IHE DELFT Institute for Water Education

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Evaluating the application of FAO-WaPOR data to support Colombia’s National Water Study on water consumption in the agricultural sector

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Introduction

Key concepts

Six terms used throughout

Water use

The water a crop actually consumes (actual ET)

Water demand

The potential water a crop needs to grow

Green ET

Crop water consumption supplied by rainfall

Blue ET

Crop water consumption supplied by irrigation

Effective precipitation

The share of rainfall the crop can actually use

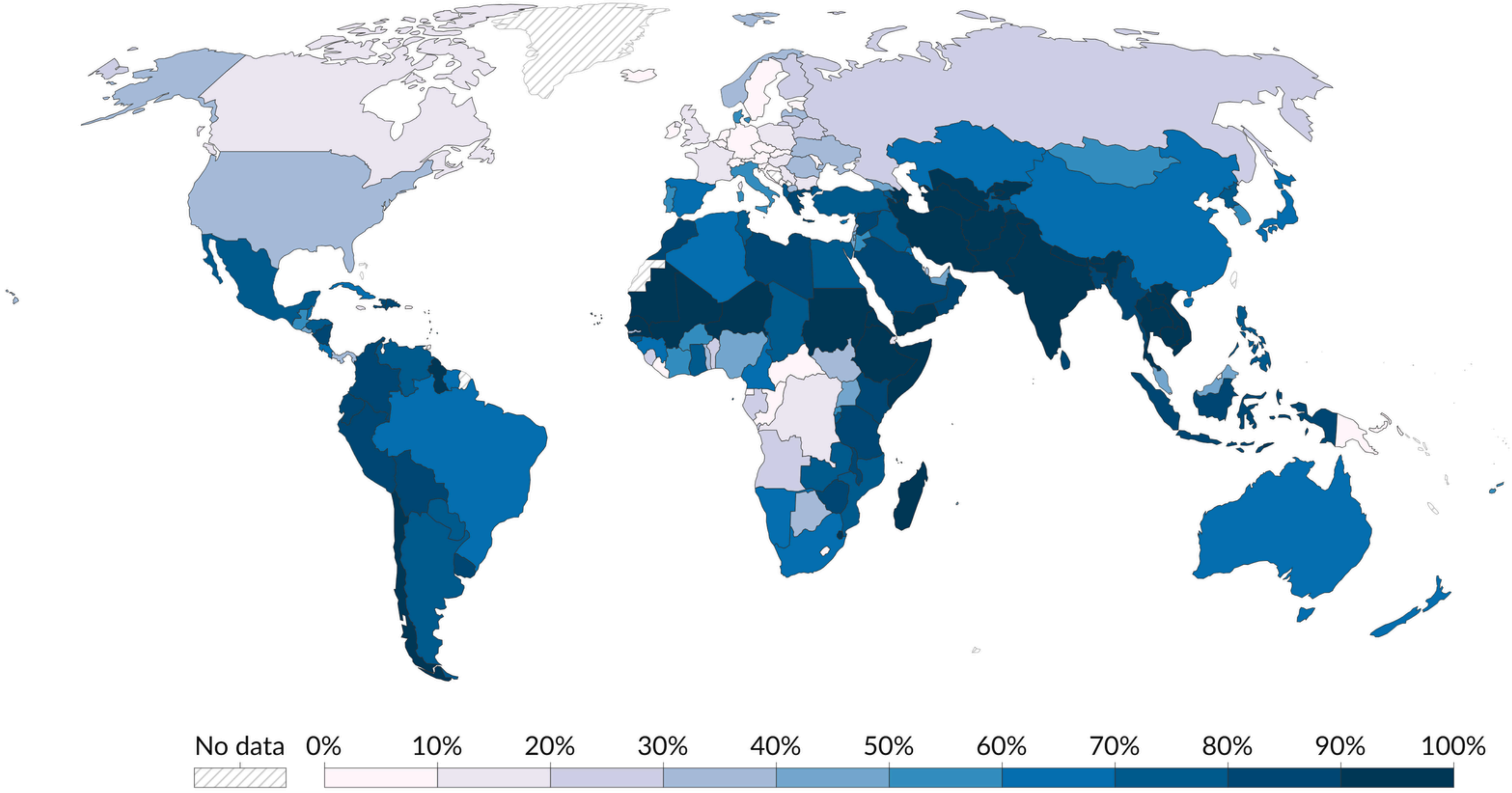
Irrigation water withdrawal

Gross water withdrawn to irrigate, including losses

Introduction

Agricultural water as a share of total water withdrawals, 2021

Agricultural water withdrawals as a percentage of total water withdrawals (which is the sum of water used for agriculture, industry and domestic purposes). Agricultural water is defined as the annual quantity of self-supplied water withdrawn for irrigation, livestock and aquaculture purposes.



Data source: Food and Agriculture Organization of the United Nations, OECD, and World Bank (2025)

Climate change & population growth intensify pressure

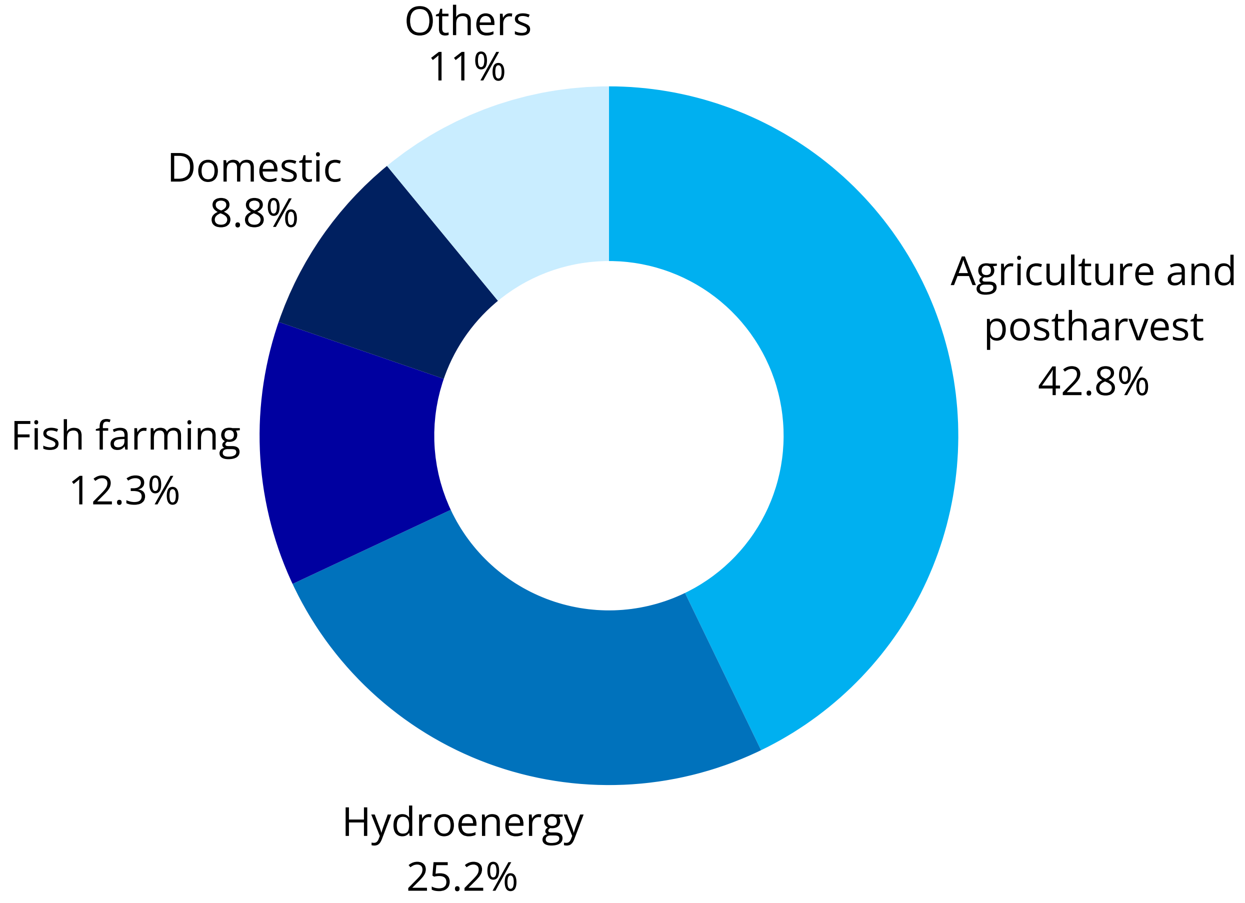
In this context, governments and institutions require explicit and accurate spatial information on the actual water usage of crops.

