Supplementary Figures and Tables

Case Study of Model on Rangeland Data of Extreme Climate Scenario

Scenario analysis of wind erosion under alternative climate and vegetation conditions is a promising future application for our RWEQ-based model. Here, we demonstrate the use of the model for scenario analysis by estimating wind erosion under a scenario of future climate change. We estimated wind erosion under future vegetation cover conditions as estimated by the Rangeland Production Model; for more details about scenario generation and the sensitivity of vegetation cover to climate drivers in this region, see Kowal et al. [37].

The future scenario describes monthly average conditions during the time period 2061–2080 under the SSP3-7.0 land use and emissions scenario (Fick and Hijmans 2017). Among the nine global climate models (GCM) for which downscaled global data are currently available, the simulation was derived from outputs of the CanESM5 GCM. We chose this GCM because for the selected time period and emissions scenario, this model shows the largest change in temperature and precipitation for the study area (Kowal et al. 2021). While the modeling procedure that we follow here could be applied to examine the impacts of any future climate scenario, our choice of the SSP3-7.0 scenario and CanESM5 GCM was guided by our desire to explore Mongolia's likely future. The results, therefore, indicate a reasonable outer bound for likely climatic changes under a "business as usual" emissions and land-use scenario. This scenario includes an average temperature increase of 7.9 °C and precipitation that is 17.9% higher on average across the study region [37].

One major limitation to our scenario analysis is the lack of available wind speed data under future climate. Because of this data availability constraint, we set the wind speed as constant in this future scenario. However, this is a serious limitation to the accuracy of our estimations, as wind speed and hence the weather factor is an important contributor to soil loss. Nevertheless, near-surface wind speeds have been reported to be decreasing in China, and the trend is predicted to continue [42].

Under the "extreme climate" scenario, which includes elevated temperatures, an overall increase in precipitation, and overall greater vegetation cover, wind erosion is estimated to decrease (Figure 5)—but with less than 38.4% change in the Eastern Gobi Steppe.

While the future scenario shows decreased wind erosion across much of the study area, the effect is patchy and some areas show an increase in wind erosion. This reflects the patchiness of predicted future precipitation patterns, and therefore changes in vegetation cover (Kowal et al. 2021). An artifact of the data appears in the northeastern part of the larger area of interest: an approximately 10 km^2 area with percentage change in soil loss up to 2000% (Figure S1)—this extreme change is explained by the fact that original soil loss values were extremely small (below 0.001 kg/m^2), thus this is not considered meaningful.

