

# Global Peatland Restoration

## Manual

Martin Schumann & Hans Joosten

**Appendix: Live case studies**

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Comments, additions, and ideas are very welcome to:

[Martin.Schumann@uni-greifswald.de](mailto:Martin.Schumann@uni-greifswald.de)

[Joosten@uni-greifswald.de](mailto:Joosten@uni-greifswald.de)

Institute of Botany and Landscape Ecology, Greifswald University,  
Germany

In the following selected case studies are described in detail to illustrate the different aspects and approaches to restoration.

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## 1 Europe

### 1.1 Great Britain

<b>Project title:</b>	<b>Cors Erddreiniog NNR</b>
<b>Project duration:</b>	1979 (still going on)
<b>Location:</b>	Island of Anglesey off the north coast of Wales, UK 53°18' N, 4°17' W UK National Grid reference: 247220 381380
<b>Peatland type:</b>	Calcareous valley mire / rich fen
<b>Aim of measurement:</b>	Maintenance of valuable plant communities - halt succession towards bog and woodland communities - creating aquatic and semi-aquatic niches

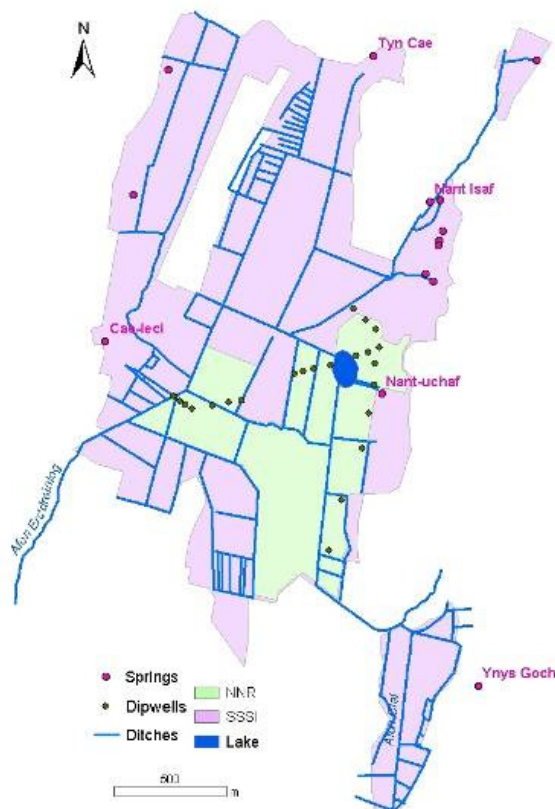
### Background

Cors Erddreiniog occupies a shallow watershed valley, and is fed by base-rich water emerging from an escarpment of limestone bedrock. It is exceptionally diverse. Most stages of wetland succession are present, including aquatic and swamp habitats, topogenous fen overlying up to 3 metres of peat, woodland and almost-natural soligenous fen; and it has orchid-rich vegetation that is unique for Great Britain, with *Schoenus nigricans*, *Dactylorhiza traunsteineri*, *Ophrys insectifera* and *Aquilegia vulgaris*. It is strictly protected by the nature conservation designations Site of Special Scientific Interest (SSSI) (1961), parts of it (70 %) as National Nature Reserve (NNR) (1969-94), as Special Area of Conservation (European SAC) and as Ramsar Site. The NNR is funded by annual budgets of the central government, (about £10,000 p.a.).

The mire was drained early in the 19<sup>th</sup> century to allow summer grazing and domestic peat cutting and the drainage was intensified in 1967.



**Fig. 1:** View across Cors Erddreiniog and its marl lake (photo O. Bragg)



**Fig. 2:** Map of Cors Erddreiniog showing its UK conservation designations in 1990

The SSSI extended to 289 ha, but only the (State-owned) NNR could be managed directly by CCW because the remainder was in private ownership. The distribution of monitoring dipwells is restricted by this consideration.

The site's conservation interest is threatened by:

1. natural succession towards scrub and woodland due to desiccation by drainage and to reduced grazing intensity following the establishment of the NNR;
2. a reduction of vegetation diversity indicated by spreading of acidophilic vegetation and *Molinia caerulea*, due to diversion of the natural supply of base-rich groundwater by ditches; and
3. eutrophication of water supply due to drainage activities within the catchment.

It has been managed under government nature conservation provisions since 1969, and is currently the responsibility of the Countryside Council for Wales (CCW).

### **Aim of the project**

To maintain the diversity of mire communities and to halt succession from fen to raised bog or woodland.

### **Realisation**

The management tools employed to directly maintain the diversity of vegetation include controlled burning, scrub clearance, mowing, fencing and grazing by ponies and a small number of cattle.

A hydrological study was carried out between 1979 and 1981 on the then existing National Nature Reserve (shown above). This showed that there was still enough water available to maintain the target plant communities. The task was to redistribute the water in time and space, in order to allow the site to flood in winter and spring. This could be done by reducing surface runoff and spreading the water across the site.



**Fig. 3:** Water control structures Left: concrete sluice at the point where the main ditch discharges into the river. Right: plastic overflow pipes controlling the water level behind a clay dam. (photos O. Bragg).

Between 1982 and 1984, a peat bund was constructed to reduce surface runoff into the main ditch discharging into the Afon (River) Erddreiniog and a concrete sluice was installed in 1993 where the river emerged from the mire. Other ditches were initially blocked with wooden boards and peat, and locally by clay bunds fitted with overflows made from plastic pipe.

In 1998, CCW purchased a strip of land on the eastern boundary containing several of the springs feeding calcareous water into the system and management work was moved to the eastern side of the site. Gradually, buried field drains carrying spring water into the drainage system are being severed at the site boundary so that the water discharges onto the fen surface, and north-south ditches are being infilled and bunded to compensate for shrinkage of the adjacent peat so that the spring water is able to flow across the surface onto the fen.

The creation of more than 70 small borrow pits led to the development of small areas of aquatic and semi-aquatic habitat. This resulted in the appearance of (*Nitella tenuissima*) and other desired swamp species.

In addition to the creation of permanently wet, nutrient-poor and base-rich conditions, continuous site management is necessary to provide adequate growing conditions for the target plant communities. This includes controlled burning, shrub clearance, mowing, fencing and grazing. This requires approximately 2 months of work for two employees (resulting in total costs of £10,000 p.a.).



**Fig. 4:** Water management work at the eastern side of Cors Erddreioniog after 1998. Left: stream emerging from a buried agricultural field drain which has been severed at the site margin in order to allow base-rich water to flow into the peatland. Right: a new peat bund holding back water in a small pool on one of the north-south ditch lines. (photos O. Bragg).

**Table 1:** Duration of management at Cors Erddreioniog

Project phase	Needed time
<i>Purchase of land:</i>	30 years
<i>Preparation and planning:</i>	Still going on
<i>Advertisement for the practical work:</i>	Various
<i>Execution:</i>	1976 – 2006 and still ongoing

### Results

Since 1979, the depth of the water table has been measured regularly in lined ‘boreholes’ (Figure xx) by the CCW site warden. Analysis of the data collected up to December 1996 showed that the water table had generally risen relative to the mire surface over the preceding 17.5 years, suggesting some success in compensating quantitatively for diverted spring water by delaying the runoff of rainfall.