(World Bank 2020).

Agriculture currently consumes approximately 70% of the water withdrawn worldwide

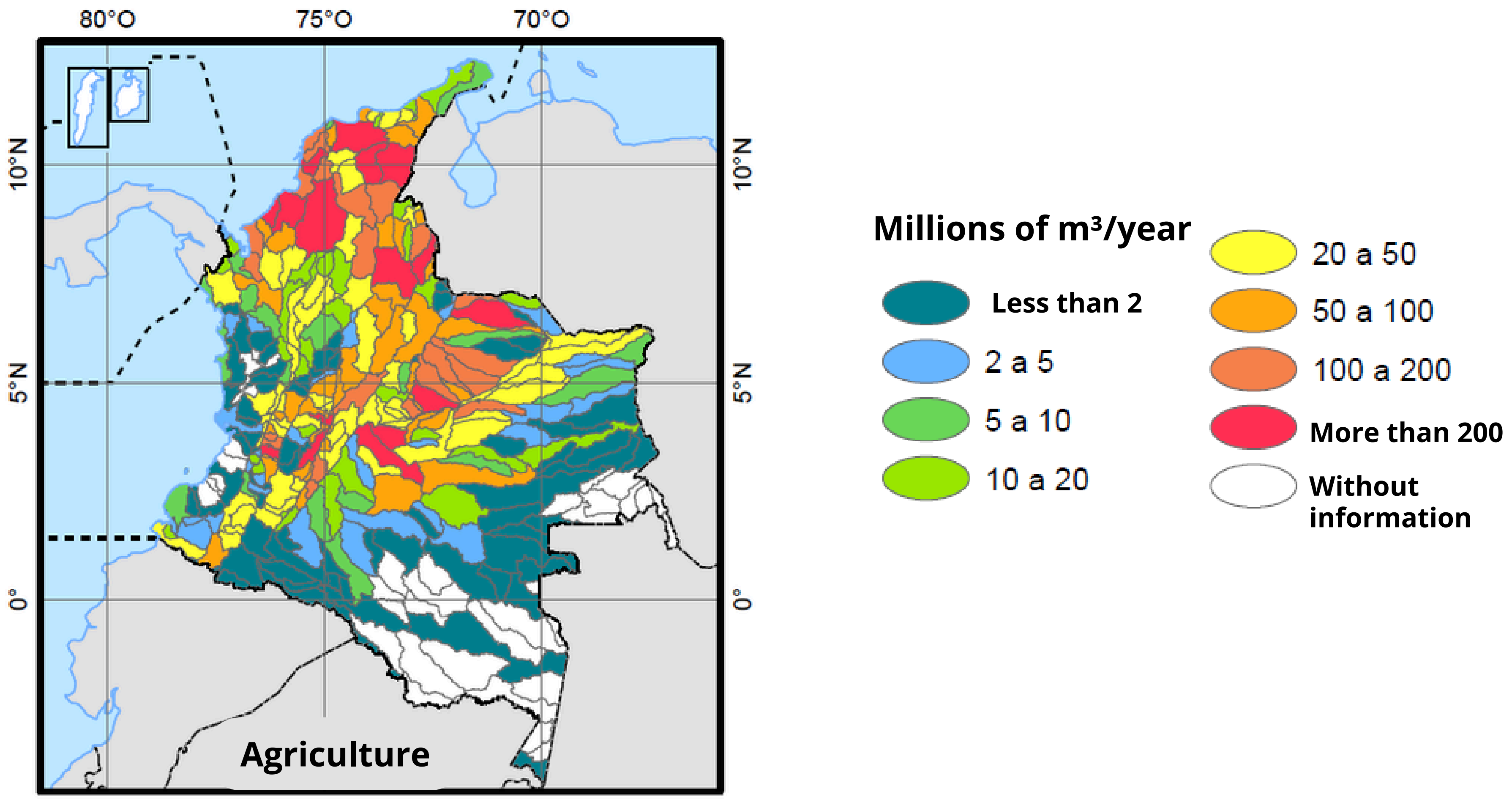
(Abbott et al. 2019; D'Odorico et al., 2019 cited in Wu et al. 2022)

Introduction
Colombia context



Water demand is crucial for Colombia's basin allocation plans, **water stress diagnostics**, and climate change strategies, as agriculture alone accounts **for 43%** of the total national water withdrawals. *(IDEAM, 2023)*

Agricultural water demand for Colombia 2020 (ENA 2022)



National Water Study (Estudio Nacional del Agua, ENA) is the official instrument for quantifying sectoral water demand.

(IDEAM, 2015)

IDEAM

Problem statement
Motivation - ENA

Colombia's sparse hydrometeorological network forces national studies like ENA to extrapolate data to under-monitored regions. *(Donado & Mercado, 2024)*

Operationally intensive

ENA performs the national agricultural water usage assessment through a methodology that involves multiple **intermediate steps.**

Outdated at release

ENA reports are released every four years using data from the two years prior. Thus, **this assessment may be outdated for decision-making at publishing.**

Inherent uncertainty

Each step of the ENA's methodology relies on **spatial and temporal assumptions**, which can increase overall uncertainty.

