Food and Agriculture Organization of the United Nations

WaPOR

FAO's portal to monitor Water Productivity through Open-access of Remotely sensed derived data

Remote Sensing for Irrigation Performance Assessment

Presenter: Marloes Mul, m.mul@un-ihe.org

IHE Delft Institute for Water Education, the Netherlands

What is Irrigation Performance Assessment

Performance assessment in irrigation and drainage can be defined as the **systematic observation**, **documentation and interpretation of activities related to irrigated agriculture** with the objective of ensuring that the input of resources, operational schedules, intended outputs and required actions proceed as planned.

The ultimate purpose of performance assessment is to achieve efficient, productive and effective irrigation and drainage systems by providing relevant feedback to the scheme management at all levels

Application of Performance Assessment

Operational performance assessment: to determine how the operational processes are performing (for overall production or at sub-processes levels such as main system water delivery, on-farm water delivery, crop.

Strategic performance assessment: to understand how a scheme/s are performing and using available resources.

Diagnostic Performance assessment: to understand the causes of low or high performance, to design and implement interventions for system improvement and rehabilitation.

Comparative performance assessment: to compare performance of one scheme with another in order to set appropriate benchmark standards or identify processes (and best practices) that lead to higher performance.

Performance Indicators examples

Productivity: measure of the efficiency of production

Service indicators

Adequacy: the ability of a system to reach targeted deliveries in terms of quantity (discharge and/or volume) service performance to the users

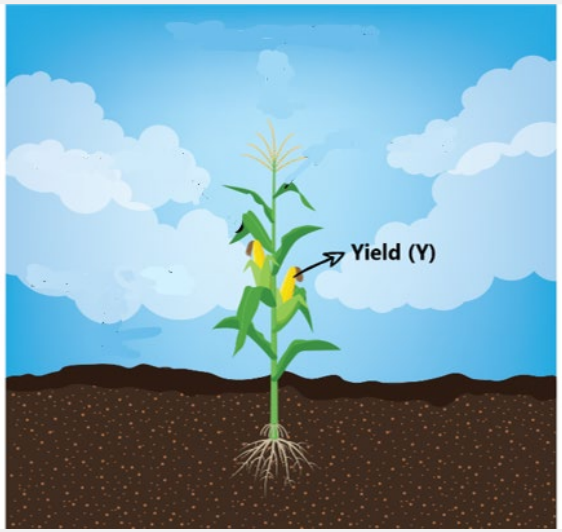
Efficiency: system's ability to minimize water losses due to oversupply

Reliability: the degree to which water delivery conforms to the prior expectations of users

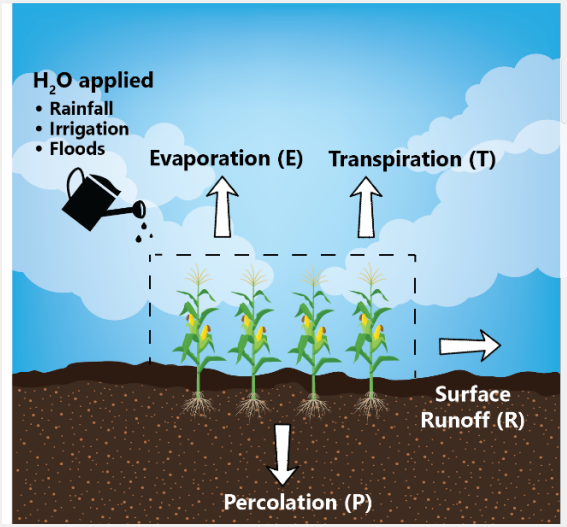
Equity: the degree to which deliveries are considered fair by all

Efficiency in agriculture

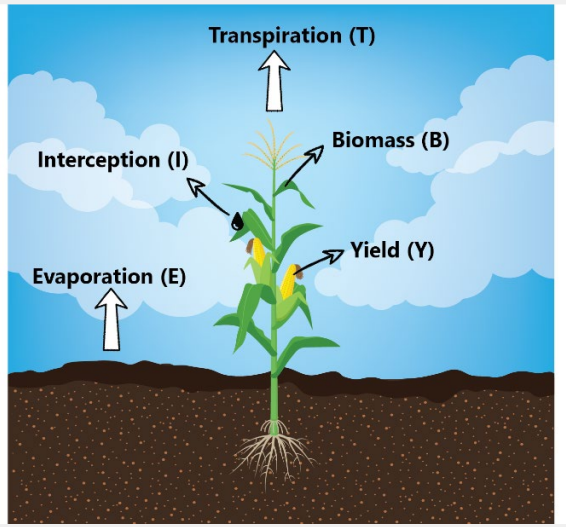
- Land productivity/ production (yield)
- Water use efficiency
- Water productivity



