Supplementary Information: Indicator-to-impact links to help improve agricultural drought preparedness in Thailand

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1 SUPPLEMENTARY TEXT (ST)

ST1: Calculation of vegetation indices (VIs) Vegetation Condition Index (VCI), Temperature Condition Index (TCI) and Vegetation Health Index (VHI)

Time series of VCI, TCI and VHI for February 2000-June 2020 were computed based on MODIS Normalized Difference Vegetation Index or NDVI (MOD13A1 and MYD13A1) and Land Surface Temperature (LST) (MOD11A2) at a monthly time-step.

Following Bachmair et al. (2018)'s approach, the VCI, TCI and VHI (Kogan, 1995) are calculated according to the following equations for each month separately:

$$VCI = \frac{(NDVI - NDVI_{MIN,i})}{(NDVI_{MAX,i} - NDVI_{MIN,i})}$$

NDVI is the vegetation index value of a certain month; $NDVI_{MIN,i}$ and $NDVI_{MAX,i}$ is the minimum and maximum NDVI value for that particular month i during the time period of analysis.

TCI is based on LST and calculated in a similar way as VCI:

$$TCI = \frac{(LST_{MAX,i} - LST)}{(LST_{MAX,i} - LST_{MIN,i})}$$

VHI is a weighted average of VCI and TCI:

$$VHI = \alpha VCI + (1 - \alpha)TCI$$

where α is the relative contribution of VCI and TCI. Mostly α is set to 0.5 assuming an even contribution from both indicators (Karnieli et al., 2006; Kogan, 1995).

NDVI and LST grids were first masked distinguishing between grid cells with crop versus forest cover, and subsequently area-averaged over provinces. VCI, TCI and VHI were then calculated for the area-averaged time series.

References

Bachmair, S., Tanguy, M., Hannaford, J., & Stahl, K. (2018). How well do meteorological indicators represent agricultural and forest drought across Europe? Environmental Research Letters, 13(3), 034042. https://doi.org/10.1088/1748-9326/aaafda

A. Karnieli, M. Bayasgalan, Y. Bayarjargal, N. Agam, S. Khudulmur & C. J. Tucker (2006) Comments on the use of the Vegetation Health Index over Mongolia, International Journal of Remote Sensing, 27:10, 2017-2024, DOI: https://doi.org/10.1080/01431160500121727

Kogan, F. N. (1995). Application of vegetation index and brightness temperature for drought detection. *Advances in Space Research*, *15*(11), 91-100. https://doi.org/10.1016/0273-1177(95)00079-T

ST2: Comparison of SPI and SPEI

ST2.1 Motivation and method

This comparison was performed to see how much of SPEI is explained by SPI, and how much the two differ. If they are dissimilar, it provides a strong argument for using both standardised indicators in the analysis. The R-squared metric was used to describe this difference, and is equivalent to the fraction of explained variance (i.e. how much of SPEI can be explained by SPI?). The analysis was done for the whole period, and also by splitting wet and dry season, and by accumulation period.

ST2.2 Results

For the 77 provinces, we found that the maximum R-squared was equal to 0.920, the minimum R-squared was 0.466 and the mean R-squared was 0.720. Therefore, for many provinces, SPI1 only explains about two thirds of the variance of SPEI1. Figure ST1a shows the distribution of R-squared values for all provinces, and Figure ST1b represents the spatial distribution of these. The R-squared is particularly low in some parts of region NE, which is the most arid one, with relatively few irrigated land compared to other regions. This highlights the importance of the evaporative component in that area.

The analysis for wet and dry season, and for different accumulation period shows that the R-squared is higher for the wet season, and for higher accumulation period (Figure ST2).

From this analysis, we found that a substantial part of the variance in SPEI remains unexplained by SPI, and therefore we concluded that it is worth keeping both SPI and SPEI for the rest of the analysis.