**Fig. 5:** Part of the re-wetted surface of Cors Erddreioniog (photo O. Bragg)

Vegetation changes have been monitored systematically in permanent squares at intervals of 10 years and there are some positive results, for example the spread of a *Schoenus nigricans* - *Juncus subnodulosus* community at the expense of *Molinia caerulea* - *Potentilla erecta* mire.

It is likely that it will be necessary to manage this site indefinitely, for two reasons:

1. The pattern of land ownership at Cors Erddreioniog effectively restricts active conservation management to the NNR area (to which the Nant Isaf spring field has now been added), and there are some incompatibilities with the requirements of

agriculture on the adjacent land, especially in terms of water management. Some of the natural supply of groundwater still does not reach the fen surface because it is diverted into the arterial drainage system.

Moreover, the ditches along the boundary between the NNR and the neighbouring fields must be maintained so that field drainage systems will continue to work, and many of these boundaries lie on peat within the fen system. Thus, complete restoration of the site's natural hydrology cannot be envisaged in practice at the present time.

2. The broad targets set for vegetation are based upon the historic condition of the site under grazing management and shallow peat cutting for several centuries. Therefore the target condition may be a cultural climax that can be maintained only through continued grazing, even if the natural hydrology can be reinstated.

The sites long term management will depend on the management of the whole catchment, particularly in regards of water quality. The presence of intensive agriculture, including pig farming and land spreading of agricultural wastes is a cause for concern.

## **Contact**

Les Colley (Senior Site Manager)  
Countryside Council for Wales  
Llyys yy Bont  
Park Menai  
Bangor  
UK-LL57 4BN

Tel.: +44 1248 672500

E-mail: [l.colley@ccw.gov.uk](mailto:l.colley@ccw.gov.uk)

## 1.2 Germany

<b>Project title:</b>	<b>Rewetting of the former percolation mire “Lehstsee”</b>
<b>Project duration:</b>	1998 (still going on)
<b>Location:</b>	53°13' N / 13°20' E / size: 6 ha - north-east Germany - north-east of Lychen
<b>Peatland type:</b>	Drained percolation mire
<b>Aim of measurement:</b>	Reinstallation of former hydrological site conditions, by: - stopping drainage - enable surface-flow conditions - initiate peat formation and water percolation



**Fig. 6:** The lake “Lehstsee” and its adjacent mires (focal area of the project: NE part)

### Background

The project is part of the large nature conservation project "Uckermärkische Seenlandschaft". With this project the German federal government (Bundesamt für Naturschutz) wishes to promote the “establishment and protection of valuable natural areas and landscapes of national importance” and offers a financial support of 17 Mio € for a duration of 11 years. The aims of the project are the rehabilitation and the revitalisation of water sources of mires, lakes and rivers within an area of 25.000 ha.

The focus of the selected restoration project is on the restoration of a former percolation mire with up to 11 m of organic deposits including peat layers of about 5 m thickness on the east shore of the lake “Lehstsee” (see Fig. 6). The drainage of the peatland started during the 19<sup>th</sup> century and was intensified during the 1980s by numerous drainage ditches leading to a

lowering of the water table by about 1.5 m and to the mineralization of the upper 20 – 50 cm of peat. The peatland was used for fodder production and occasionally grazed by sheep. The vegetation cover was characterised by eutrophic plant communities dominated by *Poa pratensis*, *Agropyron repens*, *Alopecurus pratensis*, *Holcus lanatus* and *Urtica dioica*).

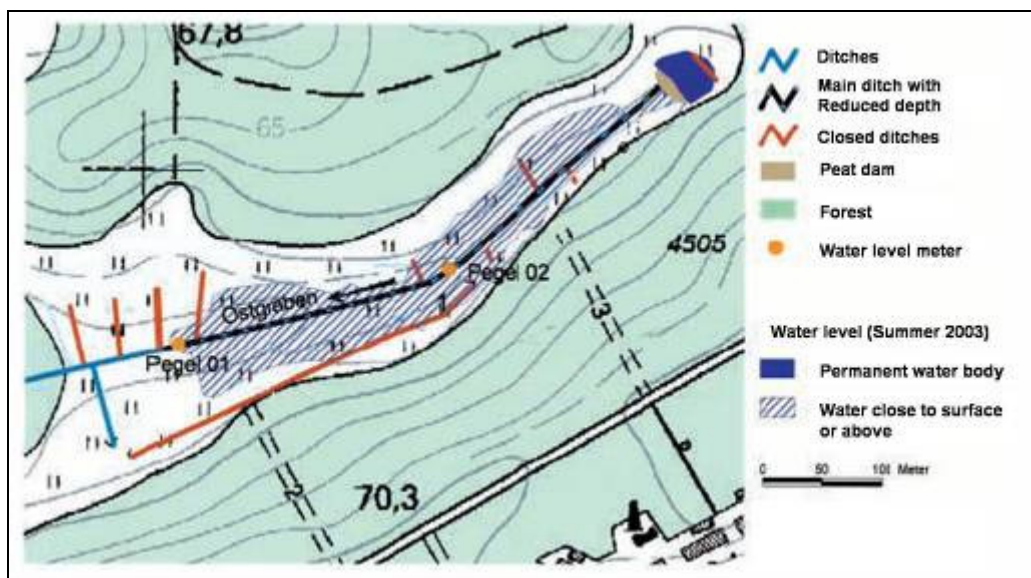
### Aim of the project

The project aims to reactivate the water storing capacity, to regenerate peat formation and the development of the mire by rewetting.

### Realisation

The Förderverein (support association) „Feldberg-Uckermärkische Seenlandschaft“ bought the area in 1998 for a prize of 7000 €.

The rewetting was complicated because the mires exhibit a strong surface slope (3 m on a length of 600 m). Simple rewetting measures like damming of drainage ditches would only have led to rewetting in small parts of the mire. Highly degraded peat layers on top of the peatland would not have allowed the re-percolation of water through the peat. But the numerous, still active springs from a large continuously water delivering catchment were advantageous and very promising for the project.



**Fig. 7:** First phase of rewetting in the percolation mire „Lehstsee“

The rewetting was undertaken in two steps to prevent flooding of the sites, to allow a gradual adaptation of the vegetation, and to evaluate the effect of differential peat swelling. During the first step (in 1999) the bottom level of the main drainage ditch was lifted from 70 – 150 cm onto a level of 30 – 60 cm. For that purpose the main ditch was filled with highly degraded peat that was taken of the site with the support of a small caterpillar pushing the highly degraded surface peat off the site. A small excavator placed this material into the main ditch. In the same way all small ditches were filled up completely. To back up the groundwater stream into the surrounding catchment a crosswise dam was erected by surplus material in the upper part of the mire (see Fig. 7).



**Fig. 8:** Revegetation after shallow peat extraction (2000)

During the second phase of the project (2006 - 2007) the rest of the main ditch was filled up completely. In addition 9 partial crosswise bunds slow down the water flow. As they force the water to spread across the peat surface they raise the water table to close to the peat surface.