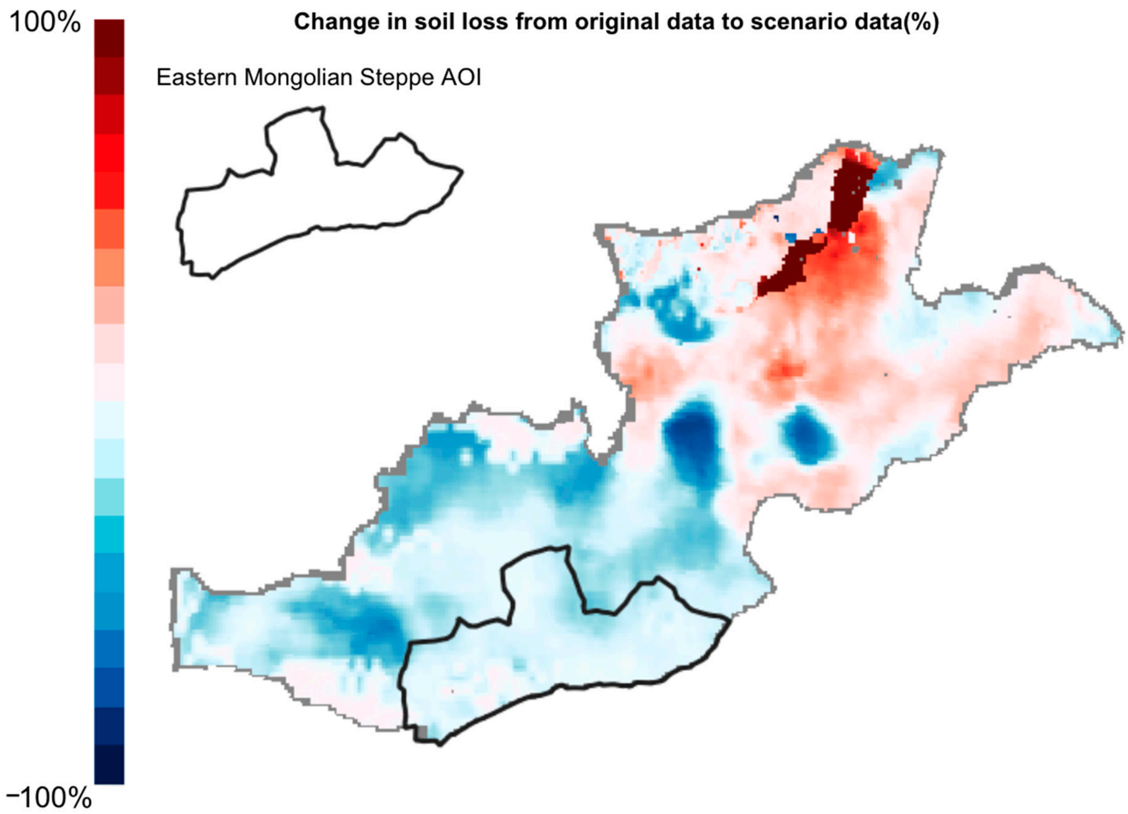

Figure S1. Percentage change in soil loss from current data to a future extreme climate scenario.

Correlations of All Model Inputs to Weather Factor (WF)

Table S1 displays the minimum, the first value, and maximum correlations of each input, which are comma separated. In parentheses next to the minimum and maximum, there is the number of the month (January is 1, February is 2, etc.) where said correlation is found.

Table S1. Correlation of model inputs to weather factor.

	Wind speed	Temp	Precip	Sol Rad	Sand Ratio	Silt Ratio	Clay Ratio	SOM Ratio	FVC
WF Correlation	−0.6 (5), 0 (1)	0 (1), 0.5 (5)	0 (1), 0.04 (5)	0 (1), 0.5 (5)	−0.01 (5), 0.27 (4)	−0.17 (4), 0 (1)	−0.2 (4), 0.05 (5)	0 (1), 0.23 (5)	−0.27 (4), 0 (1)

The weather factor is calculated using wind speed along with precipitation, number of rain days, temperature, and solar radiation. The analysis of the correlations of the model inputs to the weather factor does not show a specific parameter to have significantly high correlation in all months. This indicates that all the model inputs are significant and have complex interdependent relationships to their contribution to the weather factor. The

Pearson correlation coefficient that was used for these analyses has less accuracy for non-linear correlations.

Histograms of Soil Loss Factors

Here are the histograms for the soil loss factors of RWEQ: weather factor, erodible fraction, soil crust factor, surface terrain roughness, and vegetation factor.