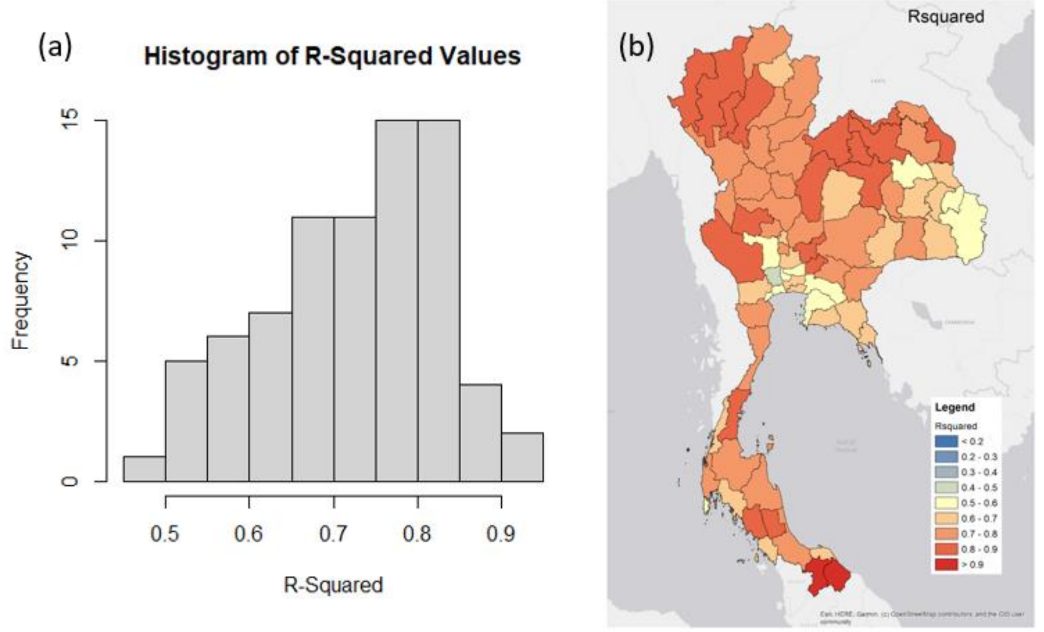


Figure ST1: (a) Histogram of R-squared values for the 77 provinces, and (b) map of R-squared per province.