**Table 2:** First phase of the rewetting of a percolation mire

<b>Project phase</b>	<b>Needed time</b>	<b>Arisen costs</b>
<i>Purchase of land:</i>	12 months	7.000 €
<i>Preparation and planning:</i>	2 weeks (design) 6 months (legalisation)	5.000 €
<i>Advertisement for the practical work:</i>	3 months	—————
<i>Execution:</i>	4 weeks	50.000 €
<b><i>Time and costs in total:</i></b>	<b>20 months</b>	<b>62.000 €</b>

### **First results**

Except for the mire margins the whole peat body was soaked with water again. In most parts water is overflowing the peat and in small areas percolation seems to occur. The mire margins are still dominated by ruderal and eutrophic vegetation, but the lower regions in the central areas show a significant vegetation change. In 2000 *Juncus effuses* and *Juncus articulatus* were dominating the site. On the areas that had been cleared of degraded surface peat countless small springs started feeding terrace-like pools that were quickly settled by *Chara vulgaris*. In summer 2000, bare peat surfaces were covered mainly by *Juncus articulatus*: Until 2002 various small sedges (e.g. *Carex rostrata*) and brown mosses (mainly

*Calliergonella cuspidata* and *Brachythecium spec.*) were dominating these areas. In selected areas species like *Carex lepidocarpa*, *Senecio congestus* and *Triglochin palustre* occurred.



**Fig. 9:** Revegetation after shallow peat extraction (2002)

Until 2002 the lower parts were almost completely overgrown by *Carex paniculata* and *Carex acutiformis* and in small parts also by *Carex appropinquata* (s. Fig. 9).

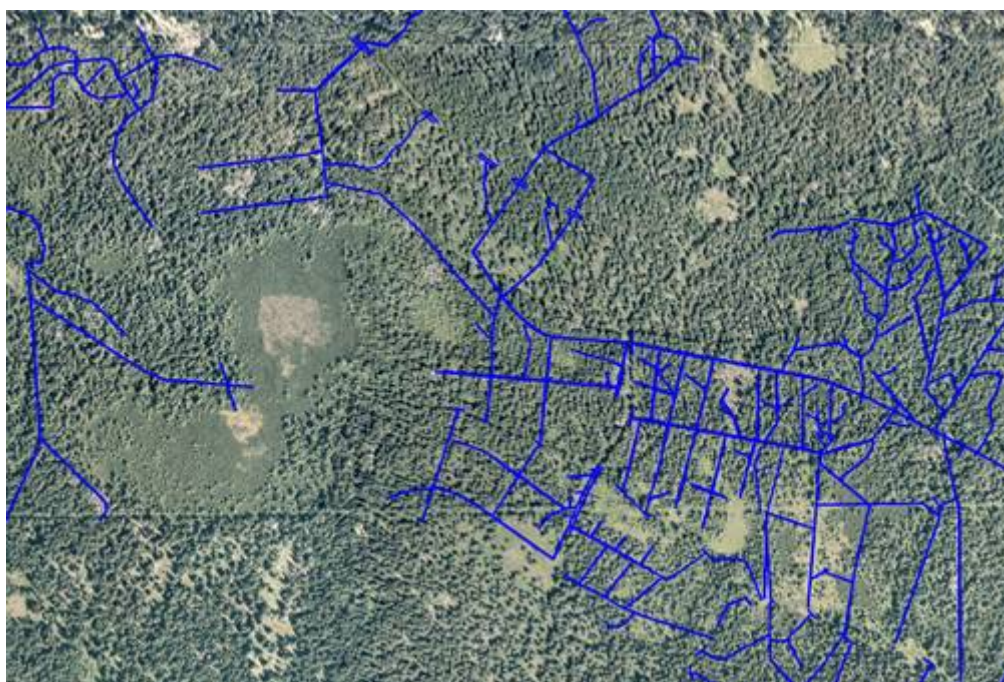
### Contact

Förderverein Feldberg-Uckermärkische Seenlandschaft e.V.  
Dr. Rüdiger Mauersberger  
Am Markt 13  
17268 Templin  
Germany

Tel.: +49 (0) 39 87 - 5 37 33  
mailto: Foerdereverein\_Uckermark.Seen@t-online.de

### 1.3 Czech Republic

<b>Project title:</b>	<b>Peatland restoration in the Sumava National Park (Czech Republic)</b>
<b>Project duration:</b>	- since 1999
<b>Location:</b>	- South-west part of the Czech Republic along the border with Germany and Austria - About 150 km south of the Prague → 9 restored sites are located on central upland plateau of the Sumava Mountains (about 1200 m a.s.l.) (49°0' N / 13°47' E) → 2 sites are located in mountain floodplain of the Vltava river (SE part of the Sumava Mts, about 750 m a.s.l.) (48° 59' N / 14° 28' E)
<b>Peatland type:</b>	- Ombrotrophic bogs and adjacent minerotrophic mires (waterlogged spruce forests and sedge mires)
<b>Aim of measurement:</b>	- Restoration of hydrological site conditions by the reduction of surface run off



**Fig. 10:** Intensively drained catchment on the central plateau of Sumava Mts.

#### Background

The ecology of many peatlands in the Sumava Mts. has been influenced by human activities like forestry, agriculture or peat extraction in the past. About 70 % of peatlands have been influenced by drainage. As a result, many peatlands suffer from water shortage which is reflected in changes of moss and plant composition (e.g. the expansion of competitive graminoids and trees).



**Fig. 11:** Drainage ditches before and after restoration

### **Aim of the project**

The project focuses on hydrological restoration. It aims to rise and stabilise the sites groundwater tables and to slow down the surficial runoff.

### **Realisation**

The project, financed through a programme of river ecosystems restoration with financial support of the Czech ministry of Environment and partly of the Administration of the Sumava National park, was started in 1999. Research and site monitoring is financed by a national programme of science and research of the Czech ministry of Environment.



**Fig. 12:** Drainage ditch crossing bog-surface

During the first phase (1999-2003: preparation phase) the major disturbances on peatlands in the region were assessed. The project was planned and prepared. This included the basic

conception of the project, the setting of priorities, the identification of favourable methods and the implementation of small pilot projects to test appropriate measures and techniques.

Project implementation started in 2004. Since then selected small catchments were restored every year. The priorities are set onto headwaters and upstream catchment areas.



**Fig. 13:** Installation of wooden plank dams with overflow

Because of sloping surfaces and different peat types the blocking of drainage ditches was realized by cascades of several wooden plank dams. The position of the dams was determined by the targeted water table which was different for various sites. Wooden planks were manually hammered into the bottom of the ditch (overlapping the ditch by minimally 80 cm into each bank side) and sealed by geotextiles. All dams have spillways to reduce erosion in front of the dams. To keep the costs of transport and provision low, mainly spruce wood was used. The revegetation of the segments between the dams was supported by the introduction of branches and *Sphagnum* clones.

**Table 3:** Time and money required in Czech restoration projects

<b>Project phase</b>	<b>Needed time (per year)</b>	<b>Arisen costs (per year)</b>
<i>Purchase of land:</i>	-	- (sites are located on state owned land)
<i>Preparation and planning:</i>	2-3 months (design)	5-7.000 €
<i>Execution:</i>	6 months	25-30.000 €
<b><i>Time and costs in total:</i></b>	<b>10 months</b>	<b>30.000-40.000 €</b>

## Results

At present (2006) 40 km of drainage ditches have been blocked at nine different sites. The rewetted area is about 650 ha. In addition, the restoration of one industrially cut over bog (70 ha) was implemented.