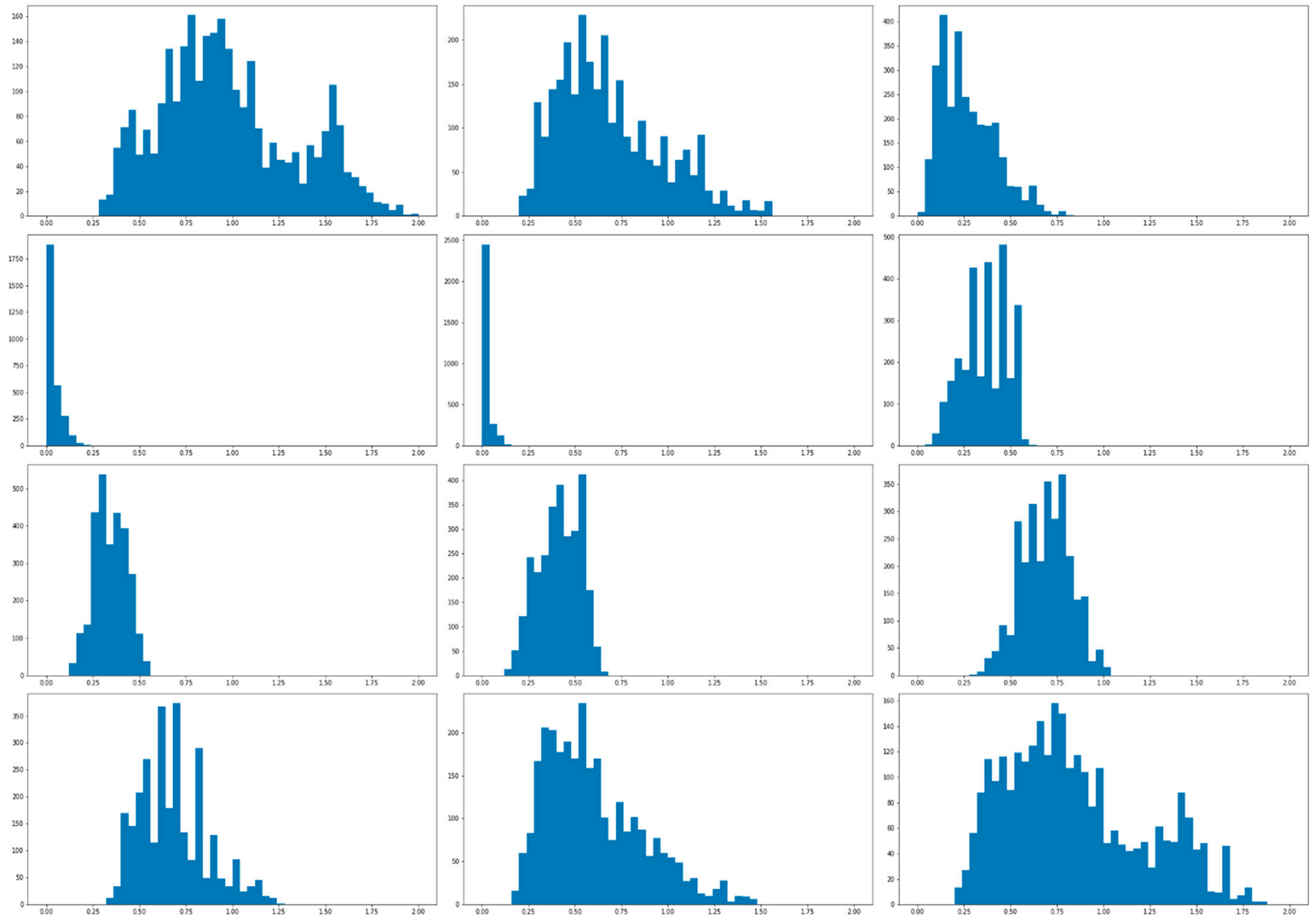

Figure S2. Monthly weather factor (WF).