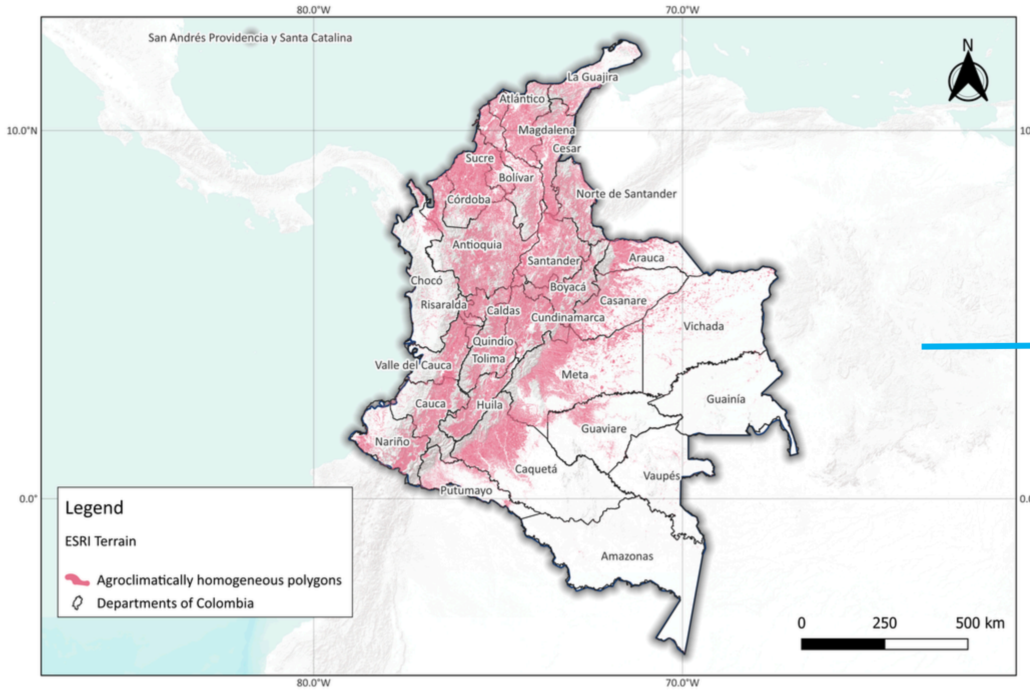
- *(IDEAM, 2015,2019,2023)*

Problem statement

ENA

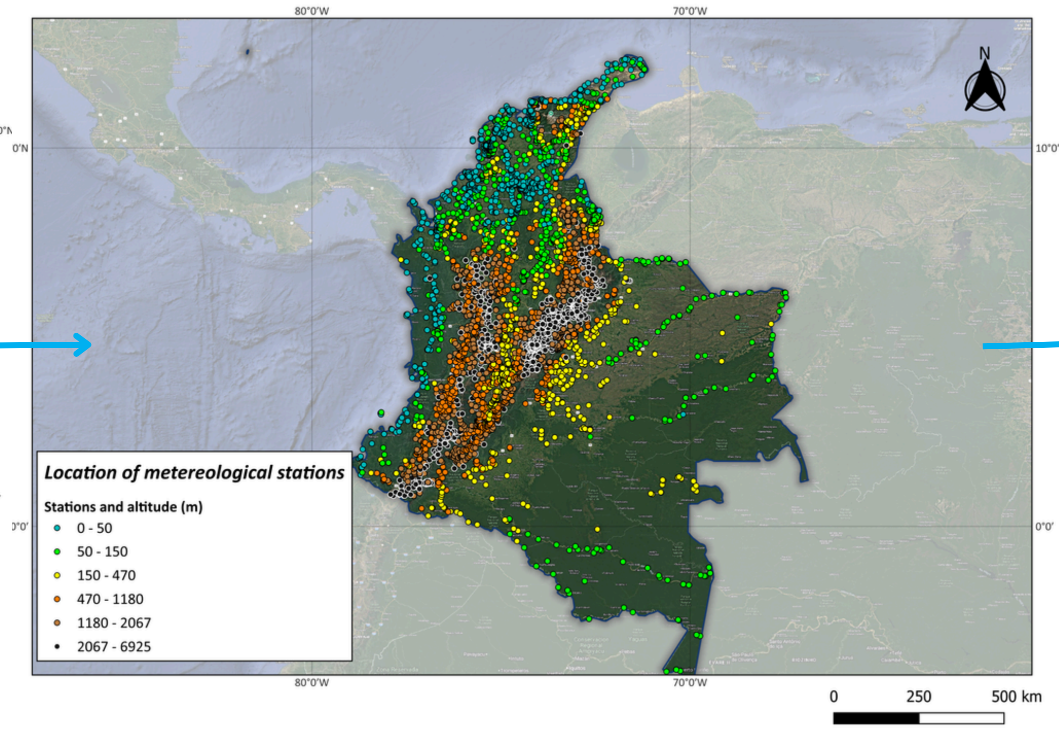
...and it runs on large volumes of input data

Agroclimatic zones (Crop mask)



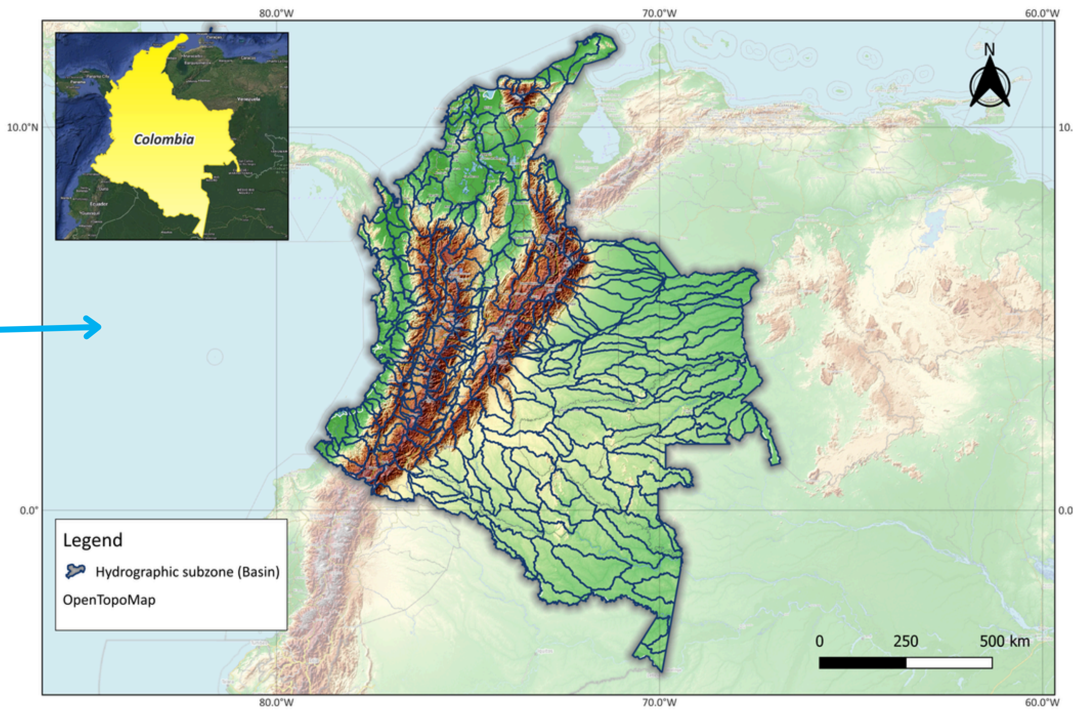
(~ 388.000 polygons)

Metereological stations



(4309 stations)

