinea-Betula pubescens forest	Moderately moist Forests and shrubberies (Meso- and eutrophic peatlands)	0.649	2+	meso-trophic-acid	1	?	1/ 0	0

Vegetation mapping and monitoring

The vegetation for all three sites was mapped in autumn 2017, identifying altogether 12 different vegetation units. Homogeneous vegetation units were differentiated in relation to physiognomic-structural aspects, to ecological site conditions and also to floristic features. For each vegetation unit and summed-up for every project site all occurring vascular plant and moss species were recorded. Later these 12, rather fine-scaled units were assigned to 7 different GEST (Greenhouse gas Emission Site Types, for both see Table 1).

In 2018 seven representative vegetation monitoring plots were placed within these standardized vegetation units (GEST) according to the GEST standard framework. The localization of the permanent plots was made by embedding magnets in the soil on one edge of the 100 m^2 square. Another corner point was formed by a colour-marked tree or stake.

Additionally, on 11 forest inventory plots structural parameters of the particular forest types were assessed. This data was necessary for calculating the sequestration rate of the wood biomass in the scenario calculations.

Details on the locations, applied methodologies, sampling designs and results are given in previous reports (in particular 2nd Monitoring Protocol). As example the respective plots of site BB-1 are depicted in Figure 3.

Figure 3: Vegetation monitoring (BB01-I to BB01-IV) and Forest Inventory Plots (For Inv Plot 1-4) on site BB-1.

Peat stratigraphy and pedological investigations

The pedological and stratigraphic investigations were performed in autumn 2017. In all three locations representative drillings were conducted by using a peat auger as deep as possible at least until the mineral layer was reached. For location 2 we also dug two soil profiles on the mineral soil

as deep as the groundwater was reached (for depths see Table 1). Supplementary we also used historical soil data from an official data base. Additionally we took samples for each horizon for each drilling spot and stored them in a cold storage cell at 4°C for later analysis (carbon, nitrogen, etc.). Details on the locations, applied determination methodologies, and results are given in previous reports (in particular “2nd Monitoring Protocol”).

Summarized for site BB-1, an early lake phase (shown by calcareous gyttjas) was followed by a long phase of terrestrialisation (with sedges-brown moss and partly Sphagnum peat layers, partly interrupted by repeated lake sediments) and later a percolation regime.

For BB-2, tight alder peat layers with lots of wooden residues and small-sedges rhizomes on top of lake sediments (shown by gyttjas, partly as old as 13,000 years BP) indicate the terrestrialisation history of this margin of the lake “Hellsee” basin.

As the bottom of the comparably small depression of site BB-3 could not be reached while drilling due to strong peat compaction the genesis remains unclear. Wooden peat with alder and birch components indicate as well a terrestrialisation history.

Hydrological monitoring

From the field campaigns in 2017 it was already known that the ground water levels in the sites BB-1 and BB-2 are only slightly below the soil surface. There against, in BB-3 the water level was around 30-40 cm below the surface, indicating a relative strong water deficit, which is confirmed by stronger peat decomposition in comparison to the other sites.

For hydrological monitoring we installed in 2018 in total five groundwater wells with permanent absolute pressure sensors (SEBA Hydrometrie, loggers) for permanent monitoring close to the monitoring plots and three gauge staffs inside the streaming water of “Pfauenfließ” and “Plötzenseefließ”. The measurements started in the end of July 2018. All loggers recorded in an hourly resolution and the gauge staffs were checked every second week by the local reserve counselor.

The calculation of the water table was performed by a software (SEBAConfig) and corrected with an air pressure device (BaroDipper; SEBA Hydrometrie).

Details on the locations, applied methodologies, and results are given in the “2nd Monitoring Protocol”. As example one graph depicting the measurements of 2018 is shown in Figure 4.