Yield



Water use efficiency



Water productivity

Productivity

- Output per unit of land (land productivity/ yield) or water consumed (water productivity)

$$\text{Yield} = \frac{\text{Production}}{\text{Area}}$$

$$WP_B = \frac{\text{Biomass prd.}}{ETa}$$

$$WP_Y = \frac{\text{Yield}}{ETa}$$

Adequacy

- The ability of a system to reach targeted deliveries in terms of quantity (discharge and/or volume) to the users

$$A = \frac{AETI}{RET}$$

Different possible targets (ETpot):

- RET
- 95 percentile of ET
- Crop water requirement

Relative Water Deficit

- To understand where more water is needed

Relative Water Deficit

$$RWD = 1 - \frac{ETa}{ET_m}$$

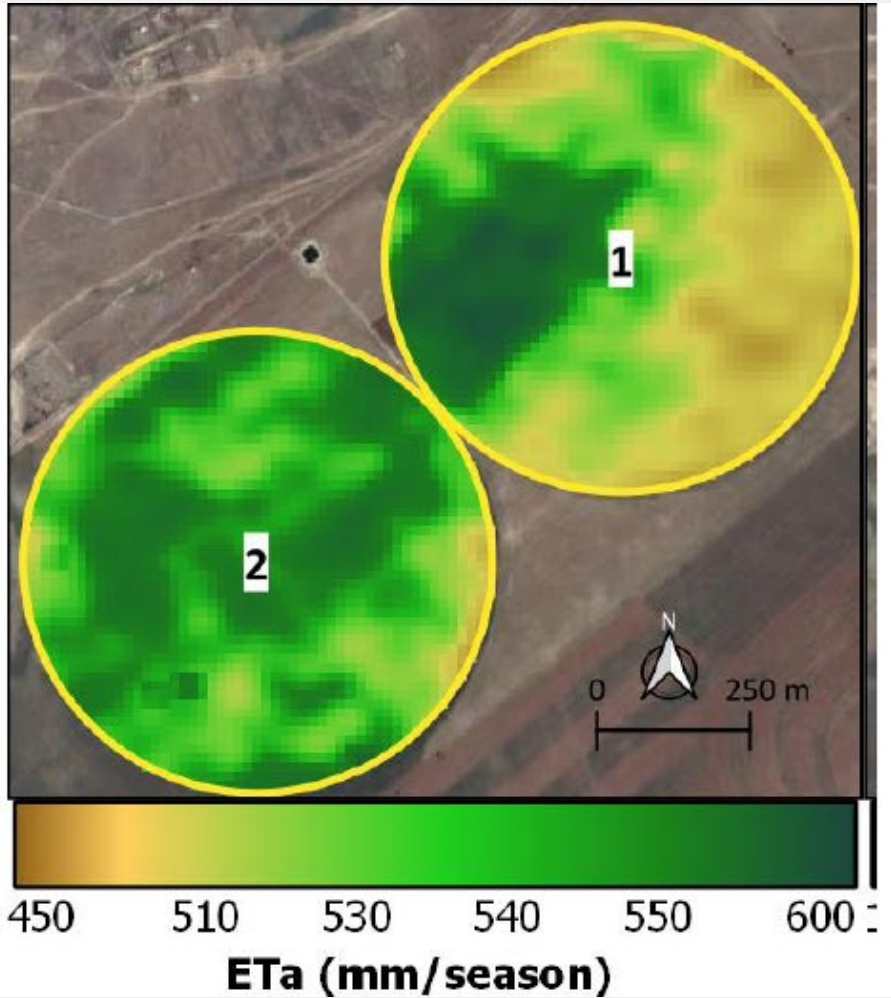
ET_m= maximum crop ET

Uniformity

- The degree to which irrigation application is spatially homogeneous in the field

Spatial variation of ET $= \mathrm{CV}(\mathrm{ETa})$

ETa per pixel in a field



Equity

Example of fairness (do farmers receive the same amount of water)

- The degree to which deliveries are considered fair by all

Has irrigation water delivery been reliable?

