Water Quality Restoration Using Dams in Bog-Mire

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1. Introduction

The importance of water quality for the ecosystem in wetland is unquestionable. It plays important roles in the diversity of wetland community. This phenomenon is much more pronounced in the bog mire, the rain-fed peat-covered wetland. Local species thrive under acidic, nutrient-poor conditions and are highly sensitive to any changes to the chemical conditions at the mire surface. In Sarobetsu Mire, this change leads to an invasion of a non-native species, Sasa spp., against its natural flora, Sphagnum spp. An effort to restore the water quality to its natural condition hence becomes important in term of plant diversity conservation. This effort is usually made simultaneously with re-establishing the hydrological regime as a whole.

Based on an evaluation and observation of experimental and implemented water management schemes, Wheeler and Shaw (1995) proposed eight possible approaches in re-establishing site hydrology; one of them is inundation using dams. This study attempted to implement the idea to increase the water level by damming the outflow water track hence holding the water within the mire. The effectiveness of damming on restoring water quality was studied. We used the data of points E (natural condition), WW and NC (disturbed points) from previous research as comparable stands.

2. Site description and methods

The study site is located in northern Hokkaido. The mire consists of both bog and fen and measures 23,000 hectares. The thickness of the peat layer ranges from 5 to 7 meters, and the surface elevation is mostly less than 10 meters above sea level. The height of the central mire area is about 6 m a.s.l. and is slightly sloped toward the banks of Sarobetsu River. The ground height at the dam site is around 2.9 m a.s.l. We built one dam and then another 7 meters downstream in November 2000, to hold water in the natural channel. We established a sampling point at both dams and at the backside of the downstream dam. The water levels at these two dams are monitored by water level loggers.

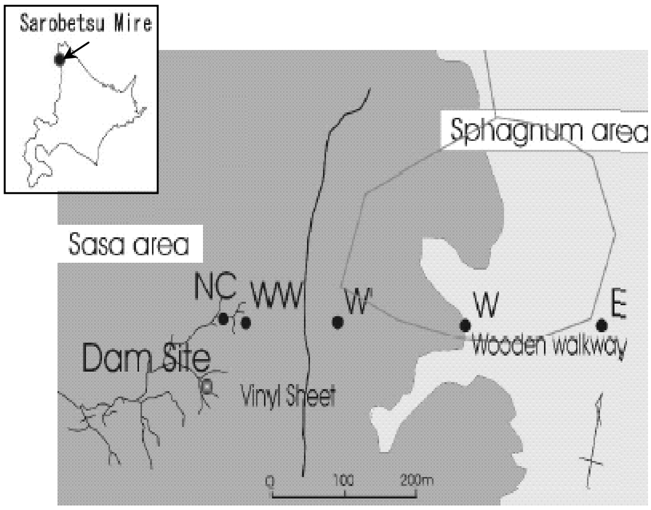

Fig. 1. Study Area

Samples were collected at a monthly interval during May – October 2001. The chemical analyses were conducted according to The Hokkaido Branch of Japan Society of Analytical Chemistry (2000) after filtration with 0.45-μm filter. The variables studied were nitrogen, phosphorus, silicate, and main inorganic ions, using ion chromatography. The study on vegetation was carried out at each point during April – November 2001.

3. Result and discussion

The dam started to show its effect after September 2001. The groundwater level at the upstream dam became higher and the groundwater level at downstream dam became lower. During July 2001 to July 2002, the water level at the upstream point increased up to 20 cm high. Conversely, during the same time, the water level at the downstream point decreased by around 20

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cm. This fact shows that the dam succeeded to hold the water in the natural channel. We were led to think that the increased volume of water came from rainwater, because the rise in water level only occurred at the upstream point. We may also conclude that the distance for these two dams is too close, because the downstream point could not gain much rainwater.