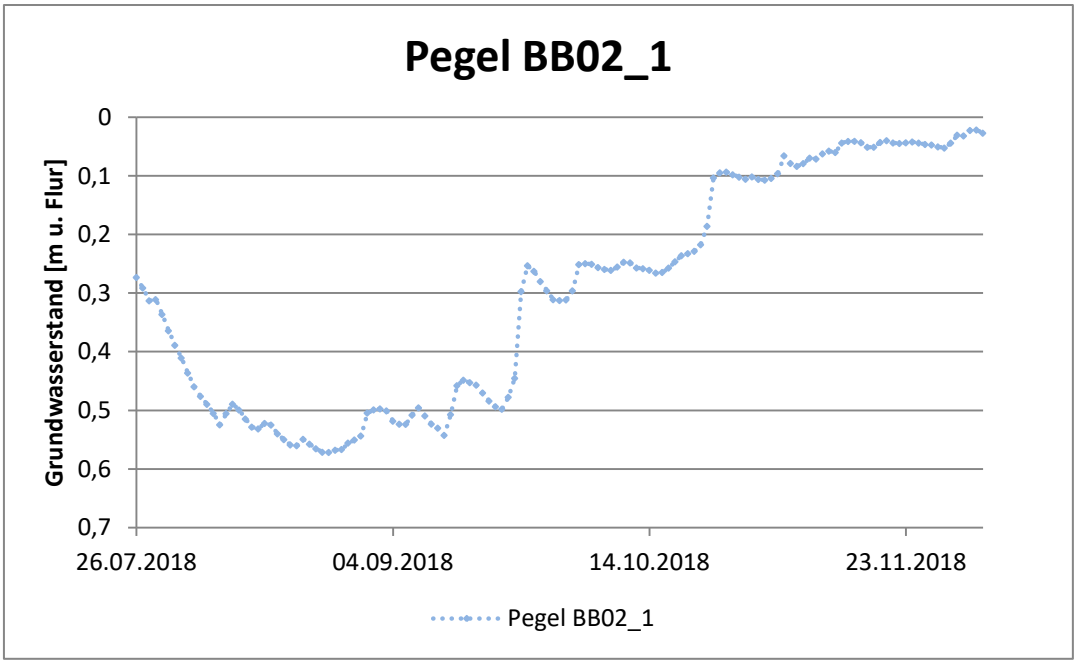

Figure 4: Measurement results of one groundwater well at site BB-2 (Grundwasserstand [m u. Flur] = ground water table [m below surface]).

Scenario calculations

One of the main goals of the project is the reduction of Greenhouse Gas (GHG) emissions from these degraded peatlands by rewetting and restoring the hydrological regime. In order to estimate and evaluate the climate effect of the restoration measures and to quantify the reduction potential of the GHG-emissions we used different scenarios based on the GEST-Approach. The GHG flux for each peatland was calculated on the base of the data on present vegetation, water level, the peat depth and composition and own calibration measurements.

For the German project site we selected three measurement plots within location BB-2, where from May 2018 on GHG measurements were performed by means of well-established closed chamber techniques basically every two weeks.

With this data, for each GEST a baseline and a post-restoration scenario was developed. On the basis of the results of the GEST analysis report we could calculate the GHG-emissions for both scenarios and we could compare the expected climate impact of the restoration measures with the situation without any actions.

Details on the locations, applied methodologies, and results with scenario calculations are given in the report “First GEST GHG balance scenarios”. The overview table from that separate report you find below.

Table 2: Summarized estimated GEST-GHG emissions in both scenarios and the reduction potentials in the German Project site with and without woods (all GHG-emissions are given in t CO2-eq. /ha/yr).