**Fig. 14:** Cascade of dams along a ditch

Within the restored areas, selected peatlands are monitored after restoration measures took place to observe changes and to evaluate the success of restoration measures. Water table and hydrochemistry of groundwater (pH, conductivity), amount of precipitation and vegetation are monitored on permanent plots.

On restored bogs the groundwater table remained stable just below the surface even during dry periods. Shrubs that were establishing after drainage are dying back with the rising water level in large areas. Several formerly drained bog pools have been reflooded. On one monitored site, new and small *Sphagnum* clones spontaneously appeared on highly degraded bog surface only 6 years after restoration. *Sphagnum cuspidatum* is successfully colonising ditch segments with open water of water with a depth of up to 50 cm. In deeper water it needs the support of branches or stems.

## Contact

Ivana Bufková  
The Administration of the Šumava National Park  
Sušická 399  
341 92 Kašperské Hory  
Czech Republic

Tel.: +420731530251  
E-mail: [ivana.bufkova@npsumava.cz](mailto:ivana.bufkova@npsumava.cz)  
web-link: [www.npsumava.cz](http://www.npsumava.cz)

## 1.4 Belarus

<b>Project title:</b>	<b>Implementing conservation measures in mesotrophic fens in Belarus</b>
<b>Project duration:</b>	April (still going on)
<b>Location:</b>	52°05' N / 24°50' E - south-west of Belarus (closed to the Ukraine border) - 78 km east of Brest
<b>Peatland type:</b>	Drained sedge fen
<b>Aim of measurement:</b>	Reinstallation of former hydrological site conditions, by: - adjusting the amelioration systems - building water-regulating constructions



**Fig. 15:** Zvanets mire and it's surrounding

### Background

The Zvanets mire is the largest intact fen mire in Europe. As habitat for various globally-threatened bird species (e.g. the Aquatic Warbler (*Acrocephalus paludicola* - 16 % of the world's population), the Greater Spotted Eagle (*Aquila clanga*) and the Corncrake (*Crex crex*) it is of international importance. The mire is also habitat for eight World- and Europe-wide threatened plant species. The non-avian biodiversity, in terms of both habitats and species, is of high international significance.

The mire is located on the divide of two river systems (Dnieper and Bug). Large areas are still in a close-to-natural hydrological condition. But there are negative impacts especially by the Dnieper-Bug Canal and the operation of a fish-farm close to the mire.



**Fig. 16:** Drainage network at the margins of Zvanets mire

Their intensive use of water leads to serious water level changes (severe floods or rapid declines of the groundwater table) that are destructive to the mire and lead to unwanted vegetation successions, to extensive fires and to the destruction of bird nests by floodwater. The water source of spring floods is drained off by an extensive drainage systems within and surrounding the mire (Fig. 15 and Fig. 16).

### **Aim of the project**

To safeguard the mire's importance as key habitat for threatened species the hydrological regime should be improved towards a stable condition.

To reduce the draining effect of canals, it was decided to shut the excess run-off by water control structures, so that the water level could be maintained at the soil level after flood recession and any further water reduction would only be by evaporation.

### **Realisation**

Based on the management plan for Zvanets, agreed with the Ministry of Natural Resources and Environmental Protection, Polesie Giprovdokhoz developed a construction project "Implementation of Urgent Activities of Management Plans of Key Fen Mires of Belarus".

With the implemented water regulation structures the following hydrological conditions were planned to be established:

- During spring (March-April), the entire territory of the mire should be evenly flooded by spring waters. The top tussock level is the optimum flooding level. In the years when there is no flood on the Pripyat, it is desirable to ensure water supply from the Orekhovsky Canal.
- By 10 May, the water level should be 10 cm below the top tussock level on most of the mire (145.4 m mark).
- Between 10 May and late June, the water level should be near the soil surface. It is necessary to ensure that in early May the water level stays around the soil level and subsequently any water discharges are accounted for only by evaporation (all sluices must be shut down). During that period any sharp level fluctuations should be avoided.
- Between July and September/October the mire should have a clear summer low-water period with levels 10-30cm below the soil level.

- To prevent autumn and spring fires and conduct controlled burning, the mire should be re-flooded up to the top tussock level for the winter (provided there is water in the Orekhovsky Canal).

From 2003 until 2005 fourteen water regulation facilities (overflow weirs (W 1-7), sluices (SL 1, 2, 5), sand-&-gravel blocks (S 1-4) – were built at Zvanets, see Fig. 15 and Fig. 17). In total about 80 000 USD were spent for implementing construction and monitoring activities.



**Fig. 17:** Dam constructions at Zvanets mire

Additionally, one adjustable sluice (SL-3) was built in 2005 by K. Marksa collective farm and another adjustable sluice (SL-4) was reconstructed by “Novoselki” fish farm as contributions of these enterprises towards the optimization of the hydrological regime of the mire. Most construction (W 1-7, SL 1, S 1-4) took place in the first year of the project.



**Fig. 18:** Sluice constructions at Zvanets mire

### **First results**

The regularly monitored water levels show that the initial interventions were successful in reducing the water discharges from the mire and to ensure the targeted water levels in normal and even during low-water years.

The leveling carried out on 11 May 2004 on the mire from the village of Povitie to the fish pond showed that the surface of the mire in the south was flooded 5-15 cm, whereas the section adjacent to the fish pond was 20-35 cm and even 70 cm below the surface. After a dam started to block the run-off and a fish pond's sluice was rebuilt, the northern part of the mire started to be flooded just like the central one.



**Fig. 19:** Restored area at Zvanets mire

To guarantee optimal habitat conditions for the threatened species of the mire, long periods of floods have to be avoided. Therefore a controlled acceleration of water discharge from the mire had to be guaranteed. This was achieved by two extra sluices that were built in 2005.

To assess the efficiency of the implemented measures the monitoring of hydrological regime, vegetation composition, bird species composition and of the population development of the Aquatic Warbler was organized.

The monitoring data proved that the mires hydrology approached its natural regime. Besides, the built facilities and observation of the new rules for water use allowed both to avoid abrupt reduction of the water levels and to prevent summer floods significantly.

The population of the indicator specie (the Aquatic Warbler) is stabilizing. The density of breeding pairs and the breeding success is increasing.

## Contact

Dr. Alexander Kozulin  
APB BirdLife Belarus  
220072 Minsk, Akademichnaya 72  
Belarus

Tel.: +379 17 2949069  
E-mail: kozulin@biobel.bas-net.by

## 1.5 “Kamskoje-Osinovyje Kotly peat bog” (Western Russia)

<b>Project title:</b>	Local Environmental Action Programmes (LEAPs) for the protection and restoration of peat bogs in Nizhegorodskaya oblast
<b>Project duration:</b>	July 2002 – March 2003
<b>Location:</b>	56°25' N / 45°24' E - ca. 50 km east of Nizhniy Novgorod city
<b>Peatland type:</b>	Extracted raised mire
<b>Aim of measurement:</b>	Pilot project to devise practical dam designs and installation methods for two contrasting situations in abandoned peat fields, with wider social and ecological implications



**Fig. 20:** Location of Kamskoje-Osinovyje Kotly peat bog restoration site

### Background

The Kamsko-Bakaldinskaya is located 50 km to the east of Nizhniy Novgorod city on the left bank of the Volga River. It covers an area of more than 100,000 ha which contains a unique assemblage of mires of various types and ages that provide habitat for many rare species. Part of it is designated as a Ramsar Site.

