

Leveraging Remote Sensing for Enhanced Irrigation Performance Assessments in Data-Limited and Water-Scarce Regions Northern Jordan Valley as a Case Study

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Introduction

- Jordan's renewable water resources < 100 m³/year below the absolute scarcity threshold of 500 m³/year.
- Irrigated agriculture accounts for 50% of available water in Jordan, but inefficiencies and over-irrigation persist.
- NJV, the country's agricultural heartland, faces mounting pressure from other water sectors and declining Yarmouk River flows.
- Monitoring NJV scheme performance an imperative

A New Approach: From Supply to Consumption

- Conventional methods measure water *supplied*, whereas satellite-derived data capture actual water *consumed*, bridging a vital knowledge gap .
- FAO's WaPOR v3 productivity data (20 m resolution) enables spatially explicit, multi-scale productivity assessments.

Introducing the IPADT

- The *Irrigation Performance Assessment and Diagnostics Tool (IPADT)* was jointly developed by IWMI, the Jordan Valley Authority (JVA), and FAO.
- It tracks NJV water use and scheme performance using satellite, field and hybrid indicators
- The tool integrates remote sensing data with JVA supply records to assess irrigation performance across the NJV for the 2018–2025 period.

Materials and Methods

Data Sources

Five datasets were integrated to assess irrigation performance across the NJV (Table 1). Monthly WaPOR Level 3 AETI and NPP rasters (20 m) were preferred over dekadal products for better alignment with agricultural reporting periods and reduced computational load. Rainfall contribution to crop growth was quantified as effective rainfall following FAO-56 methodology. Cropped area was mapped from Sentinel-2 imagery (10 m) using a supervised classifier to distinguish active cropland from fallow land.

Table 1: Datasets summary

Variable	Source	Resolution	Period
Actual ET (AETI)	WaPOR V3	20m/monthly	2018-2025
Net Primary Prod. (NPP)	WaPOR V3	20m/monthly	2018-2025
Reference ET (ETO)	WaPOR	5km/monthly	2018-2025
Rainfall	CHIRPS	5km/monthly	2018-2025
Supplied Water	JVA Records	Farm Unit	2021-2025

Analytical Framework

The IPADT framework derives multi-scale irrigation performance indicators at three nested spatial levels: Scheme, Development Area (DA), and Farm Unit (FU). Monthly rasters were aggregated to annual totals and clipped to JVA boundary shapefiles at each scale.

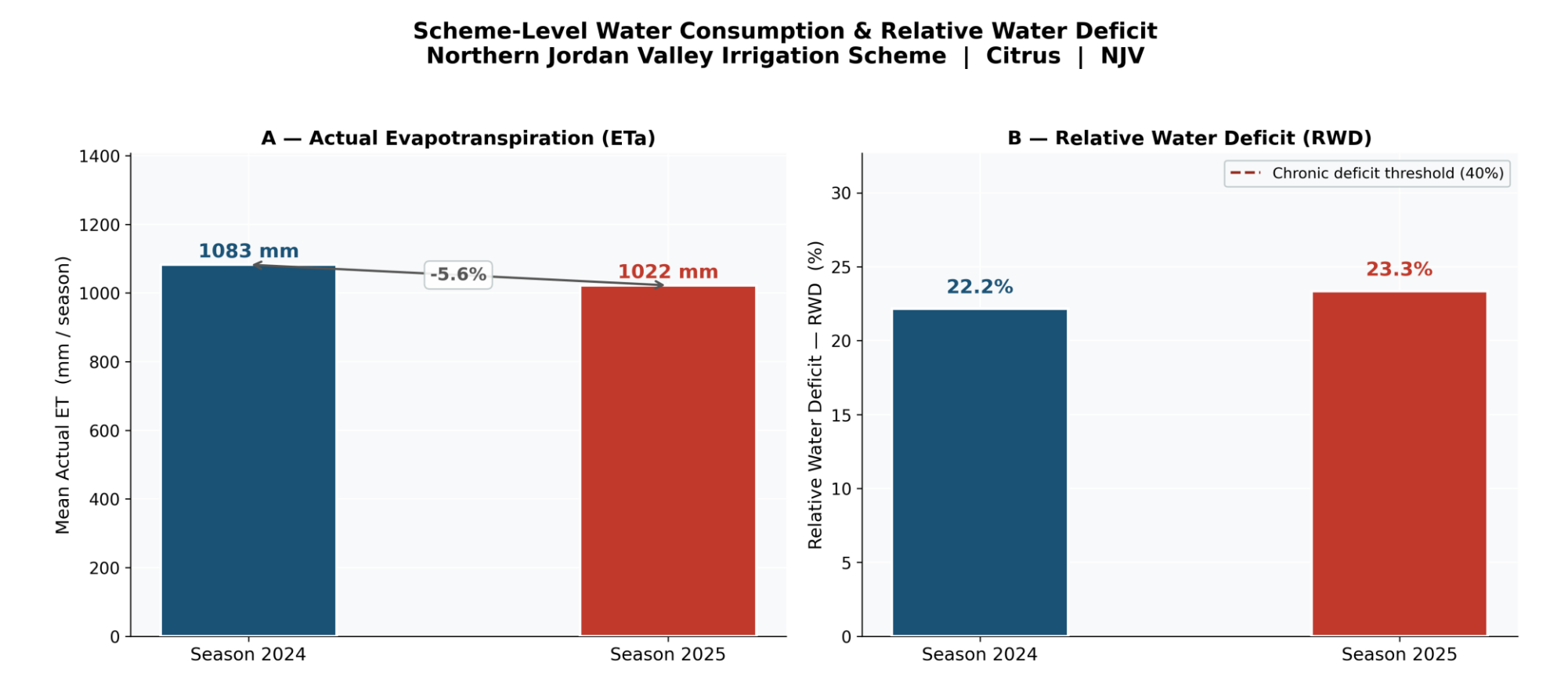
Five indicator categories were calculated:

- Consumption: volumetric crop water use (ET_a), spatial equity, and uniformity of water distribution
- Supply: metered sold water and relative irrigation amount (irrigation + effective rainfall)
- Deficit: relative water deficit (RWD) and crop water deficit (CWD = ET_p - ET_a)
- Productivity: biomass water productivity and cropped area fraction
- Temporal: monthly ET_a, ET_o, and rainfall trends for intra- and inter-annual variability analysis

Results

Scheme-Level Performance (2018–2025)

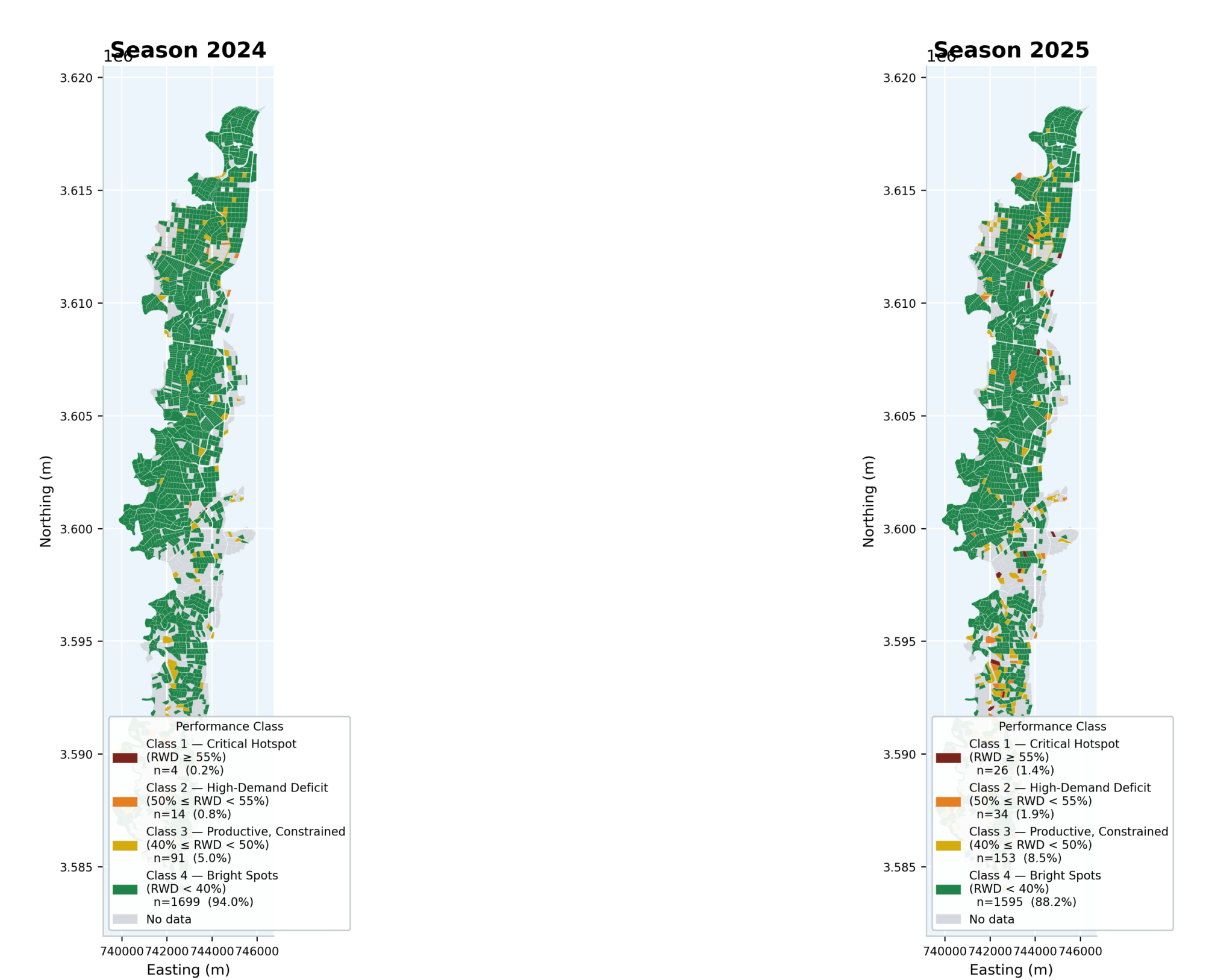
Annual ET_a rose 30% (732 → 941 mm) while volumetric consumption increased from 50 to 62 MCM. Canal supply remained fixed at ~30–31 MCM/year, producing a persistent structural deficit. RWD held consistently at ~40% across all years — confirming chronic deficit irrigation regardless of climatic conditions.