Hydrographic zones



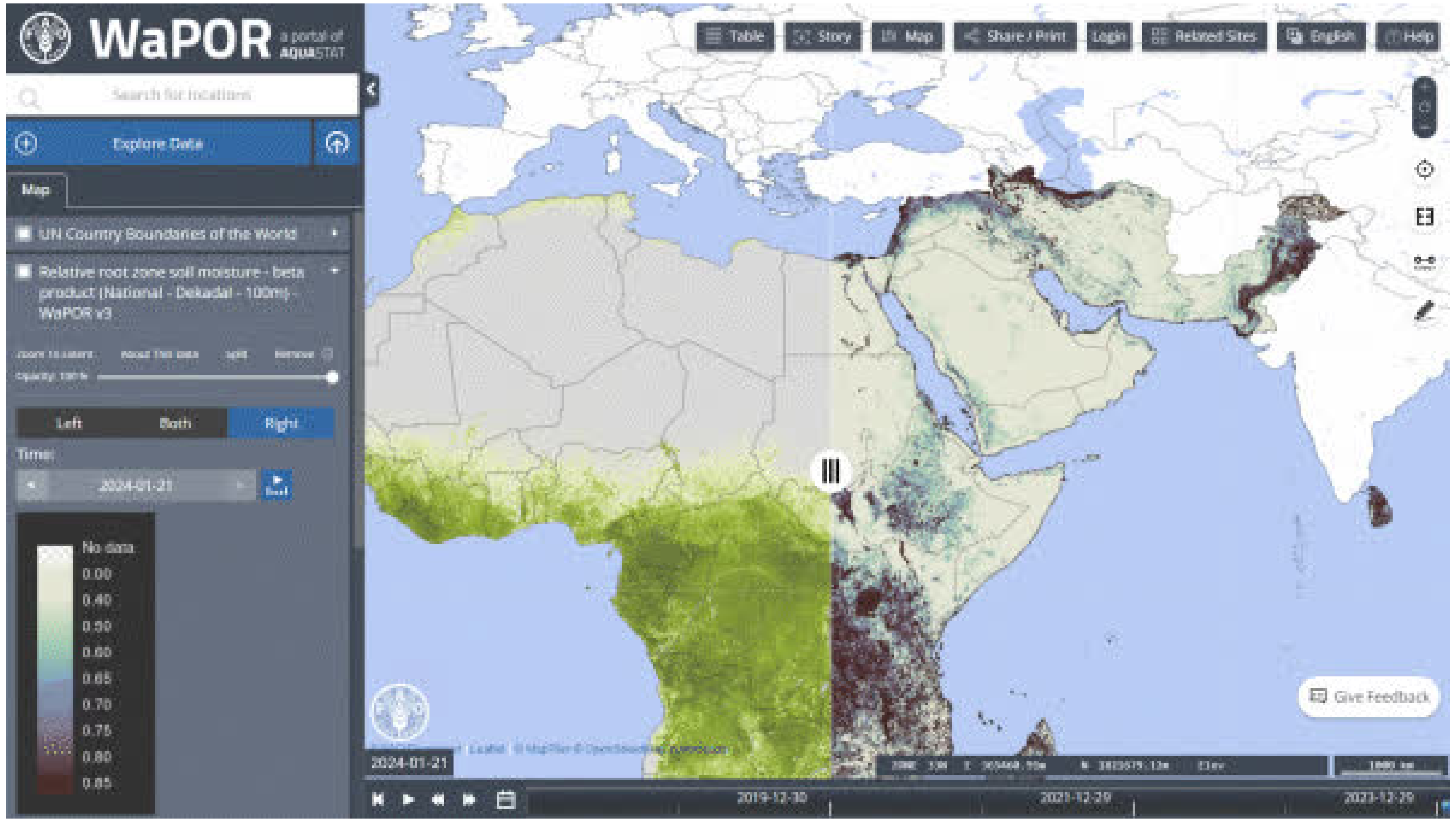
(301 Basins)

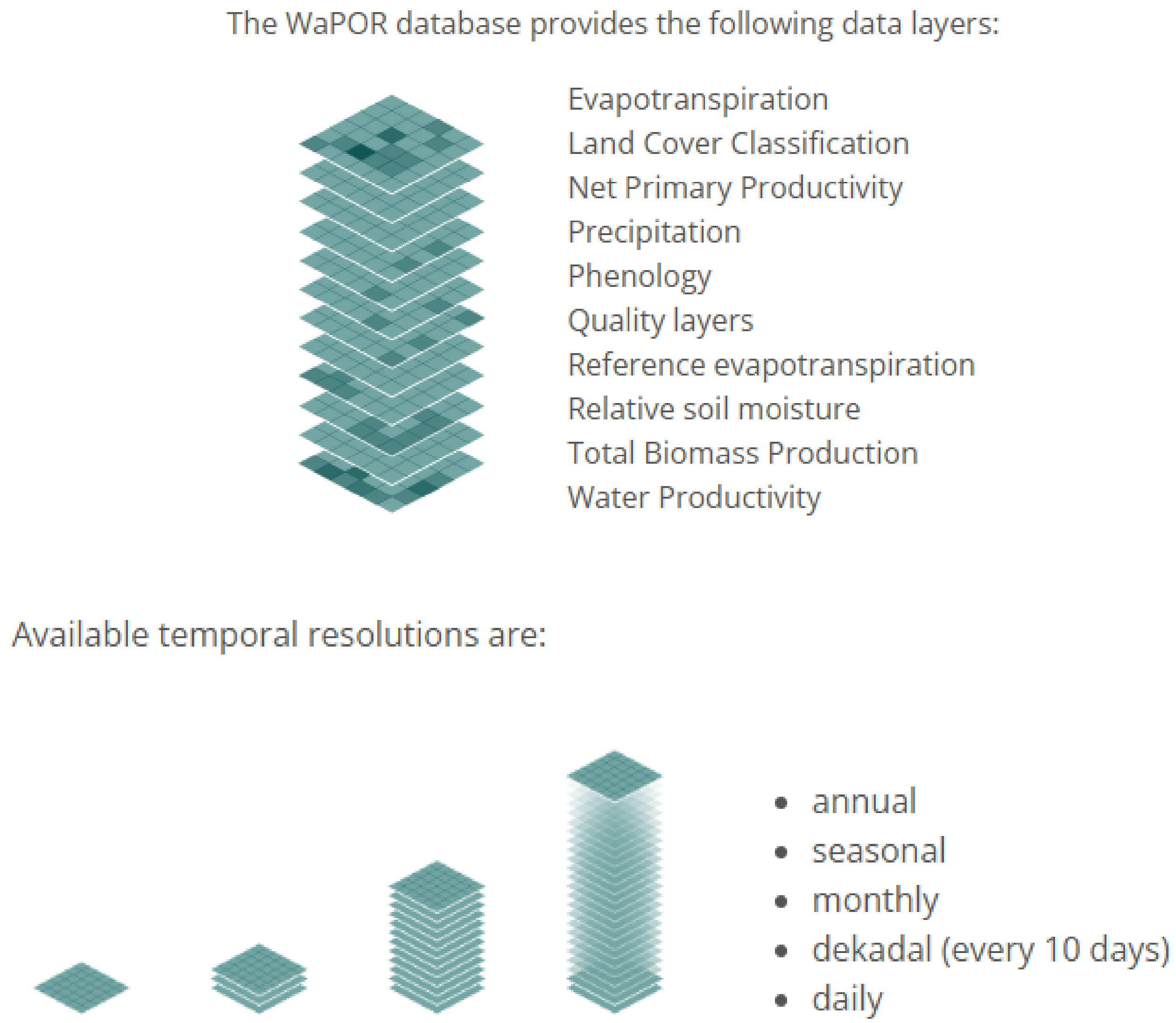
ENA's method is data intensive and requires numerous calculations, making it operationally demanding.

