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DATA ARTICLE

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High-resolution mapping of available water content in Senegal using iSDA Africa dataset and USDA Rosetta3 model

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Abstract

This data article presents a high-resolution map of available water content (AWC) for Senegal, derived from the iSDA Africa dataset and the USDA Rosetta3 model, as well as the method used for its production. The map covers the entire country at a resolution of 30 m and provides a valuable resource for hydrological studies and spatialized crop model simulations in the region where water is a limiting factor for crop production. The dataset is based on existing soil properties data and leverages pedotransfer functions (PTFs) to estimate water retention capabilities from soil properties. This AWC map derived from datasets with enhanced accuracy offers a more precise estimate of soil water retention capacity, which can be instrumental in informing water and agricultural management, policy decisions and investments. The dataset, including intermediate variables, is available in geotiff format at Cirad Dataverse under the DOI 10.18167/DVN1/SGNSII and complies with FAIR data principles, allowing its broad reuse. The code used to produce this dataset is also made available under the DOI 10.5281/zenodo.10078399, so that AWC maps can be produced for any territory covered by the iSDA Africa product.

KEYWORDS

AWC (available water content) mapping, Senegal, soil water availability

1 | INTRODUCTION

Soil water availability is recognized as a vital ecosystem service, playing a key role in nutrient cycling, primary production (Dobriyal et al., 2012), climate regulation, gas exchange and water flow management, as well as erosion and flood control, water purification and the provision of food, feed, fibre and fuel (Adhikari & Hartemink, 2016). In Sub-Saharan Africa, where agriculture predominantly relies on rainfed systems and where food security mainly depends on subsistence crops, estimating the availability of water in soil is critical for monitoring crop development, predicting crop yields and hence ensuring food security. One important factor for estimating the water available to crops is the available water content (AWC), which refers to the difference between the soil water retention (SWR) at field capacity (FC, when the soil has drained excess water and can hold no more water against gravity) and the SWR at the permanent wilting point (PWP, when plants can no longer extract water from the soil). This metric represents the total amount of water that can be stored in the soil and made available to plants under normal conditions. AWC is an important parameter in bucket-type models, used in hydrological (e.g., HBV, Seibert & Bergström, 2022; Staudinger et al., 2021) and crop modelling (e.g., DSSAT, Jones et al., 2003; AquaCrop, Salman et al., 2021; SARRA-H/O, Baron et al., 2003; Dingkuhn et al., 2003) applications.

Quantifying the spatial variation of AWC is crucial for planning and risk mitigation purposes (Poggio et al., 2010). In the context of food security studies, accurate AWC maps are essential for predicting yields in water-limited areas, as they provide plausible estimates of soil water holding capacity for spatialized crop simulation models, which simulate water balance considering factors such as climate, rainfall, soil properties, crop management practices and plant growth.

Traditional approaches for generation of AWC maps are based on geostatistical extrapolation of direct AWC measurements and/or values derived from soil properties surveys through pedotransfer functions (PTFs). These PTFs use readily available soil data, such as texture and organic matter content, to estimate soil hydraulic properties. Identifying the most generic and accurate PTF for a specific region and soil properties dataset can be challenging, as PTF accuracy and applicability depend on factors such as regional soil characteristics, the range of soil properties in the development dataset and the particular hydraulic properties of interest. Turek et al. (2023) emphasize that PTF development must occur alongside the development of suitable extrapolation and upscaling techniques to accurately represent soil spatial heterogeneity. Among the many PTFs available, the USDA model Rosetta3 (Zhang & Schaap, 2017) was developed against an extensive dataset of US soils, and stands out due to its widespread use and validation across different regions. Rosetta3 estimates soil parameters for the van Genuchten-Mualem (VGM) water retention model based on soil texture data, including sand, silt and clay content, while sometimes incorporating additional properties such as bulk density. From these parameters, it becomes possible to compute SWR at matric potentials corresponding to FC and PWP.