The central peat bog *Kamskoje-Osinovyje Kotly* (2,770 ha) has been badly disturbed by peat extraction. This disrupted the integrity of the wetland area and fragmented the populations of rare plants and animals. Peat working ceased during the economic crisis of the 1990s leaving the people of the nearby village “Kuzmijar” without jobs and surrounded by drained bogs

with depleted resources of traditional wild foods (berries and mushrooms) and which burned, causing serious smoke problems, each summer.



**Fig. 21:** View across Kamskoje-Osinovyje Kotly peat bog (October 2002 by S. Brooks)

In 2002–3, a local NGO known as Dront Ecological Centre, in partnership with the University of Dundee (UK), undertook a pilot project, funded by the British Council Small Ecological Projects (SEPS) scheme and the government of Nizhegorodskaya oblast, to re-wet some of the abandoned peat workings using locally available labour force. As there are many settlements whose people have been unemployed since the collapse of peat enterprises, and peatland restoration is a relatively new concept in Russia, the involvement of local people and the demonstration value of the work were possibly more important elements of the project than the practical aspects.

### **Aims of the project**

1. To develop the capacity of NGOs, local communities and decision-makers to discuss and to solve common environmental problems as an integral part of adopting modern (LEAP) approaches to environmental management and planning, through awareness raising and training.
2. To establish the ecological network principle within the nature conservation plan for Nizhegorodskaya oblast, and to emphasise its importance within a successful nature conservation strategy for Russia.
3. To set up an accessible knowledge base for understanding and implementation of the LEAP and ecological network approaches elsewhere, for practitioners and decision makers at different levels.

### **Realisation**

A wildlife survey was conducted on the Kamsko-Bakaldinski bogs in early July 2002. Later in the same month, four principal members of the Russian project team visited the UK for a 10-day workshop and study tour during which British experience in peat bog management and protection was discussed and demonstrated. On returning to Russia they began negotiations with local government and industry to secure agreement in principle, and then to seek potential sites for a programme of bog restoration.

It proved difficult to identify a suitable site, since it was necessary to find an interested peat enterprise, and to avoid locations where dam construction would cause flooding of areas where extraction was planned or where conflicts with foresters and the local community might arise. The team also hoped to find an area with no wood/tree layer.

They finally obtained all the necessary approvals to work on a suitable 25 ha plot within the Kamskoje-Osinovyje Kotly peat fields (Vorotynski district). The project was then discussed with local residents and a detailed survey of the site, including vegetation mapping and recording of wildlife, was carried out in September and October.



**Fig. 22:** One of the smaller drainage channels before dams were installed (photo S. Brooks)

The drainage channels on this plot were all deeper and wider than those seen in the UK, and were of two different sizes, the ditches marking the sides of the plot being connected by pipes to a larger canal at one end. The construction of dams was planned with and carried out under contract by the local peat factory “*Enterprise Kamska*”, providing employment for local people. It was anticipated that any metal or plastic materials used would be stolen, so each dam was made from two parallel wooden barriers with peat infill.

The dam designed for the canal incorporated an overflow pipe and doubled as a bridge, facilitating movement of machinery and people for fire-fighting. Ten dams were installed between mid-November and mid-December.

**Table 4:** Approximate time requirements and costs

<b>Project phase</b>	<b>Needed time</b>	<b>Arisen costs</b>
<i>Preparation and planning:</i>	5 months	38,800 €
<i>Execution:</i>	1 month	1,100 €
<i>Dissemination:</i>	3 months	14,600 €
<b><i>Time and costs in total:</i></b>	<b>9 months</b>	<b>54,500 €</b>

Awareness raising for the project included a web-site:

<http://www.dront.ru/lr/peatbogs.ru.html>, an illustrated brochure and a press release which attracted newspaper, radio and television coverage. Finally, a workshop was held in March 2003 at the health resort *Beriozka* in Nizhny Novgorod province. This was organised jointly by Dront Ecological Centre and Wetlands International Moscow, and there were more than 40 participants representing 5 Russian oblasts and the Mariy El Republic.

### Results

The direct consequence of the construction of dams was that the water table was raised over a total area of 50 ha. It would be unrealistic to expect to observe changes in vegetation within such a short timescale, and transplanting trials were in any case planned for the spring of 2003.



**Fig. 23:** A single dam, designed to double as a bridge (photo Ecological Centre Dront)

The most significant outcome of the project was, however, the high level of interest that it generated for peatland re-wetting as a fire prevention measure. The provincial authorities were already concerned by the high frequency of summer peat fires over the preceding two years because the smoke is a public health issue that can necessitate costly evacuations, and because of the associated losses of forest. From here, interest spread to other local (raion) authorities who were interested in peatland restoration as a means of creating employment; provincial (oblast) authorities whose main concern was to reduce the incidence of peat fires, and eventually to the federal Ministry of Natural Resources in Moscow, which sent representatives to Nizhny Novgorod to discuss the issues involved.

### Contact

Dr. Anzhela Bakka  
Ecological Centre “Dront”,  
603134 Nizhni Novgorod,  
ul. Kostina, 2, ap.164,  
Russia  
Tel.: 7 (8312) 30-28-81  
E-mail: bat@dront.ru

## 2 Asia

### 2.1 Central Kalimantan (Indonesia)

<b>Project title:</b>	<b>Restoring degraded peatlands in the area of the Mega Rice Project (Central Kalimantan)</b>
<b>Project duration, implemented by:</b>	2002 - 2006 Wetlands International - Indonesia Programme
<b>Location:</b>	2°20' S / 114°30' E Block A of ex - Mega Rice Project (Desa Mentangai, Kabupaten Kapuas)
<b>Peatland type:</b>	Tropical peat swamp forest (severely drained, regularly burning)
<b>Aim of measurement:</b>	Restoration of degraded peatlands due to drainage and fire, by: - blocking canals (restoring groundwater level) - replanting the degraded peatlands along the canal banks with indigenous plant species



**Fig. 24:** The Mega Rice Project in South-Central Kalimantan

### **Background**

The largest peat deposits of the tropics (18.5 million hectares) are located within Indonesia. More than 50 % of it is found in Kalimantan (Rieley & Page 2005). The majority of the Indonesian lowland peat swamps are ombrogenous (bogs) with a maximum thickness of 12 m (Rieley et al. 1997). In the Indonesian deposits peat accumulation started, with rising sea levels about 3500 to 5500 years ago. Sub-coastal and inland peatlands started to develop much earlier, ranging from Late Pleistocene (40,000 years ago) through to the early Holocene (10,000-7000 years ago) (Rieley & Page 2005). Forests and peatlands in Indonesia (especially in Kalimantan and Sumatra) are experiencing constant degradation, mainly caused by: farming activities, irrigation and drainage networks, plantations, illegal logging, and fires. Large amounts of carbon are released by peat and forest fires in Indonesia every year (cf. Page et al. 2002). Smoke and haze are affecting large areas not only within Indonesia but also within Malaysia.

