CONTROLLING SASA INVASION FOR MIRE CONSERVATION IN SAROBETSU MIRE

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1. Introduction

The shrinking of high-moor bogs around the world has become an important problem, because these areas are ecologically valuable but very vulnerable to external impact.

Sarobetsu Mire, a mire of fen and bog in northern Hokkaido, is a case in point. Its ecosystem is gradually losing its natural state because of destruction by human perturbations, such as drainage, changes in waterways, and the development of agricultural land and tourist resorts. These artificial activities have caused the water level to decrease, which threatens to change the entire mire ecosystem. As a consequence, a new non-native fauna, *Sasa sp.*, is growing rapidly and invading areas of natural species.

Previous studies in Sarobetsu Mire have investigated the main causes of the changes in the natural vegetation (from sphagnum to sasa). These studies have identified the factors contributing to sasa growth as the decrease in groundwater level, mineralization by increased microbial activity promoted by soil dryness, the inflow of water from another water system and the mixing of mineral soil (Tachibana et al., 1999).

For this study, we built small dams to prevent excessive water flow in the natural channel and to preserve rainwater. We studied how the dams affected the water quality by retaining rainwater and increasing the water level. We compared the data from the dam site with data that had been collected continuously during the past 5 years. We also studied the effect of water quality restoration at the dam site on the growth of Sasa. It was found possible to use the growth rate of invading sasa as a variable for Mire Management and Conservation. Ecological conservation in this study was considered to be the maintenance of natural mire conditions toward supporting the continued existence of native plant species.

2. Site description and methods

2.1. Study site

Sarobetsu Mire is 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 mire contains relatively large amounts of mineral matter, as a result of river flooding and the presence of volcanic ash (tephra). Part of the area has become grassland, and another part (the study area) has been conserved in its natural state as a national park.

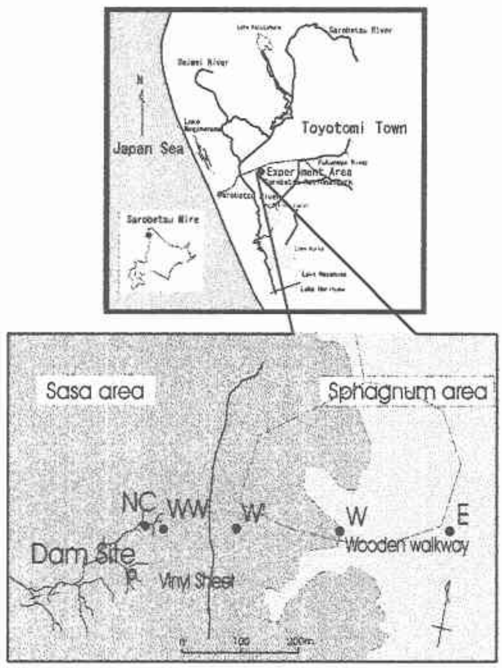

Fig. 1. Location of the study site and sampling points, including 5 previously established points. Point E and point NC were chosen as stands representative of having unchanged and degraded water quality, respectively.

The mire landscape varies by season according to what communities are dominant. In the early summer, the yellow of Ezokanzo blossoms dominates, and Tachigiboshi, sphagnum and bearberry give special views at other times. In the recent years, these communities have been invaded by *Sasa* sp., the Japanese dwarf bamboo.

2.2. Sampling points

The investigation was performed in Sarobetsu National Park. We built one dam and then another 5 meters downstream of it, to hold water in the natural channel. We established a sampling point at each of the dam, those are upstream and downstream point.

The installation of dam for the purpose of sasa elimination was tentatively conducted in 1984. But

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after three years, in 1987, the water storage examination of the dam was stopped (Environmental Conservation Bureau, 1993).

2.3. Groundwater level measurement

We installed a water logger at each sampling point to monitor the change of water level on an hourly basis. We calculated the average value and standard deviation to show the fluctuation of the groundwater level.

2.4. Water analysis

Samples were collected at monthly intervals during May - August 2001. Physical variables were measured in the field and all the chemical analysis were conducted in the laboratory according to Water Analysis (Japan Society of Analytical Chemistry, 1994) after filtration with 0.45-μm filter. The variables studied were nitrogen, phosphate, silicate, and main inorganic ions, using ion chromatography.