Combined with existing soil properties maps, a number of global SWR and/or AWC maps were derived using these PTFs (Turek et al., 2023). However, the increased availability of Earth Observation datasets and their use as covariates led to the development of new digital soil mapping (DSM) methods. As a consequence, soil properties maps now reach high levels of spatial resolution, precision and accuracy, which leads to a renewed interest in the context of AWC mapping. While this approach already has been explored by Tóth et al. (2015) using the SoilGrids250 dataset (Poggio et al., 2021), a new DSM dataset for soil properties, iSDA Africa (Hengl et al., 2021), proposed a continent-wide high-resolution 30 m product that has not been used yet for this purpose. The iSDA Africa dataset provides a valuable resource for methods based on PTFs, as it covers various chemical and physical properties at multiple depths. It presents a 30-m resolution soil information system for Africa, featuring the most extensive compilation of reference soil sampling points ($N \approx 150{,}000$) and Earth Observation data to date, which allows for detailed pan-African maps of soil nutrients. To our knowledge, no other paper citing this dataset has had more reference points. A recent review showed that the highest resolution so far for AWC products was obtained using the Africa Soil Information Service (AfSIS, https://africasoils.net) 250 m world soil dataset (Turek et al., 2023). According to Hengl et al. 2021, the original AfSIS 250 m maps had limitations, including data harmonization issues and a lack of satellite data (particularly Sentinel-2 data). By contrast, iSDA suggests an average improvement in the R^2 value from 0.6 at 250 m resolution to 0.8 at 30 m predictions.

In this paper, we introduce as a pilot a high-resolution map of AWC for Senegal, derived from the 30 m iSDA Africa soil properties maps and the USDA Rosetta3 model. This map provides a valuable resource for spatialized hydrological and crop modelling in the region, where water is a limiting factor for crop production. We provide a detailed description of the workflow used to produce the map, including the methods used to derive AWC from the soil properties maps. The workflow and the dataset comply with FAIR data principles (Findable, Accessible, Interoperable, and Reusable), allowing other scientists, whether soil scientists or those in related disciplines, to use the dataset in their own research.

Highlights

- We offer available water content (AWC) maps for Senegal.
- The methods and code used here are provided and can be used to model AWC across Africa.
- They can be easily adapted to produce refined datasets as newer versions of iSDA become available.

2 | MATERIALS AND METHODS

The high-resolution map of plant-AWC for Senegal was produced by computing SWR capacity from 30 m soil property maps obtained from the iSDA Africa initiative, using PTFs implemented in the USDA Rosetta3 model. To achieve this objective, we followed a five-step workflow:

1. Downloading soil properties maps for silt, clay, sand, bulk density and depth to bedrock from the iSDA data repositories;
2. Running the Rosetta3 model to estimate SWR parameters;
3. Calculating volumetric water content at FC (water content at −30 kPa) and PWP (water content at −1500 kPa) matric pressure levels using the estimated SWR parameters;
4. Computing AWC and interpolating filtered values;

Steps 1 to 4 were repeated twice: once for the 0–20 cm horizon and once for the 20–50 cm horizon.

5. Finally, integrating AWC values over the entire soil depth to produce the high-resolution map.

2.1 | Step 1: The iSDA Africa soil properties database

In this study, we used the iSDA Africa dataset (Hengl et al., 2021), which provides 30 m resolution soil properties maps for Africa. These maps were generated from an extensive compilation of soil samples (approximately 150,000), as well as 250 m resolution (MODIS, PROBA-V, climatic variables and others) and 30 m resolution (digital terrain model derivatives, Landsat, Sentinel-2 and others) image covariates, using a 2-scale 3D Ensemble Machine Learning framework implemented in the mlr R package (Hengl et al., 2021). The iSDA Africa database aims to support various applications, including soil and fertilizer policies, agronomic advice, environmental programs and nutrition interventions. From this dataset, we used soil properties predictions for silt, clay and sand content, as well as fine-earth bulk density at two depth intervals (0–20 cm and 20–50 cm), and retrieved from the Zenodo repository on 15 April 2023 (v0.13). We also used predictions for depth to bedrock, which was retrieved from Amazon S3 bucket on 19 April 2023 (Table 1).

TABLE 1 References of downloaded datasets.