In 1995, the *Mega Rice Project* (MRP - Development of one million hectares of peatland for food crop production in the province of Central Kalimantan) was initiated by presidential decree. New agricultural land was needed to substitute land losses and to replace the import of 2 million tons of rice per year. Especially on Java former rice paddies have been converted to non-agricultural use for urban, commercial and industrial development.

Peatlands in Central Kalimantan were chosen for the realisation of the project, because this area was only sparsely inhabited by indigenous people – an ideal precondition for transmigration. The other idea was to save expenses for the essential irrigation of rice paddies, by using areas that naturally offer enough water.



**Fig. 25:** Major drainage channels of the MRP in Central Kalimantan

Thousands of canals, with a total length of 4.470 km were built from 1995 until 1996 to prepare the area for agricultural use and for the establishment of 22.500 transmigrante households.

500.000 hectares of prime peat swamp forest were cut down and removed to fuel pulp mills. In total, 9.2 km<sup>2</sup> of peat swamps (41 % of the total area of all peat swamps in Central Kalimantan) are severely affected by the MRP.



**Fig. 26:** Transmigrate settlement in Central Kalimantan

The project failed - not a single blade of commercial rice was grown. Today the area of the MRP is in a severely degraded and dangerous condition. The previously water soaked peatland is unable to store water during the rainy season and became dangerously fire prone in the dry season.



**Fig. 27:** Large areas are burning during dry seasons until the beginning of the rainy season

Regularly occurring fires within the area are the largest landscape disaster of recent times! If this situation continues the peatlands within the area, together all their benefits (see above) will disappear.

### **Aim of the project**

The project aimed to restore the hydrology of the forest and peatland ecosystems through blocking the ditches and canals in MRP area.

### Realisation

Within the CCFPI Project “Climate change, forest and peatlands in Indonesia” (from 1992 until 1996) Wetlands International Indonesia was organising a programme to restore parts of the MRP area (block A). This included the blocking of several drainage channels and the replanting of degraded areas with indigenous plant species.

With a budget of 1,810,000 US \$ water losses of the area were reduced by the construction of 45 dams (2002 until 2006). 15 small canals (1-3 m width) and 5 big canals (25–35 m width) have been blocked. With the support of local villagers the dams were largely constructed by the use of easily available material (wood, stones and peat). In some cases additional by plastic sheets were integrated into the dams to guarantee their water tightness (see Fig. 27 and Fig. 45).

Small dams (1-2 m width and 0.75-1.5 m deep) were completed within 2-3 days, if 4-6 people were involved. All together (incl. preparation of material) a small dam costs about Rp 3-5 millions or 330-550 US \$.



**Fig. 28:** Small dams made of wood, plastic and peat (blocking canals of 1 – 3 m width)



**Fig. 29:** Large wooden dam, filled with stones

Large dams (15-30 m wide and 1,5-2 m deep) required 70-90 days with the involvement of 10-16 people and about Rp 150-260 millions or 16,500-28,500 US \$ for completion. A detailed overview about the results of this project can be found in (Suryadiputra et al., 2005).

Local villagers have been encouraged to pre-grow indigenous tree saplings that will later be planted into the restoration areas.



**Fig. 30:** Tree nurseries are developing and offer an alternative income to locals

### Results

Apart from blocking the canals in Mentangai area hydrological changes, carbon fluxes as well as the establishment of the planted seedlings are monitored.

Until 2004 at least 16 fish species (e.g. *Chana sp.*, *Clarias sp.*, *Anabas testidineus* and *Trichogaster sp.*) re-established populations within blocked sections of ditches.

**Table 5:** Number of ditches and canals blocked within the area of the former MRP

No	Villages	Number of canals/ditches	Number of dams
1.	Dusun Muara Puning	3	8
2.	Desa Bintang Kurung	4	12
3.	Desa Batilap (di sungai Bateken/anak sungai Puning)	7	16
4.	Desa Batampang	1	2
5.	Desa Mentangai (Large canals)	5	7
<b>Total canals &amp; dams</b>		<b>20</b>	<b>45</b>

Since 2004 about 11.000 seedlings of 17 indigenous plant species (mainly *Dyera lowii*, *Shorea belangeran*, *Lophopetalum ssp.* and *Metroxylon sagu*) have been planted with by local villagers. Small tree nurseries are developing in great numbers. Some villagers even managed to live of the selling of pre-grow tree saplings. Further information (in Indonesian only) is provided by Wibisono et al. (2005) and Najiyati et al. (2005).



**Fig. 31:** Rewetted area of the former Mega Rice Project

**Contact**

Wetlands International Indonesia Programme  
Attn. Mr. I Nyoman Suryadiputra  
Jl A. Yani No 53  
Bogor 16002, Jawa Barat  
Indonesia

Tel.: +62-251 -312189  
E-mail: [nyoman@wetlands.or.id](mailto:nyoman@wetlands.or.id)

## 2.2 Ruoergai marshes (China)

The Ruoergai marshes in the northeast of the Qinghai-Tibetan Plateau constitute one of the world's largest expanses of high-altitude peatlands (3400 – 3900 m a.s.l.). As the headwater of the Huang (Yellow) River, they are of high importance for the regulation of water storage and supply but also for biodiversity conservation and carbon storage. The area is one of the most important breeding areas for threatened bird species like the black-necked cranes (*Grus nigricollis*).



**Fig. 32:** High altitude peatland

There is urgent need for restoration to counteract their immense erosion and the desertification of their uplands. The roots of degradation on the Tibetan Plateau go back to soil property changes caused by several thousand years of nomadic herding.



**Fig. 33:** Grazing – symbol of the nomadic culture

Deforestation led to the deposition of heavy, clastic sediments in and over the peatlands. Animal tread increased the peat compaction. Finally the formerly prevailing percolation mires changed to surface-flow mires with a reduced hydrological buffering capacity. The increased peak interflow from the less vegetated uplands is no longer able to percolate *through* the peat but has to be transported *over* the peatland's surfaces.

This leads, especially after vegetation damage through intensive grazing, to an increased risk of gully erosion in the peat and in the mineral soils, as well as to catastrophic flood occurrences further downstream.



**Fig. 34:** Heavy erosion causes the development of erosion gullies

The shrinkage of the peat through drainage, the origin of erosion gullies, peat oxidation, and the more recent digging of drainage ditches have lowered the drainage base in the peatland basins, causing a lowering of the groundwater head in the adjacent uplands. Desertification increases as hill slope springs fall dry and drought stresses the upland vegetation. These often irreversible processes caused a whole chain of negative processes and lead to decreased productivity and immense losses of grazing ground by erosion and desertification (cf. Schumann & Joosten 2007). To counteract the rapid devastation of wetlands (incl. peatlands) the Chinese Wetland Action Plan and China's Agenda 21 is focusing on water and energy conservation and proposes to introduce sustainable management practices.

Both of the following projects are part of the UNEP-GEF project "Integrated Management of Peatlands for Biodiversity and Climate Change - The Potential of Managing Peatlands for Carbon Accumulation while protecting Biodiversity". They are also part of the Global Peatland Initiative (GPI) project "Peatland Restoration and Management on the Ruergai Plateau in Western China". For a duration of 5 years a financial support of 150,000 US \$ was available to promote the implementation of selected peatland restoration measures and to provide recommendations on sustainable pasture management.

