Relationship between topographical characteristics in catchment area and dissolved iron concentration of river in permafrost area

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[Background]
Dissolved iron flowing out from the wetlands in the Amur River basin is an important nutrient that supports the primary production of phytoplankton in the Sea of Okhotsuk. Therefore, the amount of iron supplied to the sea is supposed to change due to the increase and/or decrease of the wetland area within the Amur basin. However, in the longterm observation of the dissolved iron concentration in the Amur River, the considerably high concentration, which can not be explained by the land-use change of the wetland, was observed in the latter of the 1990s. In the 1990s, because the relatively higher temperature had been continued, Shamov et al.,2014 speculated that permafrost thawing might be caution. Therefore, we hypothesized that permafrost thawing might promote the forming of humid and reductive condition which was suited to dFe generation in active layer, and have been conducting research on the mechanism of dissolved iron production and the distribution of permafrost. It has become clear that permafrost exists under the vegetation called Mari. Mari is the wetland which is covered by hygrophyte and sphagnum in a valley, and thick peat soil is accumulated underground.On the other hand, forest areas where birch or larch are densely spread with thin peat layers on the slope and ridge. Thus, the topographical features such as valley, slope and ridge in the catchment area dominate the vegetation and soil properties, and the dissolved iron cycling. In this study, we focused on the area of the valley as a topographical feature within the catchment area, and researched with the aim to discover the relationship to dissolved iron concentration in the river.
[Materials and Methods]
The research was conducted in the Tyrma River basin, which is a further tributary of the Tributary of the Amur River, in Khabarovsk. This area corresponds to the sporadic permafrost zone. In September 2018, we collected the water from 12 rivers in total; 5 rivers flowing into the Tyrma River and 5 rivers flowing into the Gujar river which is a tributary of the Tyrma River (basin area 7 to 200 km2). After sampling the water, immediately filtration was carried out with a disposable 0.45 μm filter and stored in polyethylene containers. Dissolved iron concentration was measured by the phenanthroline method after adding a few drops of HNO3- to the sample water to adjust pH <2.
We extracted the valley area using GIS soft "QGIS". The altitude data of field site, a global numerical surface model (DSM) corresponding to a resolution of 30 m by a panchromatic stereoscopic sensor (PRISM) equipped with JAXA 's Land Observing Satellite "ALOS" was used. The catchment area on the upstream side from the sampling point of each river was extracted and the Topographic Position Index (TPI) and the inclination (degree) were calculated. Next, the cells with TPI <0 - [standard deviation of TPI ×1/2] and inclination <3 (degree) were judged as a valley and these areas were calculated. The radius(R) of TPI was set to R = 500 m or R = 1000 m according to the valley width of the river. The reason why the condition of inclination <3 (degree) was added was that if only the condition of TPI was included, even the lower part of the slope was included, so that the valley area could be overestimated.
[Results and Discussion]
Dissolved iron concentrations in some rivers showed a very low concentration of <0.02 mg / L, which is below the detection limit, while others showed high concentrations of 0.37 mg / L. The relationship

between these concentration differences and the valley area in the catchment area is shown in Fig.1. In the rivers whose valley area was less than 1 km2, the concentration of dissolved iron was less than 0.05 mg / L. On the other hand, it was revealed that the concentration of dissolved iron tended to be higher with larger valley area in the catchment area. For the rivers with the low dFe concentrations, the catchment areas ware less than 15 km2, and the valley area occupied as low as 3% or less. The other rivers whose the dissolved iron concentration higher than 0.1 mg / L, the valley area accounted for 5-8% of the catchment area. The flat valley exists along the river is a typical topography in the Tyrma basin. In such places where the inclination is small, since the movement of water is also limited and make the residence time longer, the moisture and reductive environment can be maintained in the active layer on the permafrost, and wetland like Mari which is taken precedence by hygrophyte is widely formed in the valley. As the result, this study showed that Mari covering the valley has the function of dissolved iron generation and dissolved iron flow out into rivers.

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