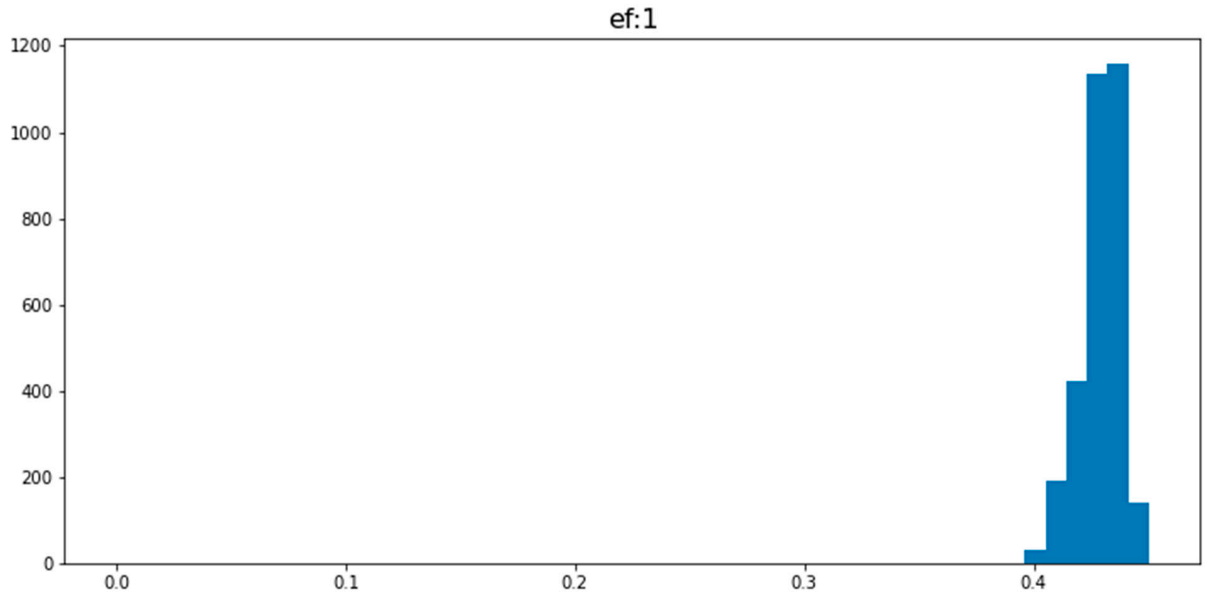

Figure S3. Erodible fraction (EF).

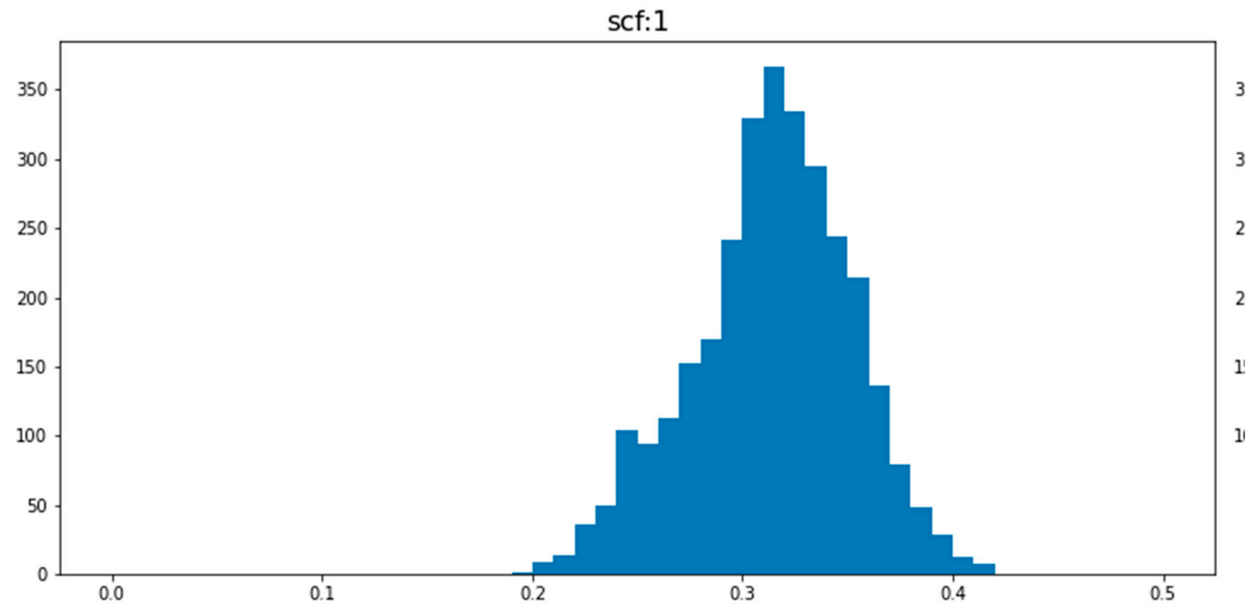

Figure S4. Soil crusting factor (SCF).