What is WaPOR?

Water Productivity through Open access of Remotely sensed data · FAO

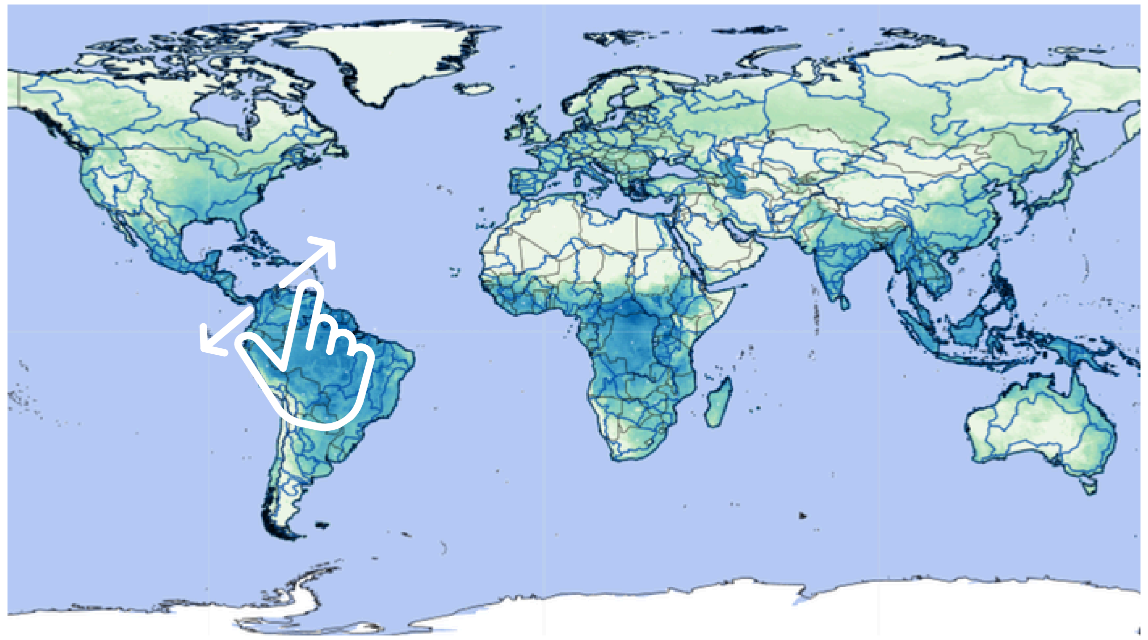
It provides open access to the water productivity database and its thousands of underlying map layers. It allows for direct data queries, time series analyses, area statistics, and data download of key variables associated to water and land productivity assessments.





Why WaPOR?

Open satellite data, a protential input for the ENA



Global coverage

National scale

Regional scale

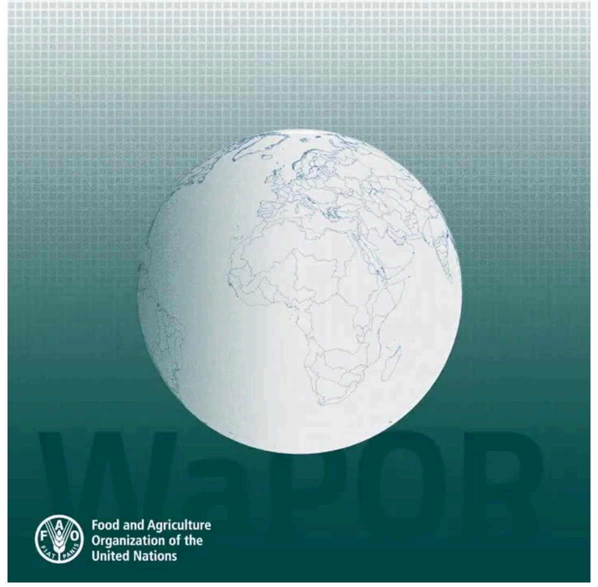
WaPOR provides open, gridded products at the national level (300 m evapotranspiration and 100 m precipitation in dekadal and monthly scales) that may supplement the ENA with near-real-time information.

Research question

Colombian mountains (Canva Education Sandra Zamora 2022)

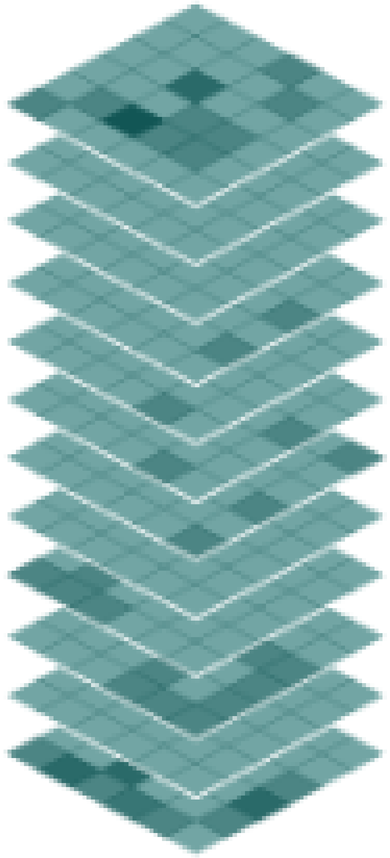
To what extent can FAO-WaPOR satellite data could reproduce the ENA's agricultural water demand estimates for Colombia?

Wapor



A few consistent raster layers could replace the ground-data burden

The WaPOR database provides the following data layers:



- $\boxed{\text{Evapotranspiration}}$
- Land Cover Classification
- Net Primary Productivity
- $\boxed{\text{Precipitation}}$
- Phenology
- Quality layers
- $\boxed{\text{Reference evapotranspiration}}$
- Relative soil moisture
- Total Biomass Production
- Water Productivity

ENA Method

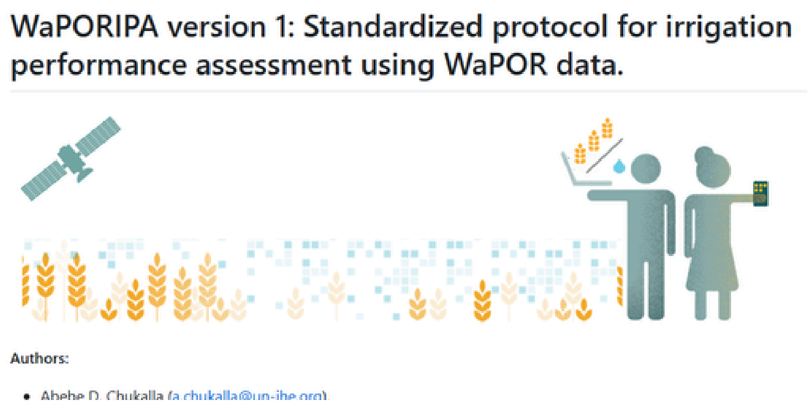
The ENA method requires numerous chained calculations

Agricultural water demand · ENA 2014 is based on the methodology (FAO 56)

1. **Input Data & homogenization**
2. **ET partitioning (ETblue / ETgreen)**
3. **Agricultural water demand**

Sequential steps, each one feeds the next, so every result depends on the assumptions made along the methodology.