Dataset	Version and download date	doi/URL
Silt	v0.13, 15/04/2023	https://doi.org/10.5281/zenodo.4094610
Clay		https://doi.org/10.5281/zenodo.4085160
Sand		https://doi.org/10.5281/zenodo.4094607
Fine-earth bulk density		https://doi.org/10.5281/zenodo.4087905
Depth to bedrock	NC, 19/04/2023	https://isdasoil.s3.amazonaws.com

2.2 | Step 2: Estimation of the VGM SWR curve parameters using the USDA Rosetta3 PTF model

The VGM model is a mathematical model used to describe the relationship between water content, water potential and unsaturated hydraulic conductivity in porous media, particularly soils. The model's parameters, such as the water retention curve shape coefficients α and n, and the saturated water content θs, can be estimated using PTFs calibrated for given geographical extents from extensive soil datasets. While these PTFs have been widely used and validated in various regions, it is essential to recognize that their accuracy may vary depending on local soil characteristics and the quality of the input data. A widely used PTF is the USDA Rosetta3 model, developed by the United States Department of Agriculture (USDA) based on a large dataset of US soils. Notably, the Rosetta3 model offers different levels of complexity, depending on the available input data (e.g., texture only or texture plus other soil properties). In this study, we used a Python implementation of Rosetta3, available online at https://github.com/usda-ars-ussl/rosetta-soil under commit hash 1b67533, to perform a pixel-wise computation of the VGM parameters from the iSDA Africa silt, clay, sand content, as well as fine-earth bulk density datasets. As the model employs a bootstrap resampling method to estimate the uncertainty of predictions, offering univariate and bivariate probability distributions of the predicted parameters, seven maps were generated: decimal logarithm of α shape parameter, decimal logarithm of n parameter, residual water content (θr) mean and standard deviation (SD), saturated water content (θs) mean and SD, and diagnostic codes. Furthermore, maps of antilogged values for α and n were produced. We invite our readers to refer to Table 2 for a summary of produced maps.

2.3 | Step 3: Calculation of the volumetric water content at FC and PWP

The VGM model was employed to compute the volumetric water content at FC and PWP using the

TABLE 2 Summary of the soil variables maps produced for Senegal.

Origin step in production workflow	Filename	Units	Description
Step 2: estimation of the VGM soil water retention curve parameters using the USDA Rosetta3 PTF model	senegal_alpha_0_20cm senegal_alpha_20_50cm	cm^{-1}	Alpha shape parameter: air-entry pressure parameter of the VGM model
	senegal_npar_0_20cm senegal_npar_20_50cm	arbitrary	n parameter: VGM curve shape parameter
	senegal_theta_r_mean_0_20cm senegal_theta_r_mean_20_50cm	%vol	Mean value for residual water content (θr) estimated by the Rosetta3 bootstrapping
	senegal_theta_r_std_0_20cm senegal_theta_r_std_20_50cm	%vol	SD value for residual water content (θr) estimated by the Rosetta3 bootstrapping
	senegal_theta_s_mean_0_20cm senegal_theta_s_mean_20_50cm	%vol	mean value for saturated water content (θs) estimated by the Rosetta3 bootstrapping
	senegal_theta_s_std_0_20cm senegal_theta_s_std_20_50cm	%vol	SD value for saturated water content (θs) estimated by the Rosetta3 bootstrapping
Step 3: calculation of the volumetric water content at FC and PWP	senegal_theta_fc_0_20cm senegal_theta_fc_20_50cm	%vol	Volumetric water content at FC (θfc), Estimated by the VGM model
	senegal_theta_wp_0_20cm senegal_theta_wp_20_50cm	%vol	Water content at PWP (θpwp), estimated by the VGM model
Step 4: calculation of AWC and spatial interpolation of missing values	senegal_theta_a_0_20cm senegal_theta_a_20_50cm	%vol	Volumetric available water content (θa), obtained by subtracting volumetric water content at PWP from volumetric water content at FC
	senegal_theta_a_mm_interp_0_20cm senegal_theta_a_mm_interp_20_50cm	mm/cm	Available water content, expressed as height of water (mm) per depth unit of soil (cm), and interpolated via nearest neighbour method
Step 5: calculation of AWC integrated along the soil depth	senegal_pawc_mm_0_50cm	mm	Integrated available water content, expressed as height of water (mm), on the 0- to 50-cm depth horizon
	senegal_pawc_mm_0_bedrock	mm	Integrated available water content, expressed as height of water (mm), on the horizon from surface to bedrock

Abbreviations: AWC, available water content; FC, field capacity; PTF, pedotransfer function; PWP; permanent wilting point; SD, standard deviation; VGM, van Genuchten-Mualem.