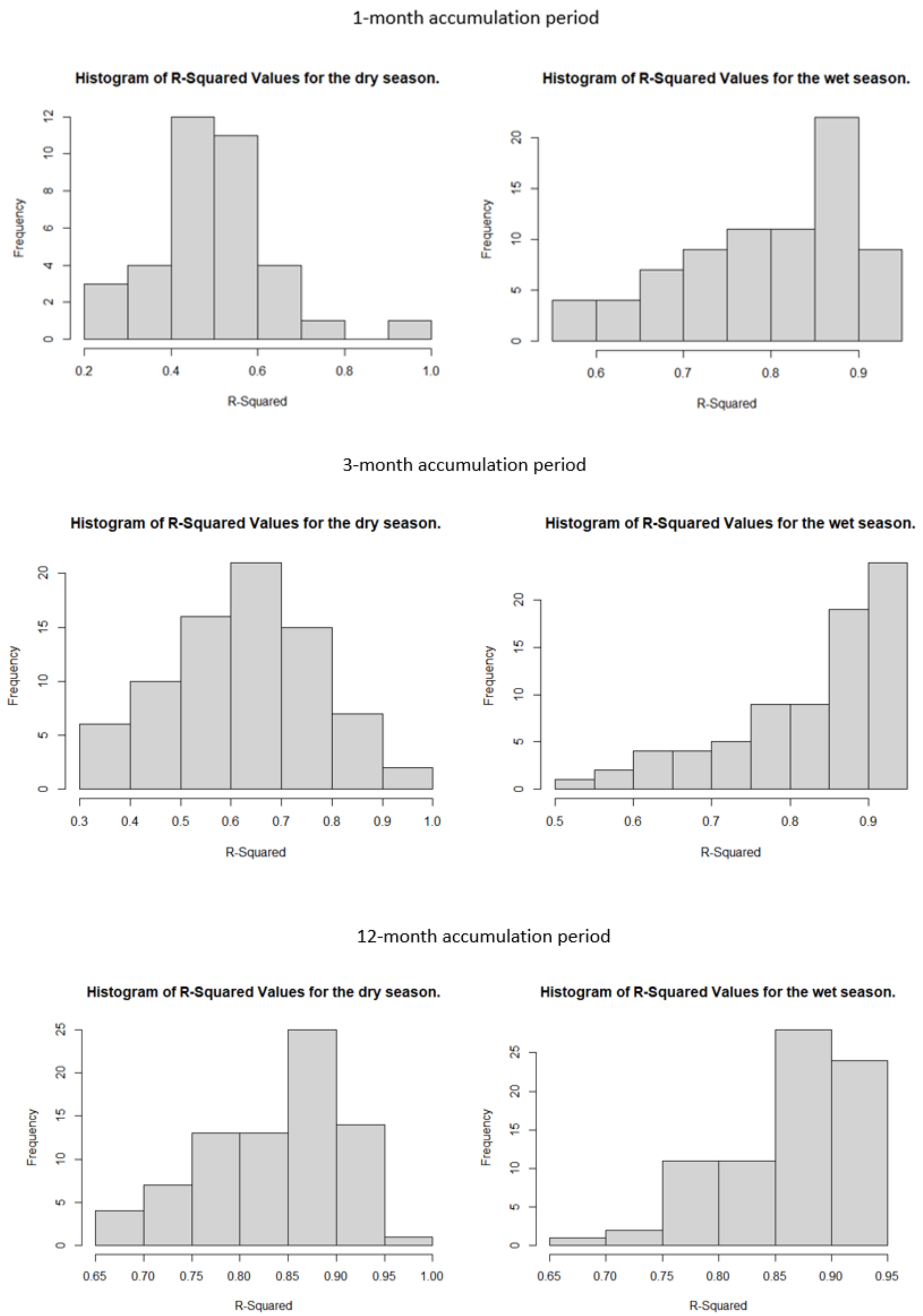


Figure ST2: Histogram of R-squared values for the 77 provinces for 1-, 3- and 12-month accumulation period, for the dry (left) and wet (right) season.

