Surface soil moisture write up

**Data set Overview**

Our data set, the NASA-USDA Enhanced SMAP Global soil moisture data, provides global soil moisture information at a 10km spatial resolution and includes five indices: surface and subsurface soil moisture, soil moisture profile (percent soil moisture), and surface and subsurface soil moisture anomalies from 2015 to 2022. The dataset is derived by taking predictions from the modified Palmer two-layer model which are then corrected through the integration of satellite derived Soil Moisture Active Passive (SMAP) soil moisture observations (Bolten, Sazib, & Mladenova, 2021). The integration of the SMAP imagery into the Palmer model is done using an Ensemble Kalman Filter (EnKF) method, and is designed specifically to correct model-based predictions for damaging impacts due to rainfall-forcing errors; especially for parts of the world without exhaustive rain gauge instrumentation (Bolten, Sazib, & Mladenova, 2018). This is of great importance as the quality of the assimilation greatly depends on the accuracy of observational and model estimates, meaning that proper evaluation of the soil moisture uncertainty is vital for the best integration of the satellite observations (Maggioni, Anagnostou, & Reichle, 2012).

**Surface Soil Moisture index**

Surface soil moisture is the water that is in the upper 10cm of soil and responds quickly to heavy precipitation and rapidly drying events (Drought.gov, 2022).

For our dataset, the surface soil moisture is assumed to hold a maximum of one inch of water meaning the top layer soil depth varies based on soil texture. Appropriate Surface soil moisture levels are necessary for the success of planting and harvesting activities for most crops with too little soil moisture during planting stifling the seed germination and too much soil moisture preventing fieldwork or heavy machinery access to the field (Bolten et al., 2018). To be specific, soil moisture levels of:

* 20-25mm are best for the germination and emergence of a new crop but can halt fieldwork or damage a newly seeded crop that is in the wet environment for a prolonged period.
* 15-20mm are normally the best for vigorous field activity.
* 10mm or less will not support the early growth potential for a newly emerged crop or seed germination (Bolten et al., 2018).

**What are the thresholds used in our study?**

For our study, threshold levels of:

* 25mm or more indicates wet surface soil moisture
* 25-15mm indicates ideal surface soil moisture
* 10-15mm indicates dry surface soil moisture
* 10mm or less indicate extremely dry surface soil moisture

**Ideal soil type for maize production**

The germination of maize seeds is dependent to a large extent on soil and environmental condition with warm, moist conditions resulting in seedling emergence of 6 to 10 days, while cool or dry conditions slowing emergence to two weeks or longer (Plessis, 2003). The optimum moisture levels of the soil is approximately 60% of the total capacity while optimum soil texture is between 10-30% clay content (Plessis, 2003). Maize grows best in fertile, deep, well-drained soils where total annual rainfall is greater than 500mm (Limited). Maize is susceptible to both drought and water logging and therefore poorly drained soils should be avoided. Furthermore, drought during silking and tasseling, which occurs during the four-week period spanning flowering, can lead to high yield losses and resultingly some form of water conservation is beneficial (Limited).

**Soil type overview by region**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **NR** | **AEZ** | **Area**  **(million ha)** | **Dominant soils**  **category** | **Dominant soils**  **type** |
| I | I | 0.7 | red soil | Acrisols, Ferralsols |
| II a | II a | 4.1 | greyish brown sands and sandy loams derived from granitic rocks | Cambisols, Luvisols, Arenosols |
| IIB | IIB | 1.8 | greyish brown sands and sandy loams derived from granitic rocks | Cambisols, Luvisols, Arenosols |
| III | II(1) | 0.7 | deep Kalahari sand | Arenosols |
| III | II(2) | 1.4 | very shallow | Leptosols, Lixisols |
| III | IV(5) | 7.6 | greyish brown sands and sandy loams derived from granitic rocks | Luvisols |
| V | V(2) | 0.7 | very shallow | Leptosols |
| V | V(3) | 0.5 | Vertisols | Vertisols |
| V | V(4) | 1.5 | brown loamy sands & loams | Luvisols, Solonetz |
| V | V(5) | 3.9 | Sands & sandy loams derived from granite & gneiss | Luvisols |

(Nations, 2006)

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