FU-Level & Water Productivity

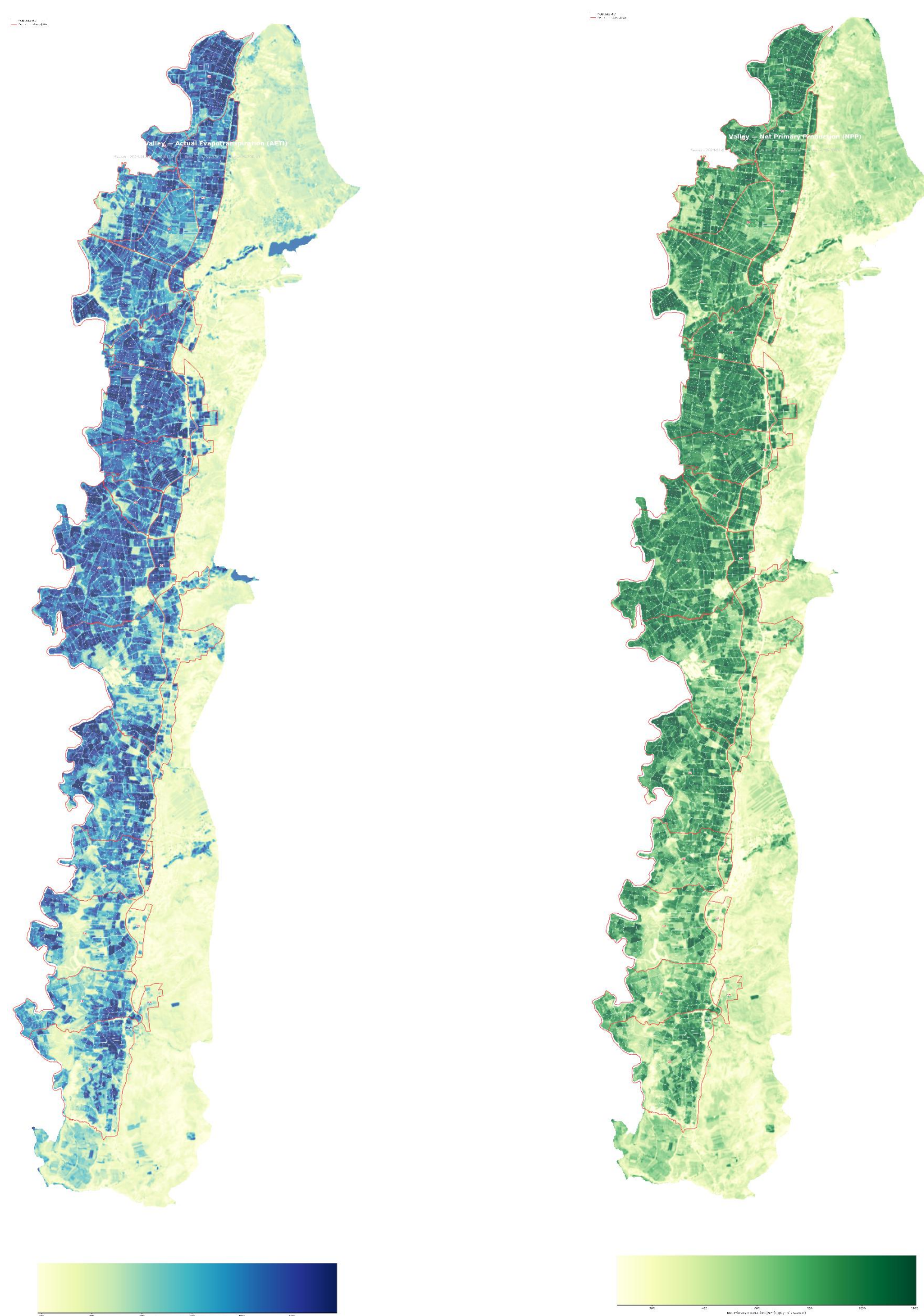
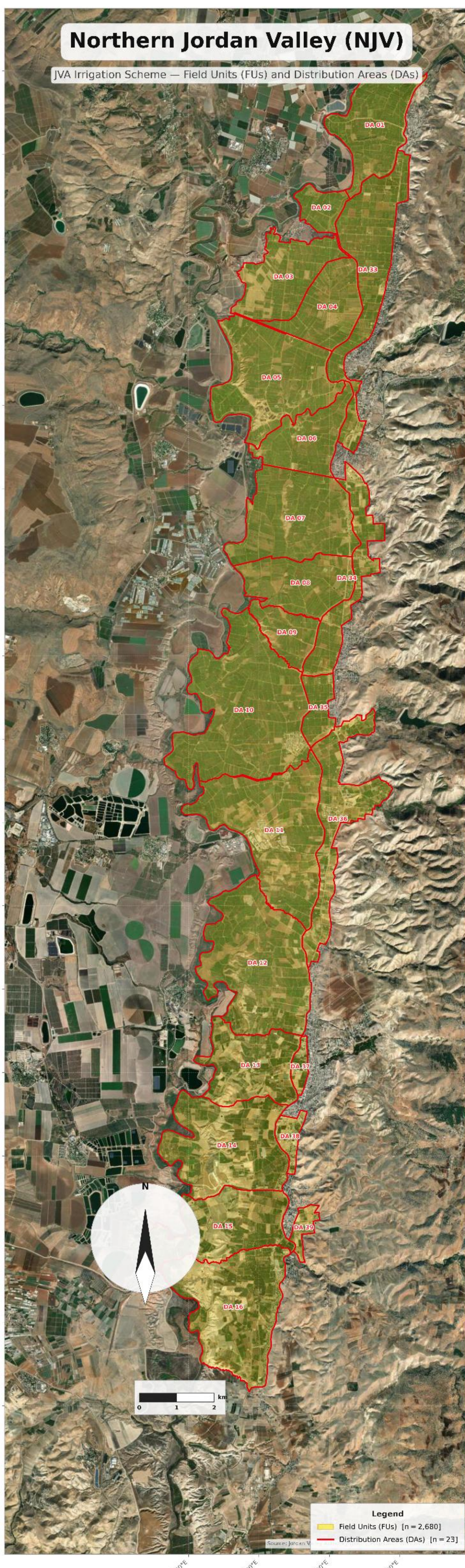
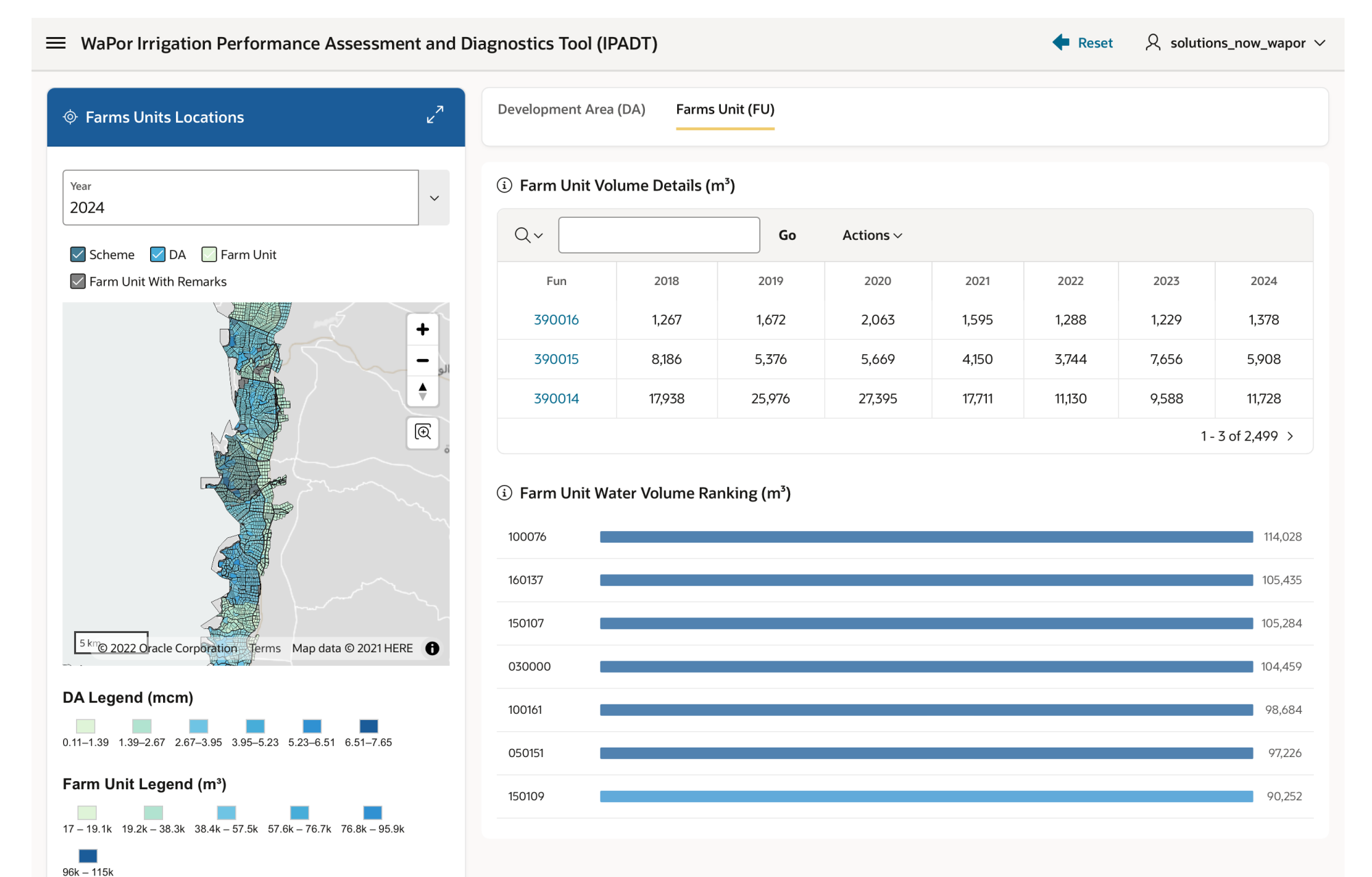
Median farm ET_a: 18,000–22,000 m³/year. Biomass water productivity is uniform across citrus farms at 1.8–2.2 kg/m³. Around 250–260 FUs show zero metered supply yet non-zero ET indicating undocumented groundwater or informal water use. One in four FUs exceeds a crop water deficit of 400 mm/year in constrained years.

Field-Unit Performance Classification — Relative Water Deficit Northern Jordan Valley Irrigation Scheme | NJV



Operationalising Irrigation Performance - IPADT Interactive Dashboard

- Developed a web dashboard to operationalise performance indicators for routine water management.
- Maps key indicators including ET_a, RWD, CWD, supply, and water productivity.
- Provides spatial and temporal data across Scheme, DA, and FU scales for the 2018–2025 period.
- Enables JVA to identify hotspots, track seasonal trends, and make informed allocation decisions.
- Designed for easy use by water managers without prior GIS expertise.
- Co-developed with JVA for direct integration into their operational system.



Performance Classification

DAs were classified into four performance classes based on combined RWD, CWD, supply volume, and ET_a, ranging from Class 1 (critical deficit hotspots) to Class 4 (bright spots with balanced supply–demand). FU-level indicators were treated as diagnostic guides requiring field validation due to pixel-mixing uncertainty at the farm scale.