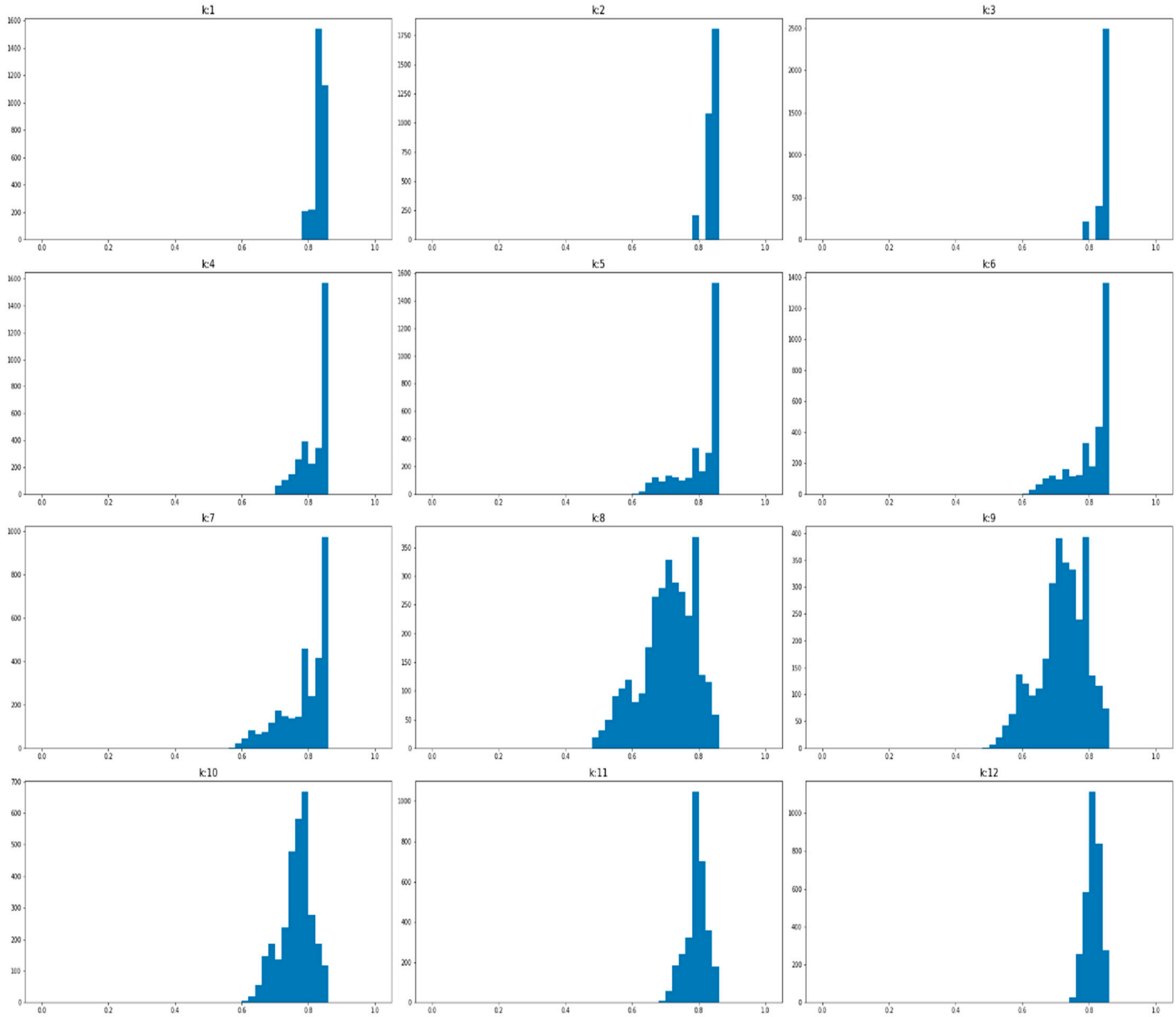

Figure S5. Monthly surface terrain roughness (K′).