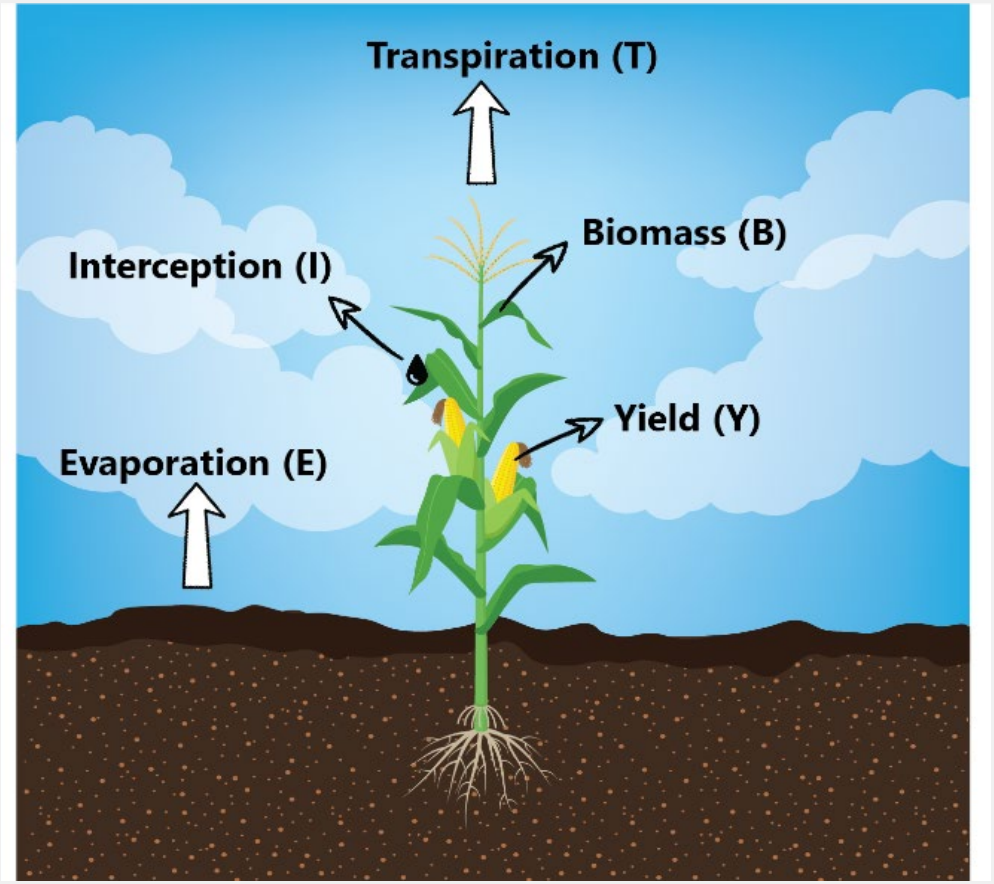
$$\textbf{Equity} = \mathrm{CV}(\mathrm{ETa})$$