2 SUPPLEMENTARY FIGURES (SF)

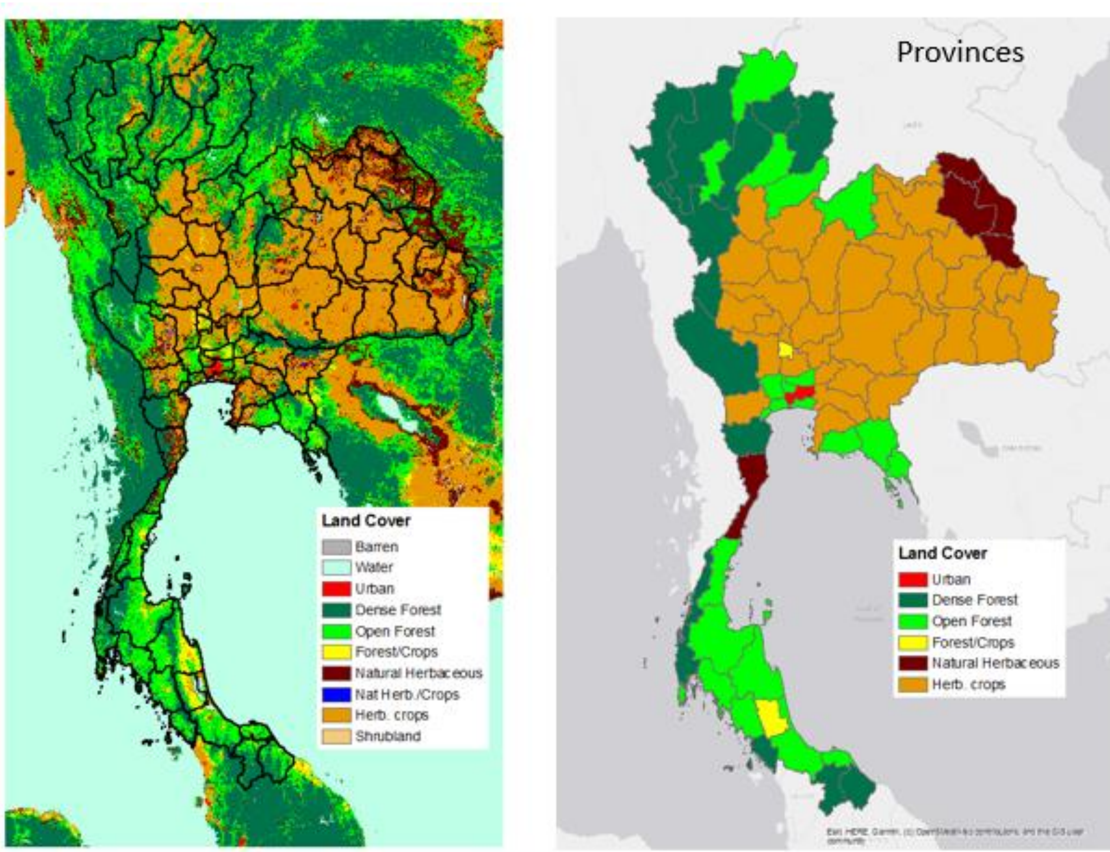


Figure SF1: (a) Land cover map from MODIS (year 2001), and (b) dominant land cover type for each province.