VGM retention parameters calculated in Step 2, thus establishing a functional relationship between volumetric water content (θ) and soil suction pressure (h).

$$\theta(h) = \theta r + (\theta s - \theta r)/[1 + (\alpha\,|h|)^n]^m,$$

where $\theta(h)$ is the volumetric water content at a given soil suction pressure h (cm or kPa); θr is the residual water content; θs is the saturated water content; α, n and m are empirical shape parameters specific to the soil type, determined via the PTF; $|h|$ represents the absolute value of soil suction pressure h; $m = 1\text{–}1/n$.

The retained suction pressure for FC and PWP were −30 and −1500 kPa, respectively, usually adopted as thresholds for calculating the AWC following USDA conventions (Soil Survey Staff, 2014). As a result, two supplementary maps were produced: volumetric water content at FC (θfc) and at PWP (θpwp) (Table 2).

2.4 | Step 4: Calculation of AWC and spatial interpolation of missing values

The AWC (θa), which is the difference between θfc and θpwp, as well as its equivalent in water height in millimetres (θa_mm) were computed. During the computation of the water retention properties, *nan* values were introduced as a result from the incertitude in the estimation of soil properties. In practice, pixels exhibiting a sum of silt, clay and sand fraction above 100% were set as errors. Subsequently assigned *nan* values were later replaced with interpolated values to produce a final map of plant-available water content (PAWC). The nearest neighbour interpolation method seemed a reasonable choice in this context and given the spatial density of valid estimations, and was preferred for map production performance reasons. Four maps were produced as a result from this step (Table 2).

2.5 | Step 5: Calculation of AWC integrated along the soil depth

Two PAWC were calculated, for two different soil depths: 50 cm and depth to bedrock. The first value, PAWC 0–50-cm, corresponds to the PAWC down to the depth corresponding to the lower limit of the deepest horizon at which iSDA soil properties predictions are being performed. The second value, PAWC 0-bedrock, corresponds to the PAWC value extrapolating the soil properties of the 20–50 cm horizon on the 50-cm-bedrock depth horizon. These values are calculated using the QGIS Raster calculator using the following formulas:

$$\mathrm{PAWC}_{0-50\mathrm{cm}} = \theta_{a\ \mathrm{mm\ interp}\ 0-20\mathrm{cm}} * 20 + \theta_{a\ \mathrm{mm\ interp}\ 20-50\mathrm{cm}} * 30.$$

$$\mathrm{PAWC}_{0-\mathrm{bedrock}} = \theta_{a\ \mathrm{mm\ interp}\ 0-20\mathrm{cm}} * 20 + \theta_{a\ \mathrm{mm\ interp}\ 20-50\mathrm{cm}} * (\mathrm{depth\ to\ bedrock} - 20).$$

Two final maps were thus introduced in our dataset (Table 2).

2.6 | Data handling

Data handling from steps 1 to 4 was performed with Python 3.9.6 using Pandas, Numpy and Xarray libraries. The openly available Jupyter notebook used in the software pipeline for this computation, allowing massive parallelization, is available on our GitHub repository: https://github.com/SARRA-cropmodels/iSDA-calcs and deposited on Zenodo under the DOI 10.5281/zenodo.10078399. Step 5 was performed using the Raster calculator function of QGIS v3.26.2-BuenosAires.