### 2.2.1 Quqingmake peatland

<b>Project title:</b>	Restoration of Ecology and Vegetation in Quqingmake Peatland near Hongyuan
<b>Project duration:</b>	2004 (still going on)
<b>Location:</b>	32°46' N / 102°30' E / altitude: 3.500 m Ruorgai-Tibetan Plateau (270 km north-west of Chengdu and 3,5 km south-west of Hongyuan)
<b>Peatland type:</b>	Surface-flow mire
<b>Aim of measurement:</b>	Reduce peatland degradation (overgrazing, drainage, erosion) and promote sustainable land use



**Fig. 35:** Location map of Quqingmake peatland (focal area of the project)

#### Background

The Quqingmake peatland is situated close to the city of Hongyuan. It is located within a valley (2 km long and up to 500 m wide). Its surface is sloping with 1° in the lower and up to 6 ° in the upper parts. The water recharge is mainly provided as surface flow from the treeless, grazed surrounding hill slopes. Various springs at the mires margin provide an

additional groundwater supply. Its long history of use by nomadic herders as well as recent drainage and peat cutting activities changed the peatlands hydrology dramatically. The previous percolation mire was changed into a surface flow mire (see chapter 1.3 Peatland types). Water is no longer able to percolate through the peat but forced to flow above its surface, using preferential flow paths in the centre of the mire.

A maximum peat depth of 7 m was determined in the central areas of the mire. The vegetation cover is dominated by sedges like *Carex* spp. and *Kobresia* spp.



**Fig. 36:** View of Quqingmake peatland

The area of the peatland has been grazed by yak and sheep for hundreds of years. In its northern part the Chinese population of Hongyuan was cutting peat by hand for private use (heating and cooking) and as fuel in a brick factory. The cutting of peat, which was not carried out according to any plan, has resulted in serious environmental degradation. The unplanned peat extraction was stopped by the local authorities in 1991 but had to be allowed to meet the fuel demands of the citizens of Hongyuan Town.



**Fig. 37:** Former peat cutting site (unplanned extraction led to heavy degradation)

During the 1980s the Chinese government identified peat as a suitable source for energy production and planned its extraction for the operation of a yak-milk powder factory in Hongyuan. For this reason a cooperative project between the Sichuan Institute of Natural Resources and the University of Lund (Sweden) was realizing a technical feasibility study of peat mining in Hongyuan from 1989 until 1993. The study advised against an industrial peat mining, because of the low quality of the peat for energy production (high ash content). Since that time the site was left open due to heavy erosion.

The Hongyuan Government decided to allocate the area of the previous peat extraction site to the Forestry Bureau of Hongyuan County in 2003. A plan for the restoration of the ecology and vegetation of Quqingmake was developed by the local forestry bureau.

### **Aim of the project**

The aim of the project is to reduce peat mineralization and to stop the heavy erosion. To rewet the dried out peat surface, water losses should be reduced by the blocking of drainage ditches. To create a productive vegetation cover, resistant to grazing and trampling, adequate species were seeded.

### **Realisation**

The area of the former mining site was given into custodianship of the Forestry Bureau, by the local government for a trial period of at least five years. If the restoration measures are successful an extension of the custodianship will be possible. In May 2004 the actual implementation of the restoration plan started. 2000 m of wire netted fence with metal poles have been erected to control the intensity of grazing on the site.

In July 2004 an international workshop on peatland conservation, restoration and sustainable use was organized to bring numerous participants from international organizations, government agencies, universities and enterprises together with local stakeholders at the site to stimulate the exchange of information and experience and to discuss the sites potential for different restoration objectives and procedures.

During the second phase of the project, the surface of the peat cutting area was levelled. This was mainly done by hand, because the area was inaccessible for machinery. The resulting bare peat surface was seeded with grass. The actual rewetting of the peatlands surface was tried to attain by the construction of a large concrete dam and by the blocking of channels by small dams - using plastic bags, filled with peat, or stones.

**Table 6:** Timetable and expenditures of restoration measures in Quqingmake Peatland

<b>Project phase</b>	<b>Needed time</b>	<b>Arisen costs</b>
<i>Purchase of land:</i>	6 months	—
<i>Preparation and planning:</i>	5 months	700 US \$
<i>Advertisement for the practical work:</i>	1 months	1,000 US \$
<i>Execution:</i>	1 month	7,300 US \$
<b><i>Time and costs in total:</i></b>	<b>13 months</b>	<b>9,000 US \$</b>

## Results

The Quqingmake peatland serves as a good example for the restoration of high altitude mountain peatlands:

- Its steep slope makes a standard rewetting, by the installation of single dams within drainage channels, difficult because water is leaving the site at high speed causing heavy erosion.

*Until now only small parts of Quqingmake peatland are rewetted, as it was not possible to erect enough dams in drainage or erosion channels to back enough water up until the next (upstream) dams are reached.*



**Fig. 38:** Dam made of plastic bags, filled with peat



**Fig. 39:** Dam is backing up water

*No device for the controlled overflow of water has been established. Surplus water is running around the sides of the dams and causes erosion that leads to the dam failure.*

- The areas climate, with heavy rainfall after long periods of draught, leads to difficulties for the restoration of the site. Enough water has to be accumulated within the site, to enable a durable rewetting which may outlast the dry season.

*To retard water from leaving the main peat cutting site, a concrete dam of several meters height and width was erected. It's backing up large amounts of water and creates an artificial pool of several meters depth. These conditions are inappropriate for the reestablishment of peat formation. The dam is a potential risk for the downstream area as it is sinking into the peat, because of its heavy weight. It is unstable and faces collapsing.*

- Only species that are adapted to the harsh climatic conditions on the plateau (very short vegetation period, strong and long lasting periods of frost, heavy, erosion causing rain events) are useful for the revegetation of bare peat surfaces on high altitudes.

*Local grass species (Carex ssp. and Kobresia ssp.) were collected to seed the bare peat surface. The seeding happened at the end of spring, after the period with regularly appearing heavy rain events to enable the seeds to root before being washed away. Because the area was fenced and cattle was kept out the bare peat was recovered by vegetation within only one year.*

- The whole area is grazed by yak and sheep. It is hardly ever possible to keep the cattle out of the restoration site unless regular fence control can be provided.

*During the first year the cattle was kept off the site by a fence. Since that time the whole fence has been stolen twice and broken several times. Herders were able to drive their cattle into the fenced area. By that time the freshly seeded grass did not have enough time to establish a root system that was stable enough to keep up the grazing and trampling of the yaks. Within days great parts of the grass cover was destroyed.*



**Fig. 40:** Rewetted peat cuttings (after surface levelling)

*Positive effects of rewetting and revegetation were achieved only in small parts of the former peat cutting site yet. More funding would be necessary to construct an adequate number of dams to reach a rewetting of bigger parts and to spread the water flow across the whole area. The long term success of the project will depend on the grazing regime of the area. Therefore the adequate grazing capacity of the site has to be identified and controlled.*

→ A monitoring plan has been developed that enables the long term evaluation of the rewetting and the revegetation measures at 10 sample sites. Information of water level, soil conditions, vegetation coverage and species composition are gathered and collected regularly by Hongyuan Forestry Bureau and by the Institute of Biology (Chinese Academy of Science, Chengdu).

