Permafrost distribution controls dFe concentrations in rivers, Russian Far East

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The Sea of Okhotsk is known as one of the world's richest marine ecosystems. This is because large amount of iron, an essential nutrient for the growth of phytoplankton, flows out of the wetlands in the Amur River basin and supports to high primary productivity in the Sea of Okhotsk (Amur Okhotsk Project 2005-2009). Interestingly, long-term observations of dissolved iron concentrations in the Amur River showed very high concentrations in the late 1990s which could not be explained by changes in wetland area. As this possible cause, Shamov et al., (2014) pointed out that the relatively higher temperature than usual in the 1990s may have caused deeper permafrost thawing and created reducing conditions in active layer, resulting to large amount of dissolved iron production. However, little research has been conducted on the generation of dissolved iron in active layer in the permafrost zone and on the runoff mechanism from soil to rivers. Therefore, we have been conducting the continuous investigation in the Tyrma River basin, where is equivalent to sporadic permafrost area, to clarify dissolved iron behavior from the soil to the river.

Our previous studies have shown that permafrost in the Tyrma exists under a wetland called `` Mari, " which is seen in gentle slope valleys (from riverside forests to slopes), and dissolved iron production occurred from August to September. In contrast, dissolved iron production was not seen in areas where permafrost does not exist. This suggests that the peat soils in the valley where permafrost exists plays an important role in the production of dissolved iron and its outflow to rivers.

In the present study, we attempted to clarify the correlation between the dissolved iron concentration in rivers and the permafrost distribution in river catchment by visualizing the permafrost distribution using satellite data. Visualization of the permafrost distribution in the Tyrma region was performed using QGIS. The method will be briefly described here. First, using the Landsat-8 satellite data, a normalized difference vegetation index (NDVI), a normalized difference soil index (NDSI), and a normalized difference water index (NDWI) were calculated. Then, these values were summarized for vegetation landscape types of wetland, forest, and grassland. As a result, these vegetations can be distinguished under the conditions of NDVI and NDSI. Based on these two values, the distribution of wetland “Mari” in the whole Tyrma region was extracted (Fig. 1 red area). Given that the results of our previous studies, the red area of Fig. 1 should be consistent with the permafrost distribution.

Moreover, we calculated these areas of permafrost in each catchment area of 24 rivers of various sizes (basin area 4.6 to 2847 km2) collected in 2019. The permafrost area / catchment area ratio and dissolved iron concentrations in the rivers showed a clear positive correlation (Fig. 2). This result indicates that the permafrost distribution created using GIS is highly reliable, and that the permafrost distribution is very effective to explain the variation in dissolved iron concentrations in the rivers. Until now, the correlation between the permafrost distribution and dissolved iron concentration has been discussed mainly by the wide differences depending on latitude (sporadic, discontinuous, and continuous permafrost area). Therefore, this is the first time to discover the correlation between the permafrost distributions and dissolved iron concentrations directly in the same region. Given that the predicted climate change, dissolved iron concentrations in river where the permafrost widely exists would be change due to deeper

permafrost thawing.

Keywords: Permafrost, Remote sensing, Dissolve Iron, Wetland

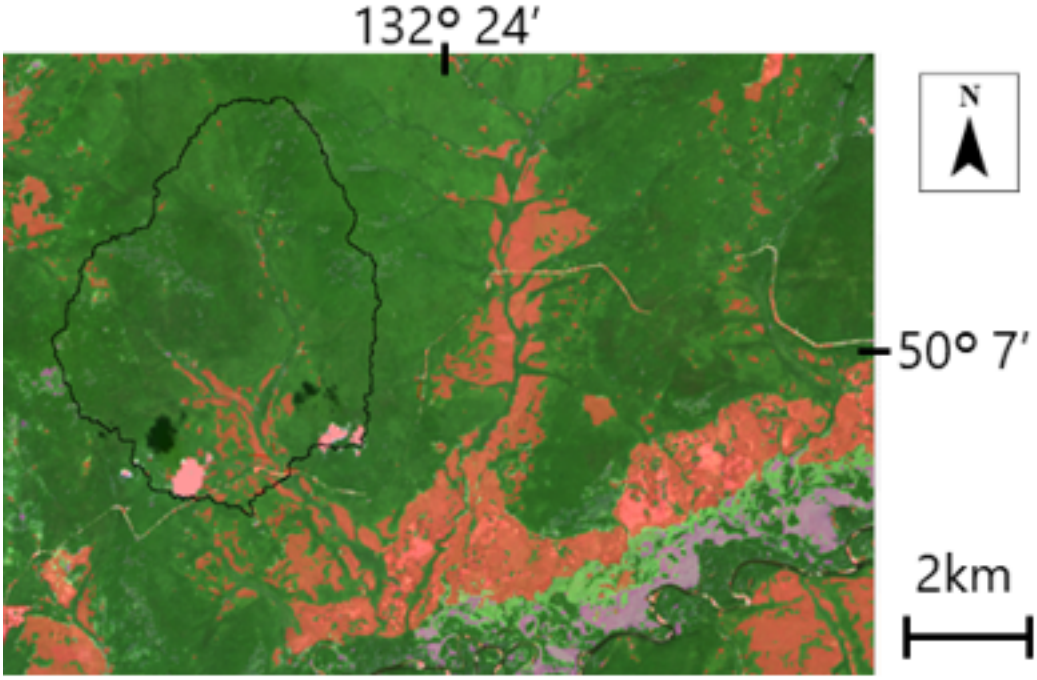

Fig.1 Permafrost distribution (Red area)

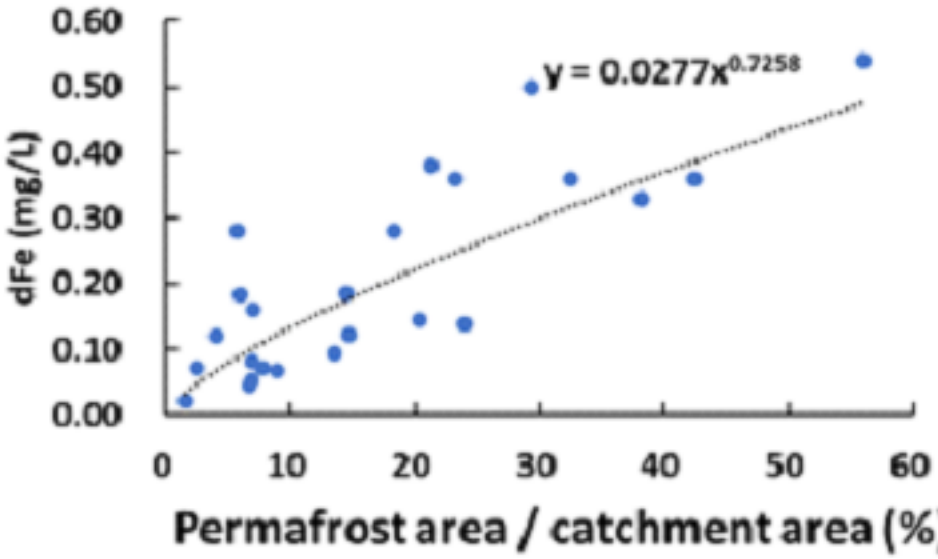

Fig.2 Positive correlation between permafrost arae / catchment area and dissolved iron concentration in each river