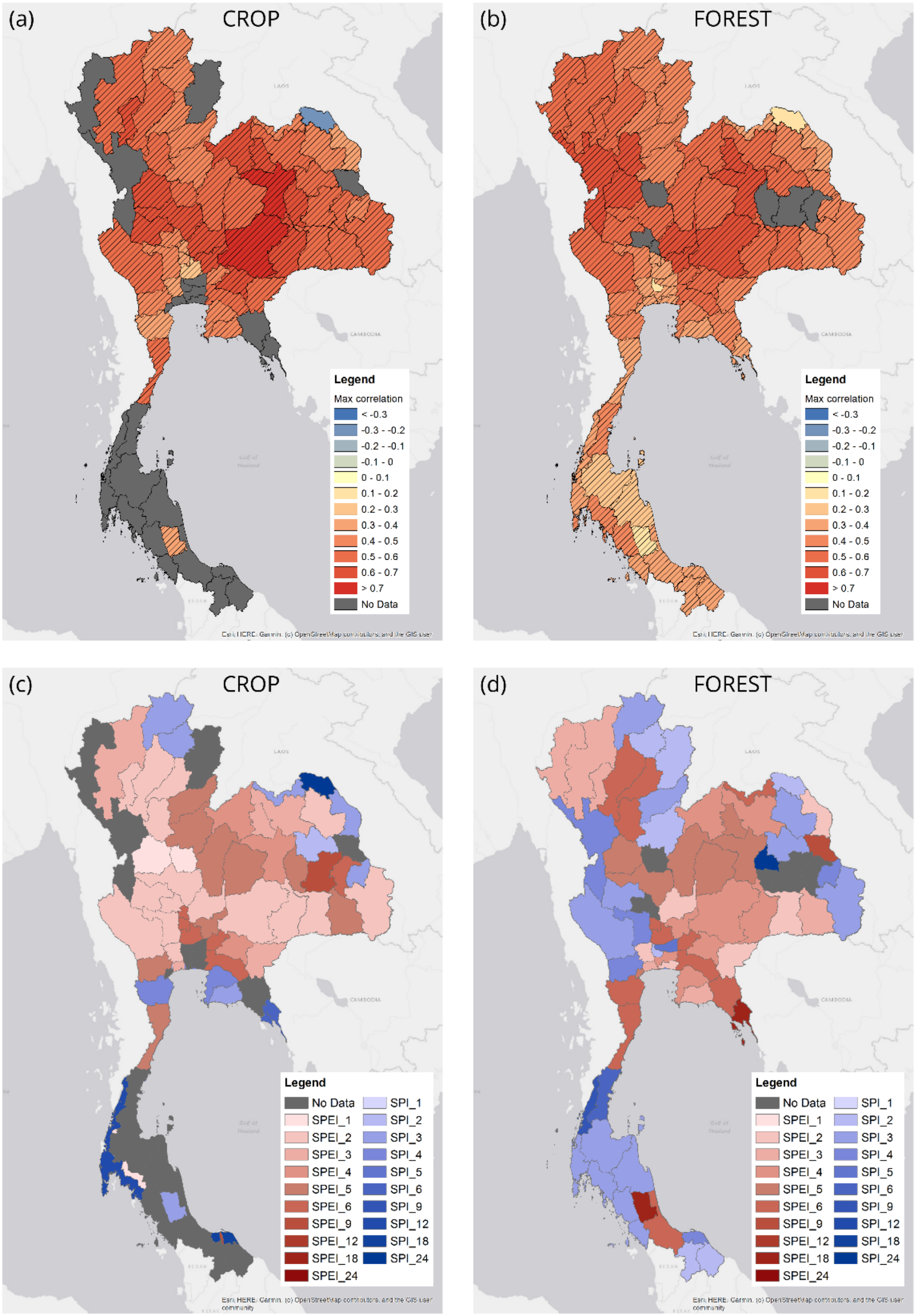


Figure SF2: For the dry season, maximum correlation (all combinations of meteorological indicator with VHI) for each province for (a) crops and (b) forest; and the corresponding meteorological indicator for each province for (c) crops and (d) forest.