WaPOR adapted method


WaPORIPA version 1: Standardized protocol for irrigation performance assessment using WaPOR data.

Authors:

- Abebe D. Chukalla (a.chukalla@un-ihe.org)

Adapted from WaPORIPA (***a standardized protocol for irrigation performance assessment using WaPOR data***), three steps, driven by WaPOR

1

Input data

WaPOR AETI

WaPOR PCP

Crop mask ENA

2

WaPORIPA · Module 2

Green & Blue ET partition

3

Irrigation water withdrawal

WaPORIPA v1 has four modules (1a–4); this study uses Module 1a (seasonal AETI) and Module 2 (green/blue partition).

github.com/wateraccounting/WaPORIPA — open, community-maintained

Open source tools used

Every layer is free to use, inspect and reuse

Open data	Open framework	Open code	Published
WaPOR	**WaPORIPA**	**Python, Bokeh**	**GitHub**

Reproducible
Rerun the whole pipeline and verify

No licenses
Free for any institution — e.g. IDEAM

Adaptable
Clone it for any basin or country

Open data + open tools → a method anyone can pick up · github.com/laagudelo/WaPORENA

Results and discussion

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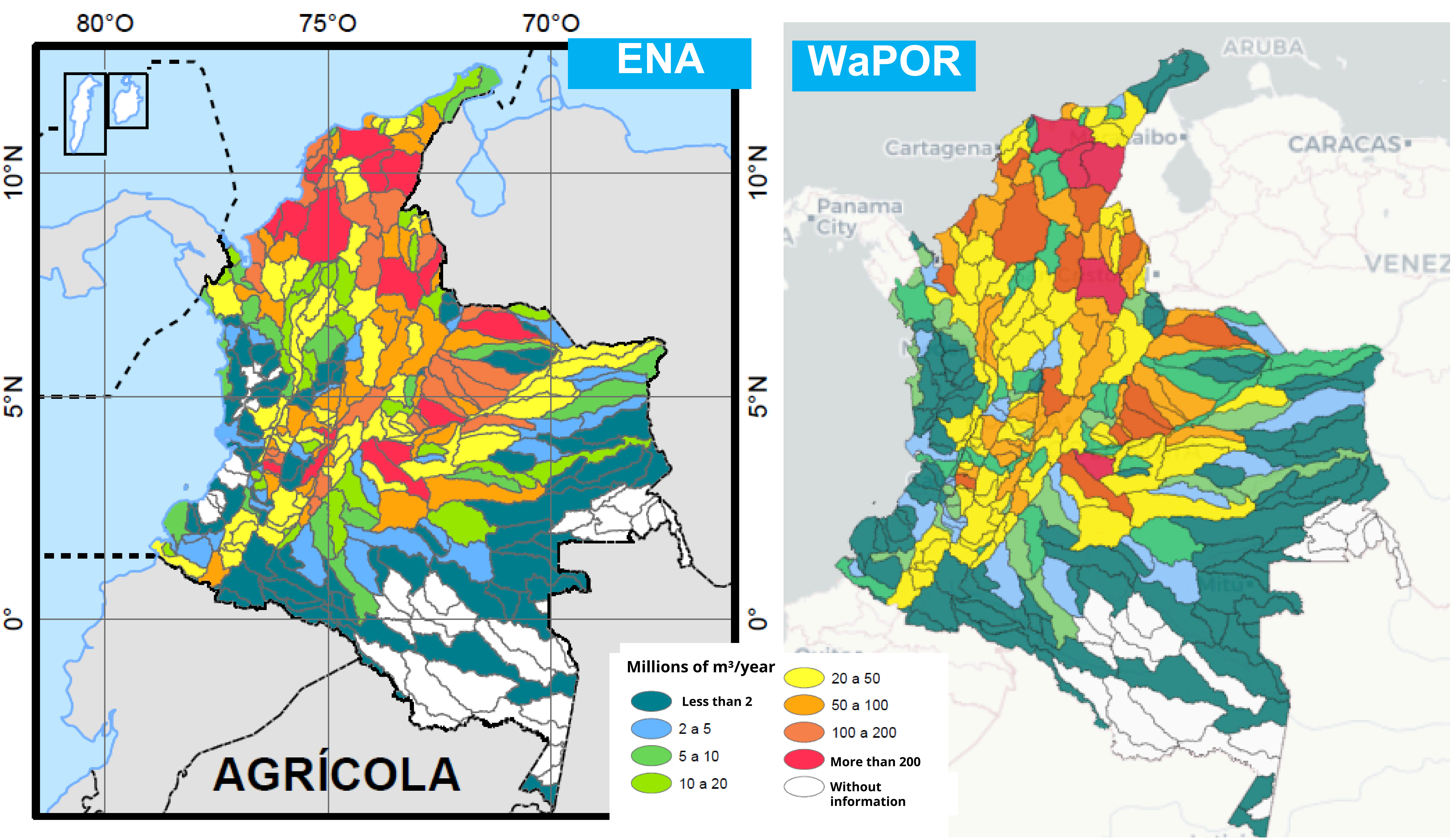
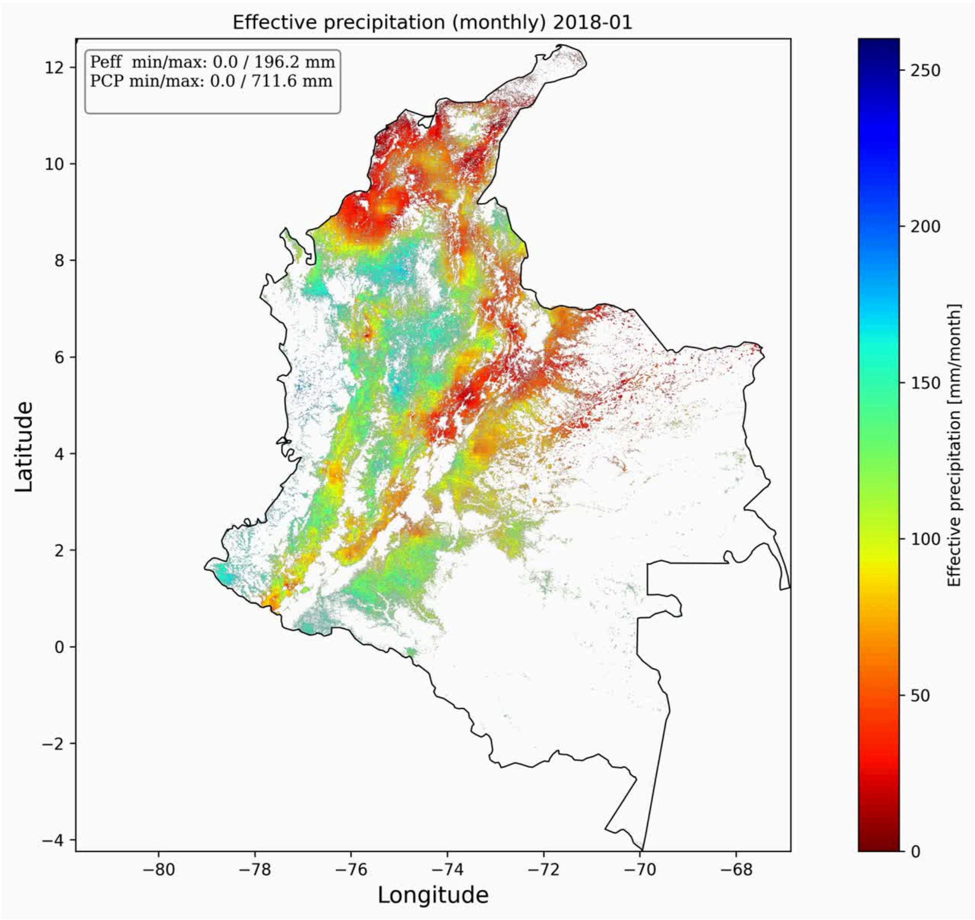


