Proposal of Priority Areas for Forest Restoration through Spatial Analysis of Damaged Areas in Northern Forests Considering Soil Moisture Changes in Mongolia

Enerel Bayarmagnai[1*], Seong Woo Jeon[2]

[1]Division of Environmental Science & Ecological Engineering, Korea University, 02841 145 Anam-ro, Seongbuk-gu, Seoul, Republic of Korea. enerel@korea.ac.kr
[2]Division of Environmental Science & Ecological Engineering, Korea University, 02841 145 Anam-ro, Seongbuk-gu, Seoul, Republic of Korea. eepps_korea@korea.ac.kr

Abstract: Forest conservation serves to prevent national desertification and fires in the long run by regulating Mongolia's nationwide water flow. In previous studies, the effects of forest fire damage due to climate change, which became hotter and drier, on soil moisture were analyzed by dividing them into short-term and long-term effects. Severe forest fire damage results in permanent loss of permafrost in the forest, while moderate forest fire damage increases surface soil moisture due to thawing of permafrost. In this study, among the areas damaged by forest fires, permafrost exists and areas with increased soil moisture in the short term were derived. Temporarily increased soil moisture permanently disappears over time, reducing the likelihood of restoration of forest ecosystems damaged by fires. Therefore, the purpose of this study is to select the priority target area for restoration of forest damaged areas due to fire. We derived forest loss areas from 2014 to 2021 using Mongolian forest maps for 2014 and 2021 in the Hansen Global Forest Change v1.9 dataset to derive damaged areas within the forest. The MCD64A1.061 MODIS Burned Area Monthly Global 500m dataset was used as research data to find the areas damaged by forest fires. Through this, forests that were permanently lost due to fire and forest areas that were restored without being permanently lost after a fire were derived. To find regions where permafrost exists, we derived regions from the WWF HydroATLAS Basins Level 12 dataset with 50 to 100 percent probability of permafrost presence. The change in soil moisture during the period from May to August, when the permafrost is thawing, was analyzed by calculating the Normalized Difference Moisture Index (NDMI) from Sentinel-2. We derived regions with increased soil moisture from 2019 to 2021 through Linear Fit analysis to find regions with increased soil moisture in a short period of time. Finally, by overlapping analysis of the damaged area within the forest and the area where the permafrost layer with increased soil moisture exists, we finally obtained an area with increased soil moisture due to the melting of the permafrost layer due to the deforestation. We propose a total of three grades as forest priority restoration areas. The area that needs to be restored first is the area with permanent forest loss due to the fire, followed by the forest that has been damaged by the fire but not permanently lost. Both areas have permafrost and are areas of increased soil moisture and are therefore considered to be recoverable. The third area selected from the priority area for forest restoration is an area with high conservation value because the forest has not been damaged but has permafrost and soil moisture has increased (Figure 1). During the research, it was found that fire areas in Mongolia are moving from grasslands to forest areas due

to climate change. Therefore, it is considered that more forest areas will be lost due to drought and fires in the future. Mongolia's forests are important carbon sinks that can mitigate climate change and have ecosystem service functions such as water flow control, atmospheric regulation, and nationwide ecosystem environment improvement. Therefore, conservation of forests existing in Mongolia and management to prevent further loss should be the top priority. This study is expected to be a useful basic data for restoration of forest damaged areas in Mongolia and management of existing forests by selecting a priority target area for forest management in Mongolia.

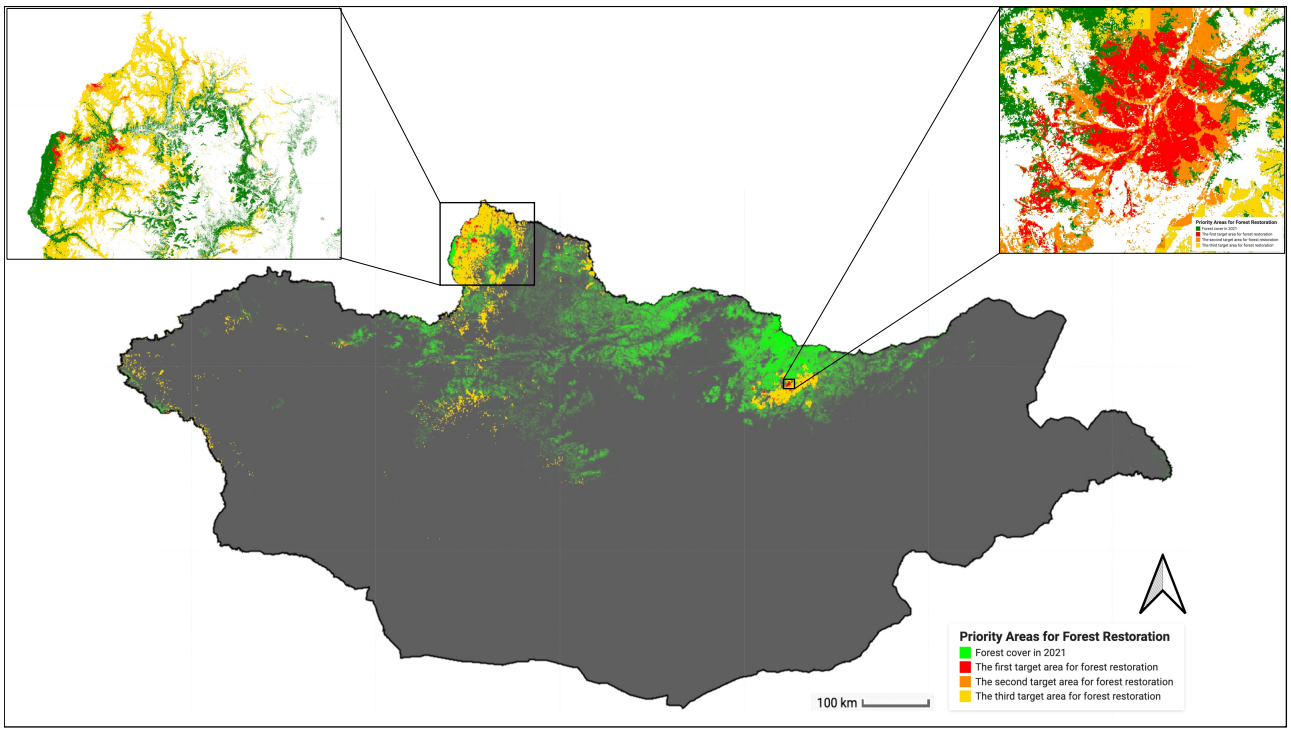

Figure 1. Priority Areas for Forest Restoration

Keywords: deforested areas; wildfire; permafrost; soil moisture changes; forest restoration

This work was supported by Korea Environment Industry &Technology Institute (KEITI) through "Climate Change R&D Project for New Climate Regime.", funded by Korea Ministry of Environment (MOE) (2022003570003)