A previous research on Sarobetsu Mire showed that the sphagnum area, represented by point E, still has the characteristics of bog mire. On a contrary, the water quality in the sasa area, points WW and NC, already changed with high pH and EC values, and high mineral and nutrient contents. The effect of the dams in restoring water quality is obvious. Almost in all aspects, the water quality has restored to its natural conditions, i.e. low pH and EC values, and low mineral and nutrient contents. This fact is reasonable, since the bog mire water comes from rainwater; its characteristics are similar to those of rainwater. The piper diagram also shows the similarity between rain water and the water from point E and both dams. All those waters are in the fourth column of the diagram. The rainwater usually contains high ratio of chloride and high sodium ions because it originated from sea water.

Table 1. Chemical properties of water at dam site compared with those at stands E, WW and NC.

Points			MIRE			DAM	
		E	WW	NC	up	down	back
n		42	41	41	6	6	2
pH		4.5	4.8	6.0	4.3	4.4	4.4
EC	µS/cm	70.1	85.0	230.7	68.4	67.0	56.7
4.3Bx	meq/l	0.049	0.330	1.734	0.029	0.018	0.010
DN	mg/L	1.0	3.1	3.3	1.4	1.6	1.6
DIN	mg/L	0.4	2.4	2.6	0.0	0.1	0.1
DON	mg/L	0.6	0.7	0.7	1.4	1.5	1.5
DP	mg/L	0.005	0.009	0.066	0.010	0.014	0.035
DRP	mg/L	0.002	0.006	0.041	0.001	0.000	0.003
DOP	mg/L	0.003	0.004	0.025	0.009	0.014	0.032
Na^+	mg/L	11.7	12.5	25.8	7.5	7.5	7.3
K^+	mg/L	1.0	1.4	3.6	0.3	1.0	1.1
Ca^{2+}	mg/L	1.4	1.8	5.8	0.9	1.0	0.8
Mg^{2+}	mg/L	2.0	1.9	9.4	1.6	1.6	1.6
Cl^-	mg/L	15.6	16.5	18.6	11.8	12.5	11.3
SO_4^{2-}	mg/L	2.4	2.4	3.5	0.4	0.3	0.3
SiO_2	mg/L	7.3	19.3	26.5	1.1	1.3	1.5
TOC	mg/L	23.2	29.2	12.4	15.5	24.1	36.7

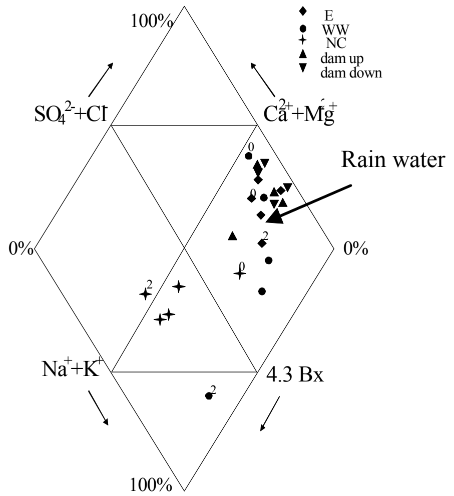

Fig. 2. Piper diagram. The values in the diagram show the depth of sampling points from the surface.

In terms of nutrient form, the dams also gave a satisfactory result. Previous research showed that at point E, nitrogen and phosphorus exist mainly in organic forms. There is less inorganic nutrient available to promote sasa growth, thus, hindering sasa invasion. In contrast, point NC is high in inorganic nitrogen and reactive phosphorus indicating that mineralization by organisms has already occurred. This study showed a similarity between water at the dam site and that at point E, where nitrogen and phosphorus still exist mostly in organic form. That means that mineralization by microorganisms was hindered.

The above results on water quality restoration, so far, are the data of surface water only. Further findings in this site for depth below 1 meter show that the groundwater characteristics are not altered; it doesn't show the criteria of ombrotrophic mire yet. It may be caused by the mineral layer that already stacked at this depth, which prevent the deeper penetration of rain water. However, the plants re-establishment seems to be only depends on the surface water. The vegetation inspection showed that some natural plants are already re-established at upstream and downstream points. It also can be seen that those three areas show different plant species composition that may be owing to different hydrological regimes. Unfortunately, we can not derive the tendencies for plant succession, as data on the state of the vegetation before the dam installation is not available.

References

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