GEST-Type	Area [ha]		CO_2		CH_4		GWP		CO_2		CH_4		GWP	
			Without woods						With woods					
	base	post	base	post	base	post	base	post	base	post	base	post	base	post
Open Peatlands														
Moist reeds and (forbs) meadows	0,05	-	0,24	-	0,40	-	0,65	-	0,24	-	0,40	-	0,65	-
Very Moist Meadows, forbs and small sedges reeds	0,16	0,83	-0,08	-0,42	0,37	1,91	0,30	1,58	-0,08	-0,42	0,37	1,91	0,30	1,58
Forested Peatlands														
Moderately Moist Forests and Shrubberies	0,65	0,65	12,98	12,98	0	0	12,98	12,98	12,28	12,10	0	0	12,28	12,10
Moist Forests and Shrubberies	6,44	1,55	29,64	7,11	0	0	29,64	7,11	-9,99	-7,67	0	0	-9,99	-7,67
Very Moist Forests and Shrubberies	5,35	9,63	-2,68	-4,82	11,24	20,23	8,56	15,41	-23,48	-41,78	11,24	20,23	-12,24	-21,55
Wet Forests and Shrubberies	2,01	2,01	-7,02	-7,02	13,56	13,56	6,62	6,62	-12,09	-12,09	13,56	13,56	1,56	1,56
Sum	**14,66**	**14,66**	**33,08**	**7,83**	**25,57**	**35,70**	**58,75**	**43,70**	**-33,12**	**-49,86**	**25,57**	**35,70**	**-7,44**	**-13,98**
Reduction Potential				**-25,25**		**+10,13**		**-15,05**		**-16,74**		**+10,13**		**-6,54**

base means baseline scenario; post means post-restoration scenario

Conclusion

Location BB-1 is characterised by a thick sedges peat layer, which are subordinated by calcareous gyttja layers, and a percolation regime. The aim of the restoration measures here is the improvement of the hydraulic characteristics (e.g. flow features) of the river "Pfauenfließ". We plan to build several river bed glides to raise the water level of the river by approx. 25 to 30 cm close to the river "Finow" in the northern part and up to 50 cm in the southern edge of site BB-1. As a result of these plannings we assume, that the water level close to the river will be near or above the current surface with smaller declines in the surrounded area. As material for the river bed glides we will use local dead wood as much as possible. In this context it is planned to cut current woods and shrubs in the northern part of location 1. With the raised water levels we expect the succession of the vegetation on the dryer sites (3+) to develop towards communities of very moist (4+) mesotrophic forest and shrubberies (see scenarios in the report "First GEST GHG balance scenarios").

Location BB-2 is characterised by tight alder peat layers with lots of wooden residues, which are subordinated by calcareous gyttja layers only in the northeastern parts close to the "Hellsee". Due to the draining effect of the main ditch (the artificial „Plötzenseefließ") and also because of the proximity to the mineral edge the south-western part is drier than the rest of the area closer to the lake.

In contrast to Location 1 the aim of the restoration measures in location 2 is not the improvement of the hydraulic characteristics, though also an increase of the water table by filling parts of the ditch is expected to help towards the transformation of the whole peatland site in a more near-natural character.

We plan to backfill the „Plötzenseefließ", so that the current water level will raise on average of 30 to 40 cm close to the ditch from the southern part near the road to the first bend. Depending on the water table of the lake "Hellsee" we expect a maximum raise of 25 cm close to the lake. The water table of the two small mineral elevations will not change significantly in the future, as well as the eastern part, which is actually regulated by the damming activities of the beaver.

Location BB-3. To maintain the moor birch forest stand and the further peatland species in a long-term perspective, a restoration is necessary that allows for higher water levels and though a conservation of the peat body. Therefore the drainage effect of the ditch has to be stopped. By closing the ditch with loamy fillings in the transition area to the mineral periphery the leaking from the ditch is intended to be stopped. Additionally we plan to fill the ditch with highly decomposed peat to raise the water table. Due to the small hydrological catchment area of only 3 ha the water supply is very low, so that we expect only a slight raise of the water table by approximately 5 cm. To increase the water resources it is planned to convert the surrounding pine forests into beech forests. For the GEST-scenario calculations we did not consider these forest conversion measures.