3 | RESULTS/DATA DESCRIPTION

We present a high-resolution map of AWC for 0- to 20-cm and 20- to 50-cm depth intervals for Senegal derived from 30 m soil properties maps using the iSDA Africa dataset and the USDA Rosetta3 model. The map covers the entire country, providing a spatially explicit representation of AWC and intermediate calculation variables (Figures 1–3). As 39.55% of the map extent has valid values for PAWC estimation, we can say that, in average, the informational resolution of this map is about 2650m^2, nearly equivalent to what can be obtained by using 50 × 50-m pixels. The AWC map shows a wide range of values across Senegal, with the lowest values in the Louga/Saint Louis regional frontier area, and the highest values in the southwest of the country in the Ziguinchor and Fatick delta regions (see Figure 3). The mean AWC on the first 50 cm of soil across the extent of Senegal is 60.2 mm, with a SD of 13.0 mm. The minimum and maximum AWC values are 12.1 and 106.6 mm, respectively.

In addition to the PAWC map, we also provide maps of the water retention curve shape coefficients α and n (Figure 1), and the saturated water content θs (see

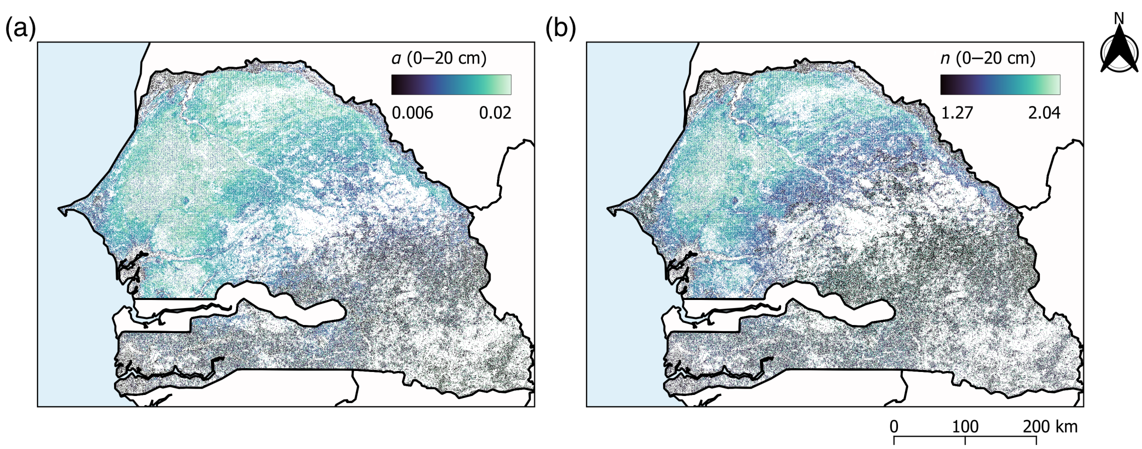

FIGURE 1 Maps of the (a) α shape parameter, and (b) n parameter of the van Genuchten-Mualem model, in the 0–20 cm horizon, as calculated by Rosetta3 model from iSDA soil properties map.