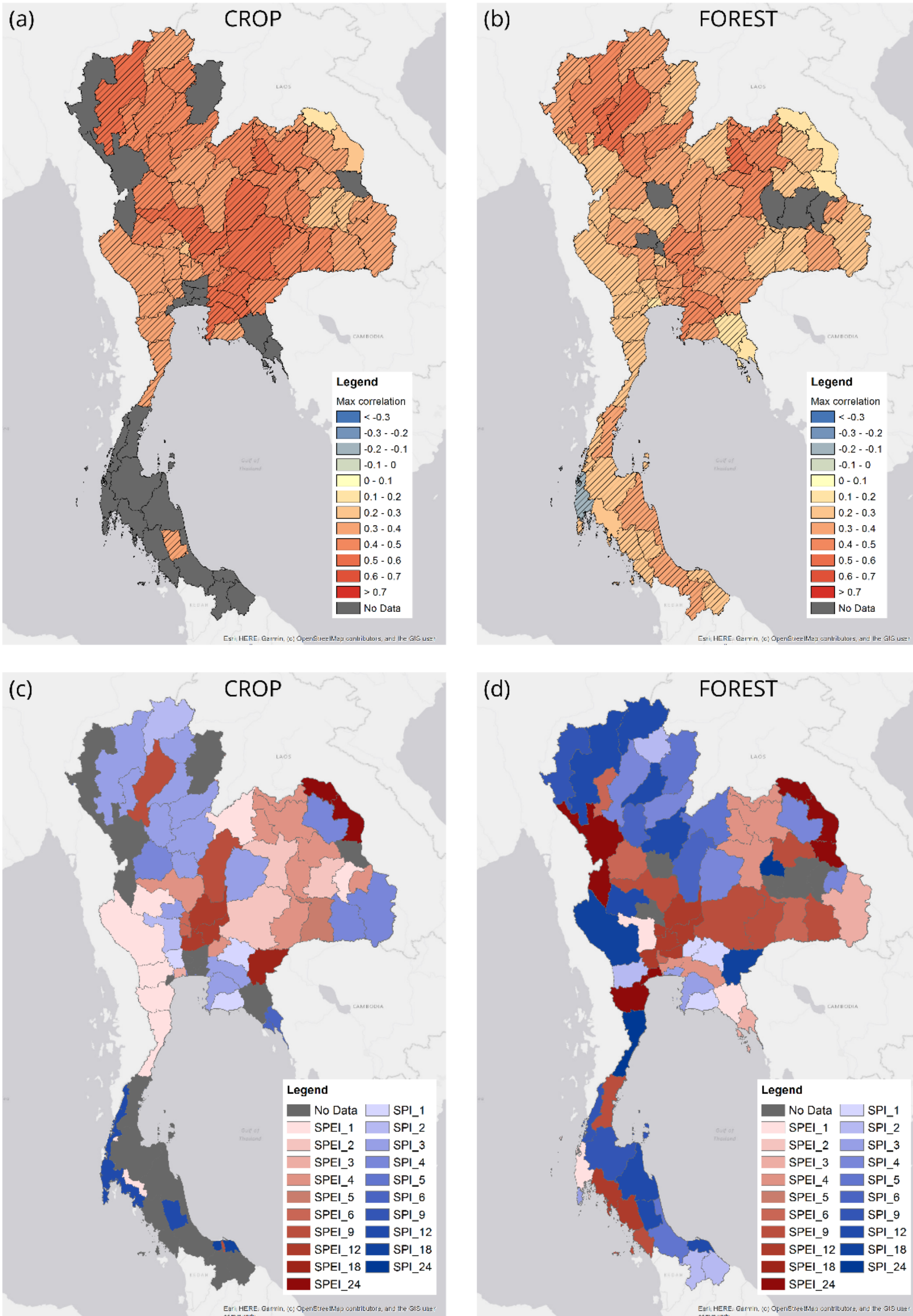
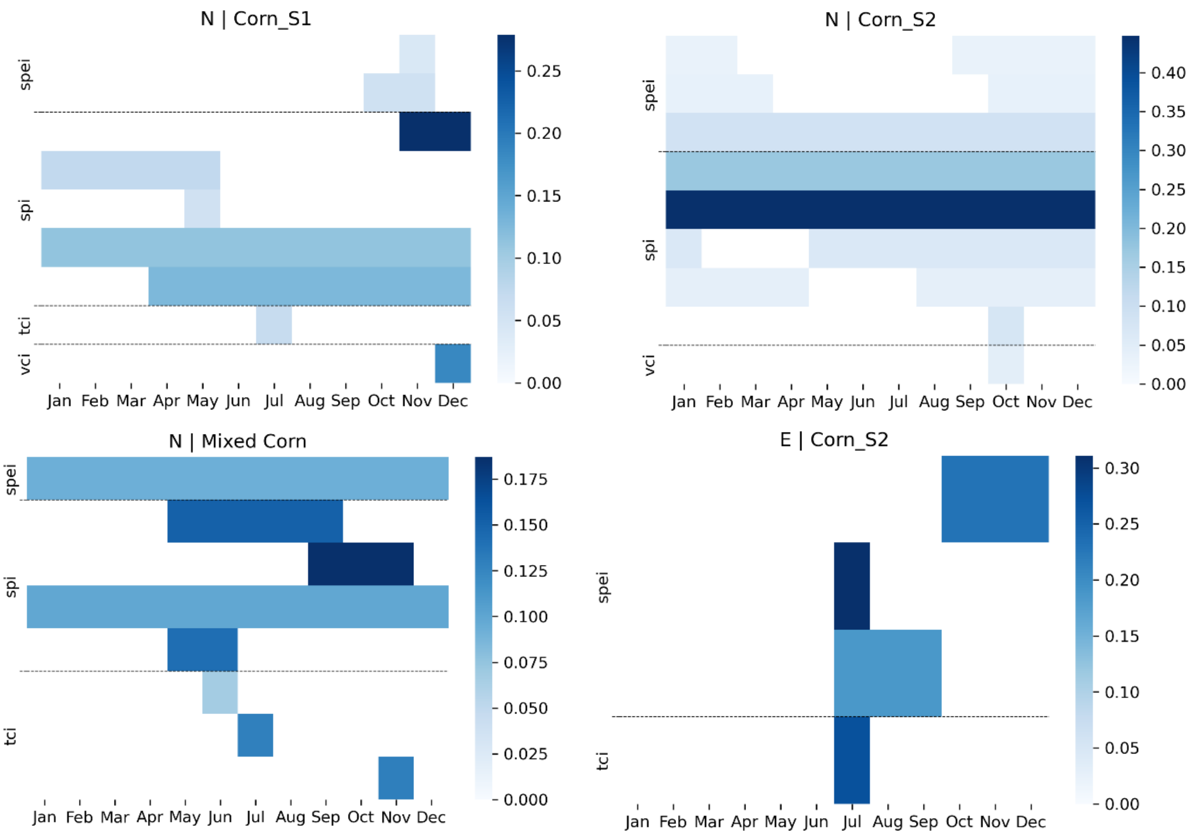


Figure SF3: For the wet season, maximum correlation (all combinations of meteorological indicator with VHI) for each province for (a) crops and (b) forest; and the corresponding meteorological indicator for each province for (c) crops and (d) forest.