ENA
WaPOR
80°O
75°O
70°O
10°N
5°N
0°
AGRÍCOLA
ARUBA
Cartagena
CARACAS
Panama City
Millions of m³/year
Less than 2
2 a 5
5 a 10
10 a 20
20 a 50
50 a 100
100 a 200
More than 200
Without information

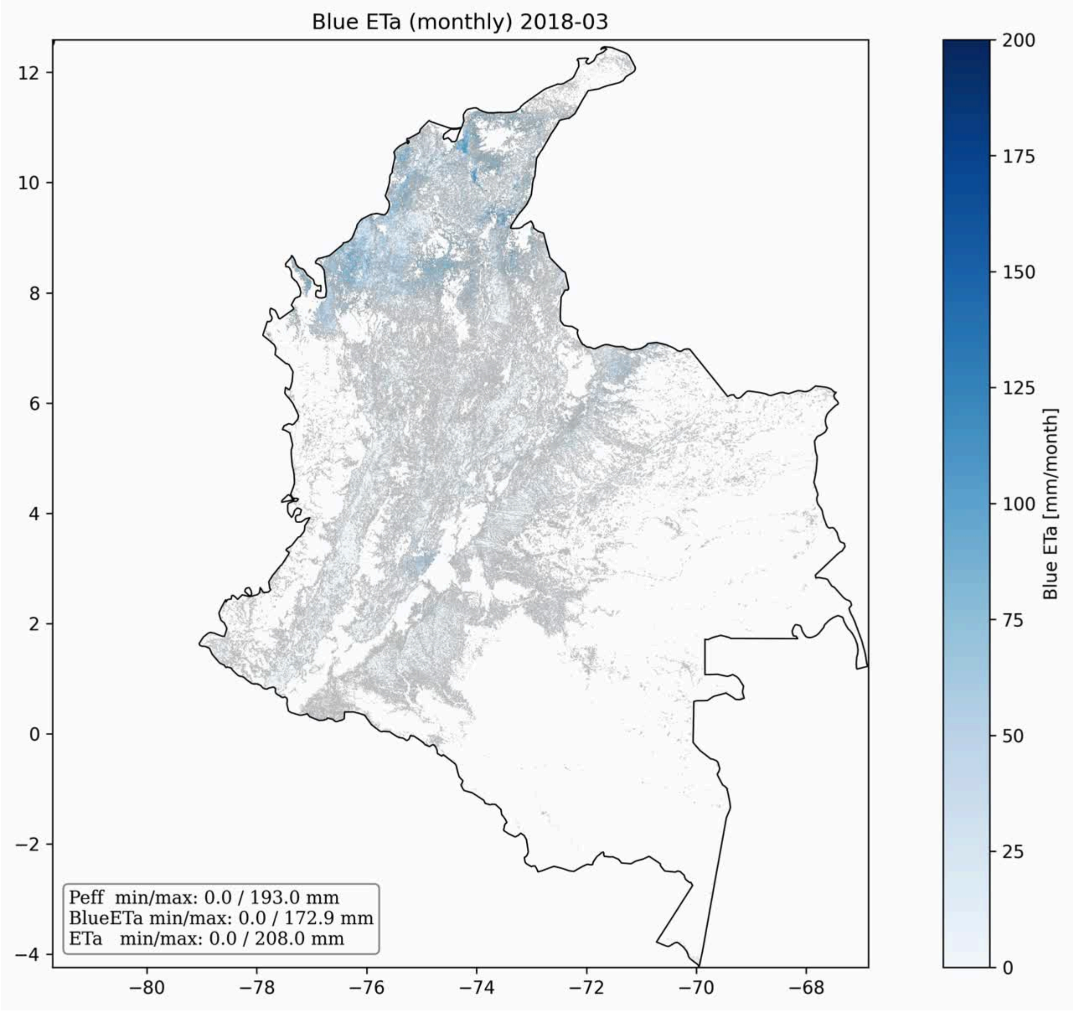
Estimation of variables using frameworks from water accounting