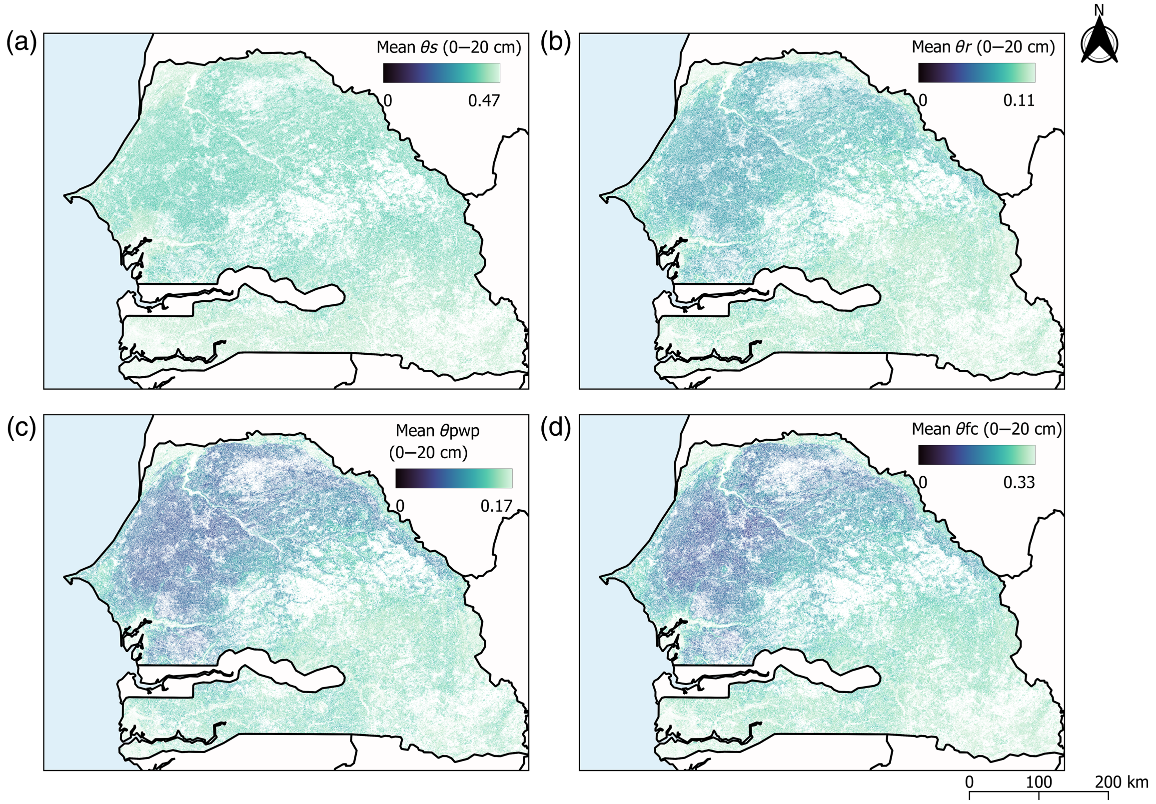

FIGURE 2 Mean value for (a) saturated water content (θs), (b) residual water content (θr), (c) volumetric water content at permanent wilting point (θpwp) and (d) volumetric water content at field capacity (θfc) in the 0–20 cm horizon, as calculated by Rosetta3 model from iSDA soil properties map.

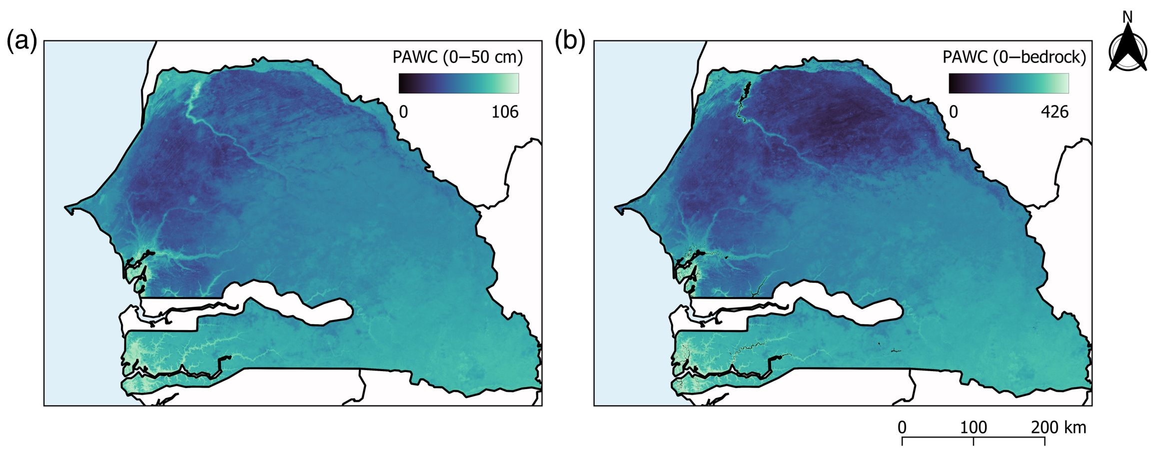

FIGURE 3 Integrated available water content, expressed as height of water (mm) and interpolated via nearest neighbour method (a) in the 0–50 cm horizon and (b) down to the bedrock, as calculated from iSDA soil properties map.

Figure 2). These maps can be used to estimate other soil hydraulic properties and to improve the accuracy of crop simulation models.