85 **Figure SF4: Heatmap illustrating the time of year (x-axis), the period of accumulation (length of bars) for each standardised index (y-axis), and their feature importance (impurity decrease) for each feature used in the corn random forest models. See Fig. 8 caption in the main manuscript for detailed description of the plots.**

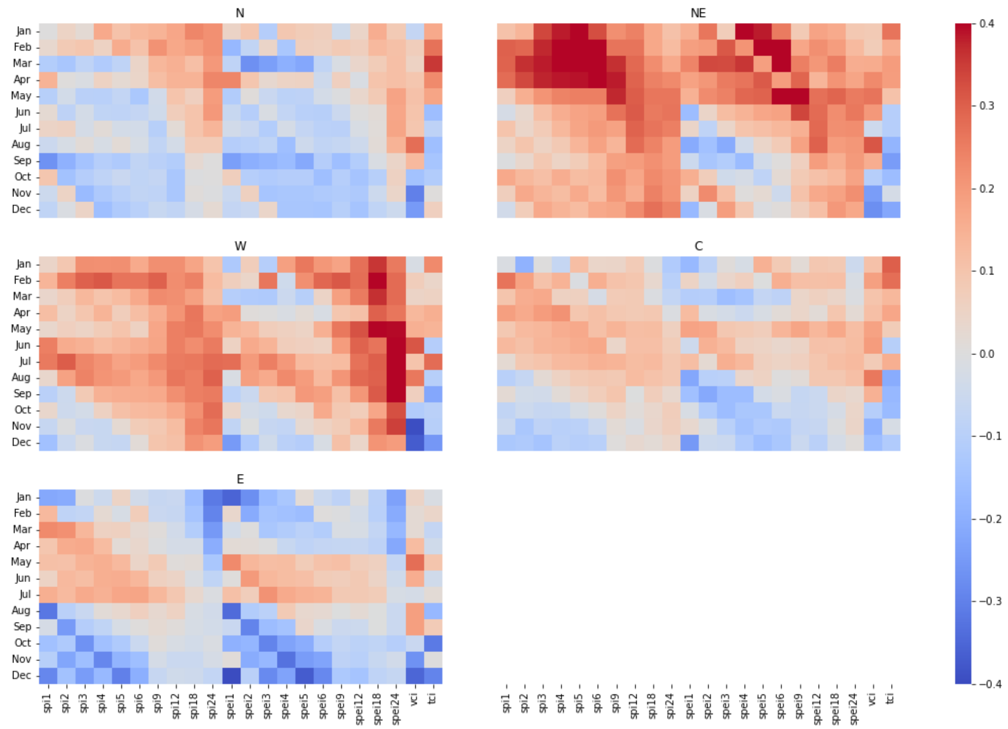


Figure SF5: Heatmap of correlation coefficients between crop yield for cassava and all drought indicators for each month of the year.

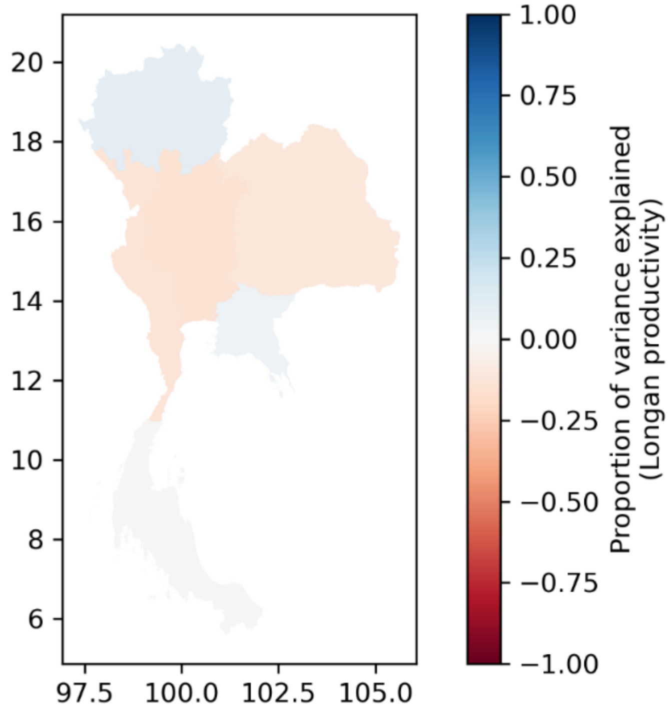


Figure SF6: Amount of variance explained in Longan productivity data by the random forest models.