WaPORIPA version 1

Effective precipitation



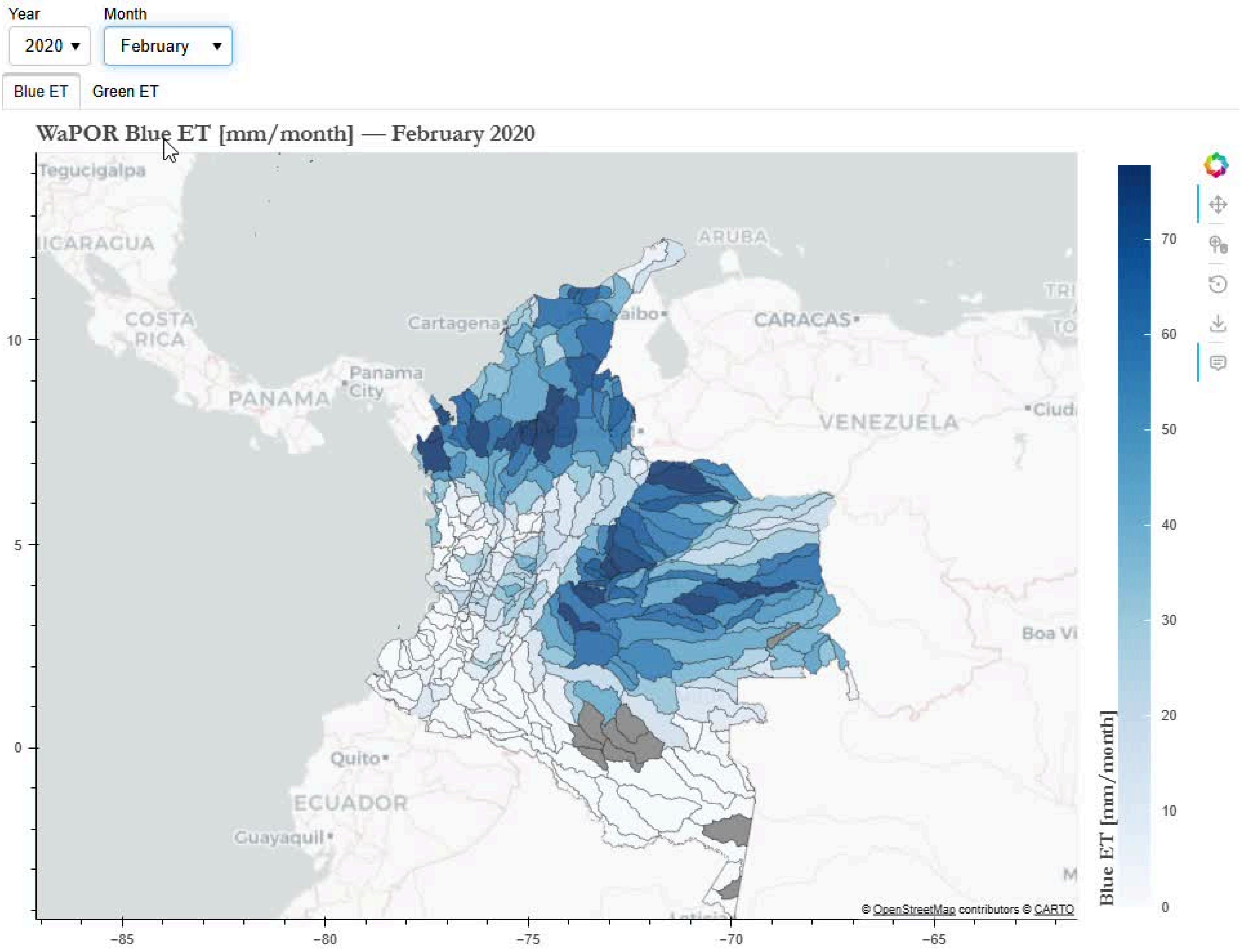
ET blue



- **Strong seasonal signal blue ET peaks in the dry season, near-zero when it rains**
- **For Peff In dry months, almost all rain counts → over 80% is used (Jan–Mar), but heavy wet-season rain mostly runs off**

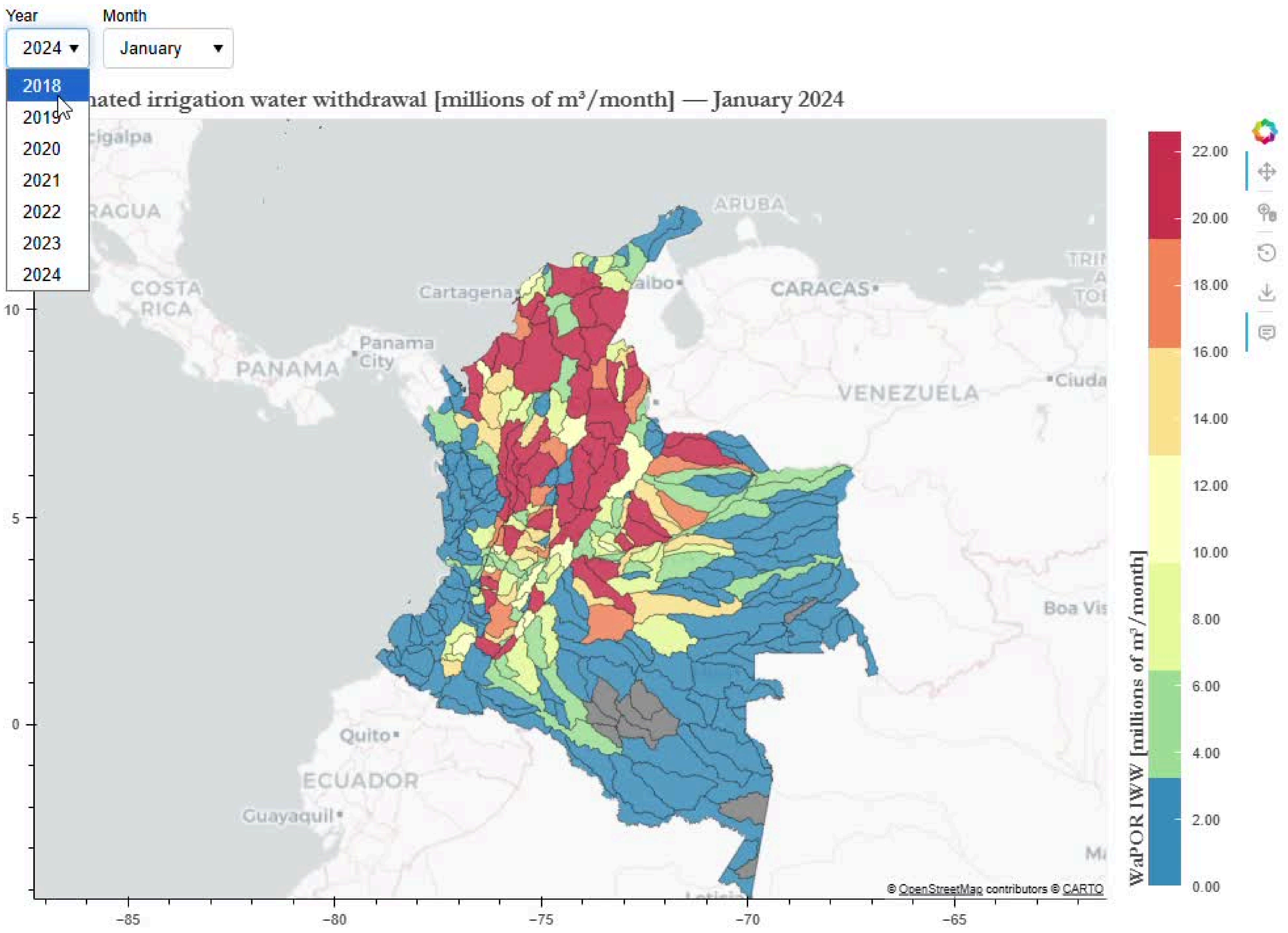
ET blue and green at basin scale for permanent crops

bokeh



- **Green water dominates most of the year.**
- **Captures intra-annual variability invisible to the 4-year ENA reporting cycle**
- **Supports drought & flood monitoring through temporal anomalies**

Estimated irrigation water withdrawal



- **Strongly seasonal demand → concentrated in the dry months (Dec–Apr), near zero across most basins in the wet season**
- **Shows where water stress is highest → central Andean basins**

Conclusions

- ENA and WaPOR products are, in some cases, **conceptually distinct**.

- ENA employs a **water-soil balance** approach that estimates potential water demand

- WaPOR's **satellite-based approach** quantifies actual water consumption, constrained by real land surface conditions.

- This investigation demonstrates that WaPOR can serve as a **powerful complementary tool** for national water accounting for agriculture for national institutions as IDEAM.

- Ideal for frequent monitoring and identifying **water stress hotspots**.

- WaPOR could also accelerate national reporting procedures, helping to inform planning strategies in Colombia for water management purposes.

Limitations

- **No field validation.** No ground data yet to confirm which product is closer to reality.
- **National scale only**. Run at country level, so regional differences get averaged out.
- **Permanent crops only.** Covers just the ~20 permanent crops in the ENA mask, no seasonal ones.
- **Validation in a paper.** The full ENA vs. WaPOR comparison is coming in an upcoming publication. **More on the Magdalena region**: This paper will also dig deeper into the Magdalena region.

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Thank you!

Questions?

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