**Contact**

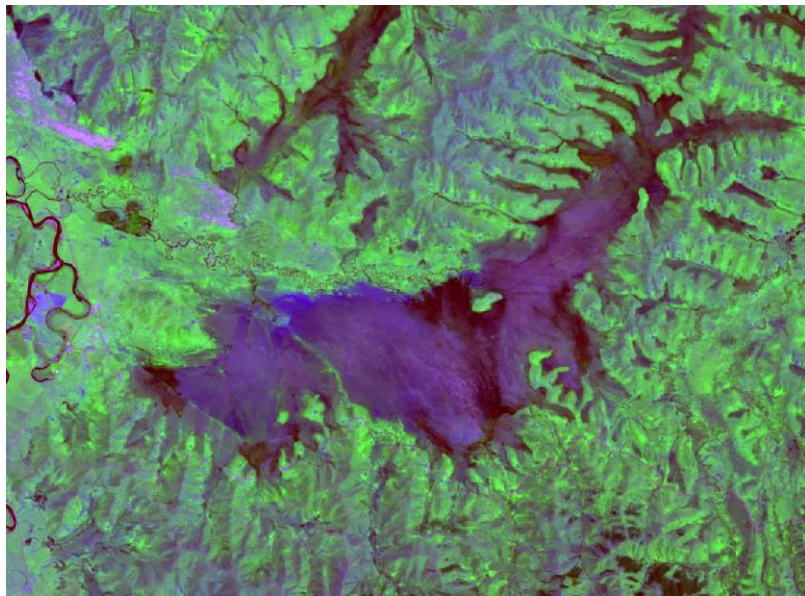
Ms. Zhang Xiaohong; Mr. Lu Yong  
Wetlands International-China  
Room 501, No3A Beisanhuan Zhonglu Road  
Beijing, China 100029

Tel: +86 10 62058405/8418

E-mail: [zxh@wetwonder.org](mailto:zxh@wetwonder.org); [ly@wetwonder.org](mailto:ly@wetwonder.org)

### 2.2.2 Rigangiao peatland

<b>Project title:</b>	<b>Peatland restoration in Rigangiao (Waqie)</b>
<b>Project duration:</b>	2003 (still going on)
<b>Location:</b>	33° 7' N / 102°44' E / altitude: 3,500 m Length: 6 km; Ruergai-Tibetan Plateau (310 km north-west of Chengdu and 42 km north -east of Hongyuan)
<b>Peatland type:</b>	Surface flow mire
<b>Aim of measurement:</b>	Reduce peatland degradation (overgrazing, drainage) Promote sustainable use



**Fig. 41:** Rigangiao peatland



**Fig. 42:** View onto the large Rigangiao peatland

### Background

The Rigangiao peatland is situated in the Wa Qie basin. It is a large mire with an area of about 100 km<sup>2</sup>. Its stratigraphy shows an irregular change of peat and silt layers. Because of the peat's large ash content, which makes the peat unsuitable for burning, no major peat extraction took place within the area. To improve the area for grazing and to create arable land, numerous canals were dug during the 1970s. The lowering of the water table by 1-2 m and the intensive grazing regime caused significant degradation.



**Fig. 43:** Heavy over grazing leads to the increase of non fodder plants

Several years ago these ditches were abandoned but continued to drain water off the site. Too many animals turned great parts of the mire into “black deserts” of bare peat, which is prone to heavy erosion. The species composition changed – non fodder species were increasing. Local Tibetan herdsmen have get drinking water from several kilometres away because the previously water soaked wet mire turned into a dry, degraded pasture!

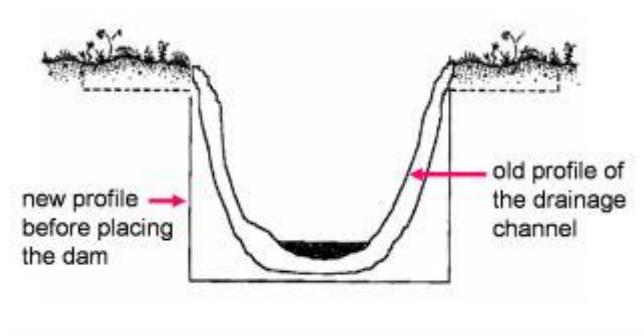
### Aim of the project

The aim of the project is to reduce the water losses in drainage channels to raise the water level within the site and to support the natural revegetation by the control of the grazing intensities.

### Realisation

**Table 7:** Timetable and expenditure of the restoration of Waqie peatland (Riganqiao)

Project phase	Needed time	Arisen costs
<i>Preparation and planning:</i>	3 months	—
<i>Execution:</i>	1 month	10,000 US \$
<b><i>Time and costs in total:</i></b>	<b>4 months</b>	<b>10,000 US \$</b>



**Fig. 44:** Preparation of the ditch (changed after Brooks and Stoneman, 1997a)

In May 2003, Hongyuan County Forestry Bureau started to block several drainage channels by small dams of plastic bags, filled with sand, and wooden plank dams (see Fig. 44). Before they were erected the construction site was prepared by cleaning the ditch and providing a proper shaped profile (see Fig. 43).



**Fig. 45:** Wooden plank dam

### Results

The rewetting of Rigangiao peatland was successful. From 2003 until 2006 the mean water level was raised by 4-7 cm. On the main part of the restoration site the water level is about 2 cm below the surface, even during the dry season (October and November). Some parts of the site are even shallow inundated (covered by water during the whole year).

Both the constructions of dams made of plastic bags and of wooden planks did show positive results in backing up water in drainage ditches. Because plank dams are more stable (better to anchor within the sides of the ditch) they seem to be more suitable for those conditions. But it has to be considered that the construction of solid plank dams is very labour-intensive and that every kind of wood is highly demanded as construction material and as fuel and therefore often dismantled by local people. Long term monitoring will be necessary to investigate the durability of untreated wood, especially at the air/water interface.

This will be done during the following years. A monitoring plan has been set up to regularly measure water levels in stationary PVC pipes and to document changes in vegetation composition at fixed spots.



**Fig. 46:** Successful rewetting by a small dam made of plastic bags, filled with sand

The success of rewetting on the site is clearly indicated by the spreading of hygrophyte species. Already in summer 2005 large areas were covered by typical wetland species like *Equisetum ssp.*, *Eriophorum ssp.* and *Menyanthes ssp.* (see Fig. 46). The latter are typical peat forming species.

Altogether the total number of plant and animal species (especially water birds) is increasing.



**Fig. 47:** Positive results of rewetting, large swampy areas with typical vegetation

There are also positive effects of reduced grazing intensities within the restoration site. Figure 64 clearly shows the difference of strongly grazed areas and areas, where the grazing is reduced.



**Fig. 48:** Different of grazing regimes (front: reduced grazing, back: over-grazing)

It is obvious that the project is much more successful than the restoration of the Quqingmake peatland, near Hongyuan (see above). This might be due to the fact that Rigangiao peatland is not sloping as much as Quqingmake peatland, and therefore not prone to heavy erosion.

**Contact:**

Mr. Chen Kelin  
Wetlands International-China  
Room 501, No3A Beisanhuan Zhonglu Road  
Beijing, China 100029

Tel: +86 10 62377031  
E-mail: [ckl@wetwonder.org](mailto:ckl@wetwonder.org)