Although the iSDA soil properties maps included uncertainty layers, our calculations only considered the iSDA Africa mean values, as we did not perform resource-intensive bootstrapping computations to account for the variability in soil property predictions as inputs for the Rosetta3 model. Regarding the variability of iSDA soil properties, we made a plausibility assumption that the sum of soil texture fractions input into Rosetta3 should not exceed 100% (as this would be representative of a high level of incertitude in the estimation of at least one of the soil texture fractions), and a methodological choice stating that we should not normalize these values before calculation. Consequently, 67.24% of pixels were discarded, and computations were performed using only iSDA's raw soil property estimations at points with plausible soil properties for sand, silt, clay and coarse fragment fractions. From these data, we calculated water retention capabilities at the two soil depth intervals provided by iSDA. We computed the PWC for both horizons covered by the iSDA dataset and further calculated PWC down to the bedrock by extrapolating the soil properties of the 20–50 cm horizon.

The map of interpolated AWC, as well as the intermediate variables, is available in GeoTIFF format at Cirad Dataverse under the DOI 10.18167/DVN1/SGNSII. The dataset is available in digital form and in standard formats (geotiff files), with a defined licence (CC BY 4.0) and online access procedure, including a Digital Object Identifier (DOI), to ensure accessibility and reproducibility.

4 | DISCUSSION

AWC maps are useful resources for comprehending water dynamics and availability in Africa, where agriculture, and hence food security, primarily depends on rainfall. These maps can inform hydrological models and spatialized crop simulation models alike, and facilitate yield prediction in water-scarce regions, which rely on soil water holding capacity. The accuracy of such simulations hinges on the precision of input data, particularly soil water holding capacity, often estimated using PAWC maps.

DSM campaigns are typically used to construct these AWC maps, through geostatistical extrapolation of numerous soil samples. In this data article, we introduce a high-resolution AWC map for Senegal, derived from the 30 m iSDA Africa dataset and the USDA Rosetta3 model. This represents the first country-wide AWC dataset at 30 m resolution, benefiting from iSDA's efforts in Africa. The iSDA Africa paper's authors acknowledge that predictions might not be accurate enough for immediate farm-scale management due to uncertainties at smaller scales, but they can serve as a starting point for further sampling and refinement (Hengl et al., 2021).

In determining the appropriate dataset for bedrock depth in our calculations of θa to PAWC in the soil profile, we evaluated two options: the ISRIC Africa SoilGrids—Depth to Bedrock (Hengl et al., 2015) and the iSDA dataset. A comparative analysis, involving visual inspection of the seasonal vegetation dynamics across the country using MODIS remote sensing products (results not shown), revealed notable differences between these datasets. The iSDA's depth to bedrock data showed a considerable variance from the ISRIC's data. Notably, we observed a stronger correlation between areas of higher water retention capacities, as estimated from our AWC maps, and regions of greener vegetation in the iSDA dataset. This correlation was less evident in the ISRIC dataset. Furthermore, the ISRIC dataset lacked a quality metric for its depth to bedrock map, whereas the iSDA dataset demonstrated a concordance correlation coefficient of 0.725 and an RMSE of 41 cm. Given these findings and the importance of data source homogeneity, we opted to use the iSDA dataset as our depth reference. Our maps offer a valuable resource for spatialized crop model simulations in the region where water is a limiting factor for crop production. Other similar products also exist. For example, Leenaars et al. (2018) introduced the RZ-PAWHC dataset, derived from ISRIC soil properties maps, which provides a 1 km resolution. Interestingly, their approach focuses on maize plants' rooting capacity, considering certain physicochemical factors that influence potential rooting depth. Their study presents the first spatially explicit maps of rootable depth and root zone plant-available water holding capacity (RZ-PAWHC) for sub-Saharan Africa, using georeferenced data from 28,000 soil profiles and DSM techniques. The average RZ-PAWHC for the region is 74 mm, with an associated root zone depth of 96 cm, largely limited by rootable depth and sensitive to FC definitions. This dataset was produced directly from DSM using point data, while we leverage existing maps specifically created for Africa. However, as the authors discuss, their approach seems to lack observational validation. Additionally, Turek et al. (2023) introduced a global 250 m point-based mapping approach for global SWR using data from the WoSIS Soil Profile Database, resulting in improved soil data availability and quality. The point-based mapping method demonstrated higher accuracy than map-based approaches for 330 and 15,000 cm suction, with similar results for 100 cm suction, potentially due to limited SWR observations.