2.5. Sasa growth measurement

We measured the effect of the dam on the growth of sasa close to the upstream point, near the downstream point, and at the middle of these two sampling points. We measured the leaves area, the stalk height, and the number of sasa plants per 10 cm^2.

3. Results and Discussion

3.1. General condition of the water quality

Table 1 compares the recent data from this study with the average water quality during the past 5 years of two extreme stands in terms of water quality. Point E in Fig 1. represents Sphagnum area with unchanged mire water quality, and point NC represents Sasa area with degraded water quality (see Fig. 1).

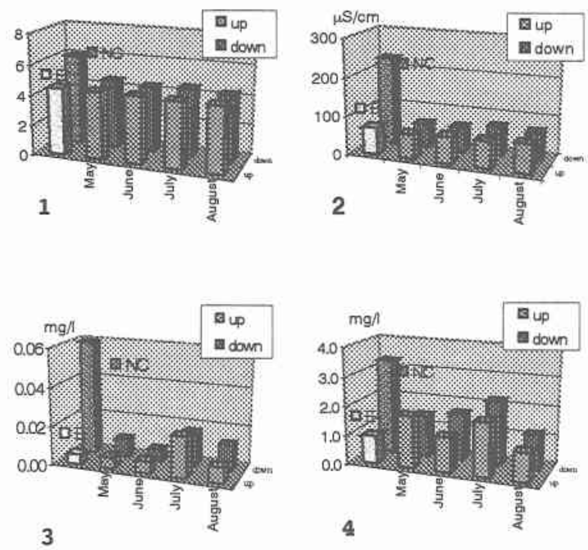
Point NC is almost neutral in pH, i.e., it no longer shows the characteristics of wetland. Water at that point also has high electrical conductivity, which correlates with high concentration of minerals and high content of nutrients, nitrogen and phosphorus. The irregularity of point NC is attributed to outside effects on that point (Tachibana et al., 1999). The natural channel in Sarobetsu Mire seemed to flow to Sarobetsu River in the past, but the human perturbations around this area might change the natural ecosystem. Because of the construction of drainage, the groundwater level has declined, enabling inflow from surrounding areas. This inflow may be transporting soil and sediment that contain high concentrations of minerals, and it may be this that is causing such change of water quality. The decline of water level may also be causing the drying of the mire, and also may be increasing the nutrient concentration, which would lead to further changes in groundwater quality.

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

Points		E	NC	May		June		July		August	
		(n=42)	(n=30)	up	down	up	down	up	down	up	down
pH		4.5	6.0	4.5	4.6	4.4	4.4	4.4	4.5	4.3	4.3
EC	μS/cm	70.1	230.7	63.5	61.1	68.7	63.0	70.1	74.3	74.1	69.8
DN	mg/L	0.98	3.31	1.80	1.46	1.22	1.66	1.85	2.19	1.00	1.18
NH_4^+-N	mg/L	0.23	2.12	0.11	0.00	0.00	0.00	0.01	0.01	0.01	0.00
NO_2^--N	mg/L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NO_3^--N	mg/L	0.18	0.51	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
DIN	mg/L	0.41	2.64	0.12	0.01	0.01	0.01	0.02	0.02	0.02	0.01
DON	mg/L	0.57	0.68	1.69	1.45	1.21	1.65	1.83	2.17	0.98	1.17
TP	mg/L	0.013	0.519	0.080	0.037	0.248	0.073	-	0.134	-	0.070
DP	mg/L	0.005	0.060	0.006	0.009	0.006	0.006	0.021	0.017	0.008	0.013
DRP	mg/L	0.003	0.034	0.001	0.000	0.002	0.001	0.003	0.001	0.002	0.000
DOP	mg/L	0.002	0.026	0.005	0.009	0.005	0.005	0.018	0.016	0.006	0.013
Na^+	mg/L	11.7	25.8	7.9	7.6	7.9	7.6	7.5	7.7	7.1	7.1
K^+	mg/L	1.0	3.6	0.4	0.9	0.2	0.5	0.4	1.9	0.2	0.4
Ca^{2+}	mg/L	1.4	5.8	1.0	1.3	0.8	0.8	1.2	1.0	0.9	0.8
Mg^{2+}	mg/L	2.0	9.4	1.6	1.6	1.4	1.5	1.6	1.6	2.1	1.6
Cl^-	mg/L	15.6	18.6	13.3	14.2	12.5	12.9	11.6	12.5	11.0	10.9
SO_4^{2-}	mg/L	2.4	3.5	0.7	0.5	0.4	0.3	0.5	0.3	0.3	0.2
SiO_2	mg/L	7.3	26.5	1.9	1.8	0.4	-	1.9	1.8	0.3	0.0