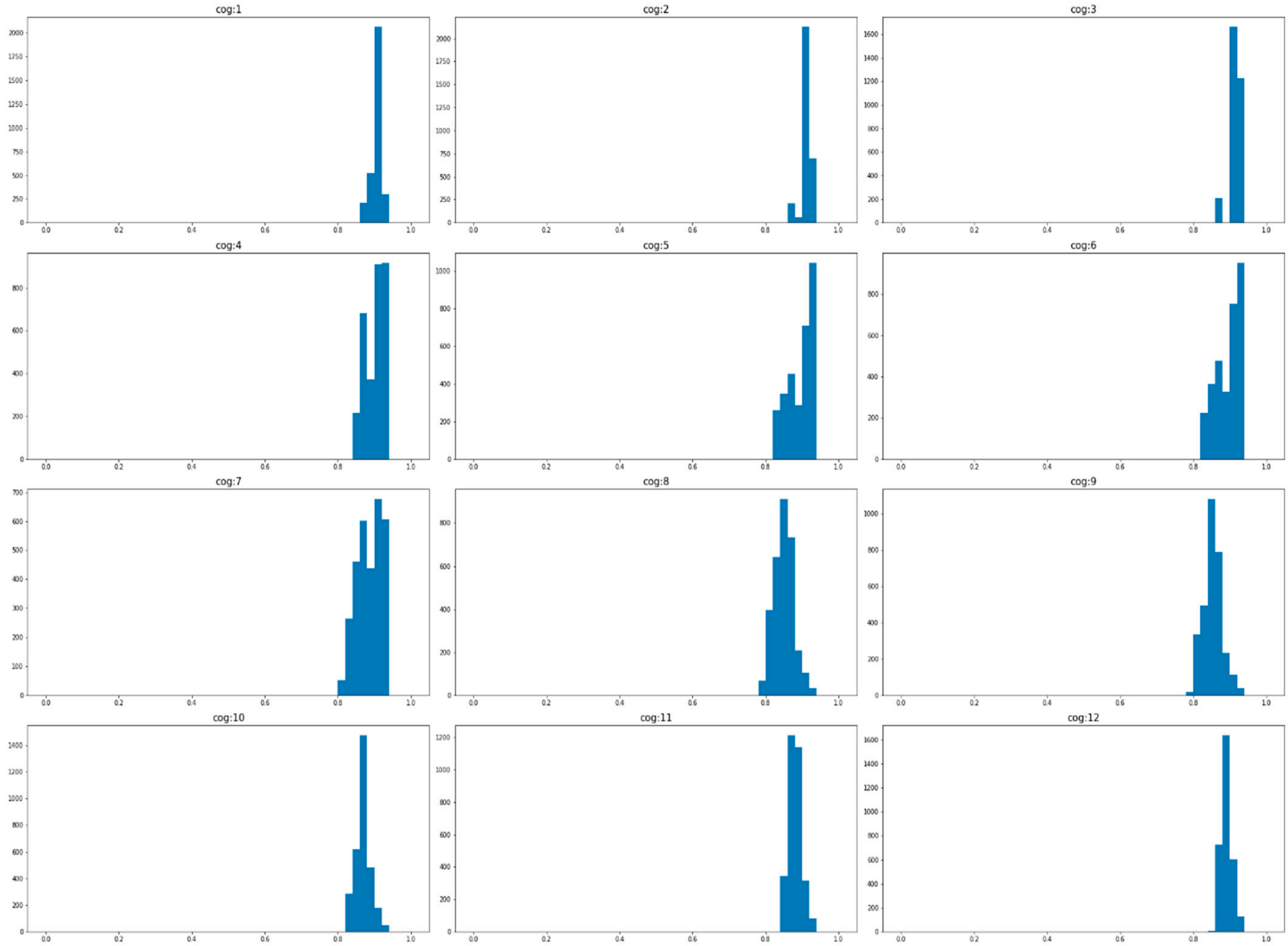

Figure S6. Monthly vegetation factor (COG).