While we believe that our approach, which takes advantage of the high-resolution iSDA product and applies plausibility filtering, may lead to a higher quality dataset, this mapping exercise is based solely on the reuse of existing datasets and should be validated using ground truth measurements in future work. One advantage of our method is that it can be easily adapted to produce refined datasets as newer versions of iSDA become available, particularly with the inclusion of data from the EU Copernicus Sentinel satellites and other upcoming missions (the product is aimed at being updated regularly, and its distribution methods are thought this way as they are provided through a STAC server at https://isdasoil.s3.amazonaws.com). Also, another advantage is that this method can be applied to any other country in Africa as iSDA data are available at the continental level.

By offering a more accurate estimate of water availability for crops, our map could significantly improve the reliability of crop simulation models, ultimately helping to optimize agricultural practices, ensure food security and support sustainable land management. The enhanced accuracy of these models using the high-resolution AWC map can also be instrumental in informing policy decisions and investments in agriculture. By providing more reliable predictions of potential crop yields and identifying areas where water is a limiting factor, our map can help guide the development and implementation of targeted interventions, such as irrigation infrastructure or water management practices, to close yield gaps and increase agricultural productivity. For example, and depending on each crop type, areas with low AWC values may require irrigation or other water management practices to achieve optimal yields, while areas with high AWC values may be suitable for rainfed agriculture. In a comparable state of idea, AWC maps could be used to refine suitability maps at the country scale.

Overall, leveraging high-resolution datasets like our PAWC map not only enhances the accuracy of water availability estimates for crops but also provides added value through flexibility, as it allows for aggregation to lower resolutions when needed, ensuring a more comprehensive understanding of water resources for optimal agricultural management and policy decisions.

5 | CONCLUSION

In this data article, we presented a high-resolution AWC map for Senegal, derived from existing datasets and a widely-used PTF. Rather than conducting an extensive field campaign, we leveraged the iSDA Africa dataset, which is based on the most extensive compilation of soil samples for Africa to date. By applying plausibility filtering and a widely-validated PTF, we produced a map that can significantly improve the accuracy and reliability of crop simulation models in the region, where water availability is a limiting factor for crop production.

Our approach not only offers a valuable resource for agricultural and land management practices, but it is also in line with the principles of open science. The dataset we produced is available in geotiff format at Cirad's Dataverse (DOI 10.18167/DVN1/SGNSII) and complies with FAIR data principles, making it readily available for other researchers to use in their own research. The detailed description of the workflow used to produce the map, including the methods and code used to derive PAWC from the soil properties maps (DOI 10.5281/zenodo.10078399), will enable other researchers to use it for their own research and facilitate comparisons with similar products.

The presented dataset can also be used to inform soil and fertilizer policies and investments, agronomic advice to close yield gaps, and environmental programs or interventions targeting nutrition. While this article focuses on the case of Senegal, the method can be applied equally to all the countries covered by iSDA Africa or any other relevant soil properties map dataset. Notably, we also provide a link to the same work performed for Burkina Faso, accessible at the DOI 10.18167/DVN1/QNX5HU.

In conclusion, we hope that our high-resolution AWC map will contribute to the broader effort of improving food security and sustainable land management in the region. By leveraging existing datasets and open science principles, we demonstrate that valuable resources can be produced in a cost-effective and collaborative manner, ultimately leading to better decision-making and resource management.

AUTHOR CONTRIBUTIONS

Jérémy Lavarenne: Conceptualization; methodology; software; writing – original draft; writing – review and editing; formal analysis. **Louise Leroux:** Visualization; writing – review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The datasets generated during the current study are available in the Cirad Dataverse repository, accessible via 10.18167/DVN1/SGNSII, 10.18167/DVN1/QNX5HU and 10.5281/zenodo.10078399. This includes processed data, and analysis scripts used in this study. The data are provided in geotiff format and is freely accessible without restrictions.

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