In contrast, water at the dam site (both upstream and downstream) still showed wetland characteristics, with low pH and low nutrient content, even though the dams are near point NC and have physical conditions similar to those at point NC. The silicate concentration also is low, and is unaffected by the growth of sasa in this area. It seemed that in almost every aspect, the dam succeeded in restoring the water quality to its previously undisturbed condition. As shown from the study area in Figure 2, the dam site closely correlate with point NC, both of which points are natural channel. After dam construction, however, this stand showed great differences from point NC.

The water at the dam site shows characteristics similar to rainwater. Previous studies by Tachibana et al. (1996) showed that groundwater of high-moor bog region where Sphagnum sp. are dominant is increased only by the addition of rainwater.



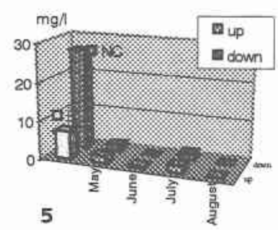
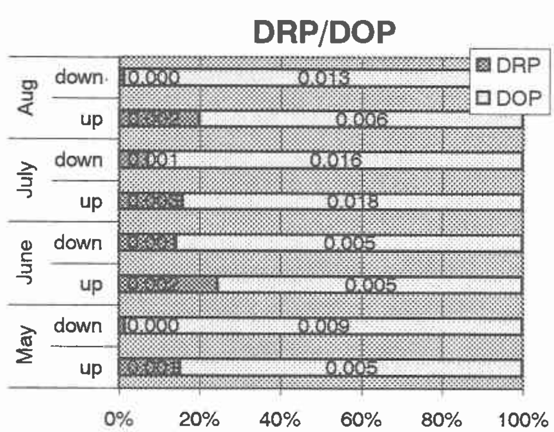


Figure 2.
Distribution of water quality, with points E and NC as comparative values
1. pH
2. elec. conductivity
3. dissolved phosphate
4. dissolved nitrogen
5. silicate

3.2. Nutrient form

Previous research showed that at point E nitrogen and phosphorus exist mainly in organic form. There is less inorganic nutrient available to promote sasa growth than at other stands. In contrast, point NC is high in inorganic nitrogen and reacted phosphor (Tachibana, 1994). This means that mineralization by organisms has already occurred, which is a state that promotes sasa growth.



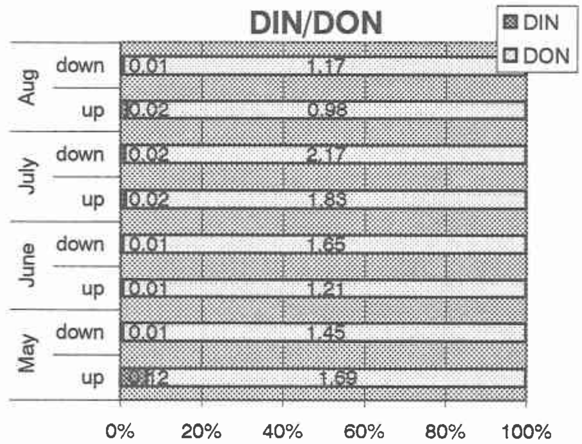


Fig. 3. Comparison of nutrient form between inorganic and organic nitrogen and between reacted and organic phosphate. The values at the bar represent the concentration of each parameter in mg/l.

Our study showed a similarity between water at the dam site and that at point E, regarding nitrogen and phosphorus: These components still existed mostly in organic form. This result, which already reported by Nakagawa et al. (2001), also shows the success of the dam in restoring the water quality of the mire, because it demonstrates that mineralization by microorganisms was hindered.

3.3. Groundwater level

Groundwater level was relatively stable after April, with the difference between high and low water within 0.2 cm. The high water level in early April may have been caused by snow melting.

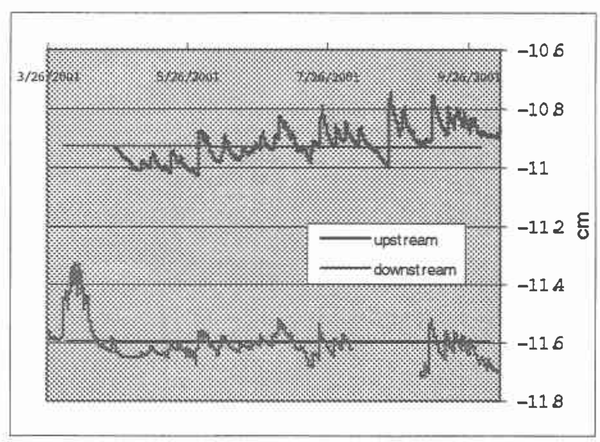


Fig. 4. Groundwater level fluctuations at the dam site. The value shows the water depth from surface. Average water level of upstream and downstream point and standard deviation of each point are -10.916, -11.603, 0.0573 and 0.0617 respectively.

As reported by Inoue et al. (1992), the fluctuation of water level at point E (undisturbed stand) was smaller than at the changed stand. At point WW, which considered as disturbed stand, almost equal with point NC, the difference between high and low water level reached up to 100 cm during August - September, but was less than 20 cm at point E.

The retention of rainwater by the dam and the relatively constant water level seemed to be factors in hindering mineralization at the dam site. The data on nutrient form showed the effect of high water level at this point. Deeper underwater, the relative scarcity of oxygen tends to inhibit the activity of microorganisms, meaning that nutrients remain in their organic state.

3. 4. Sasa growth

The effect of the dam on sasa growth is shown in figure 5. The growth of sasa seems to be influenced by dam installation. Even it does not extremely decreased, because biological effects may take longer time to show, but we can notice that the raise of water level, which lead to prevent mineralization by organisms, have good effect to minimize sasa growth.

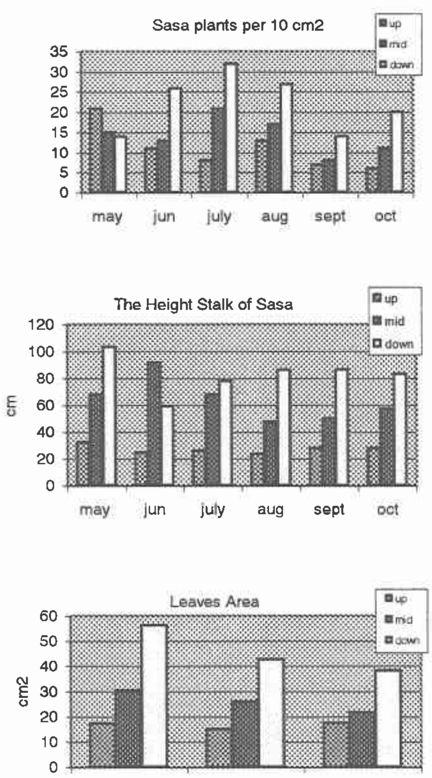


Figure 5. The dam effect on Sasa growth.

4. Conclusions

Human perturbations have changed the natural ecosystem of Sarobetsu Mire. This phenomenon started with the decline of groundwater level, which was followed by soil drying in the mire and increased nutrient concentration caused by mineralization resulting from microorganism activity in shallow water. Later, the change in groundwater quality is also influenced by inflow from outside of the mire, which is thought to cause migration of soil and sediment that contain high concentrations of nutrients and minerals.

The small dam installed in the natural channel successfully hindered mineralization. The high water level may also prevent inflow from outside the mire and soil migration, as happened at the other natural channel (point NC). The decrease in sasa growth around the dam also showed the dam's effect.

These results suggest ideas for future research on the management of wetland ecology. Mire conservation can start from retaining rainwater that is similar in characteristics to the water of natural wetlands, such as in having low pH and low mineral content. Retention of this rainwater keeps the water level in the natural channel high, which in turn prevents inflow from outside and soil migration, and hinders mineralization.

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