Avg ETa per field in the scheme/block

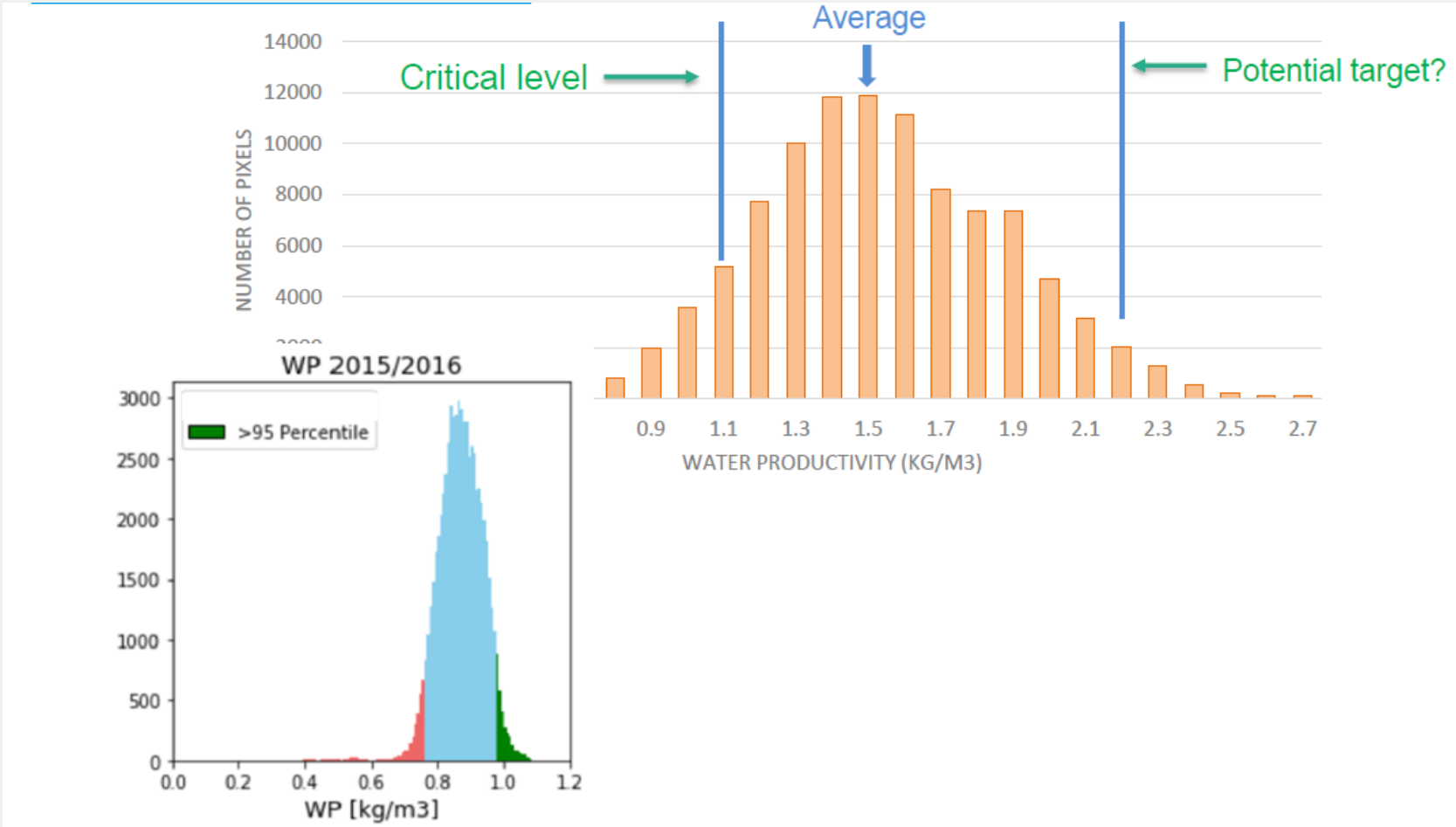
Beneficial fraction

The amount of evapotranspiration that goes into transpiration (for plant growth)

$$Bf = \frac{T}{AETI}$$

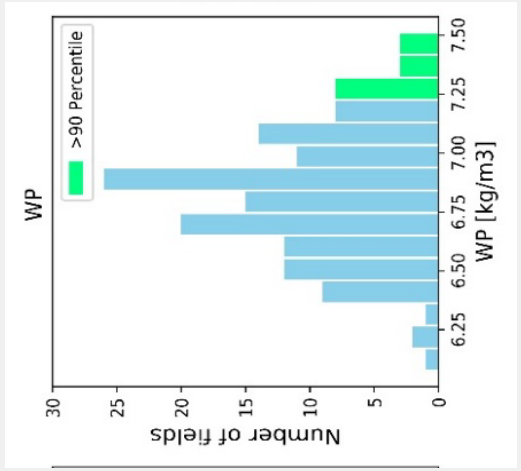


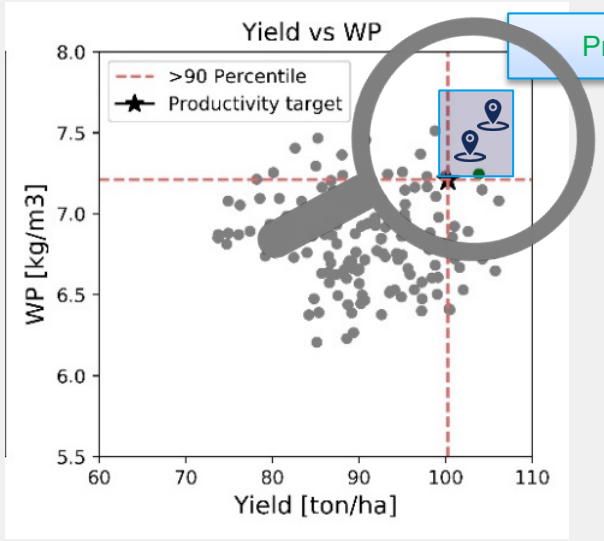
Setting targets, identifying bright spots



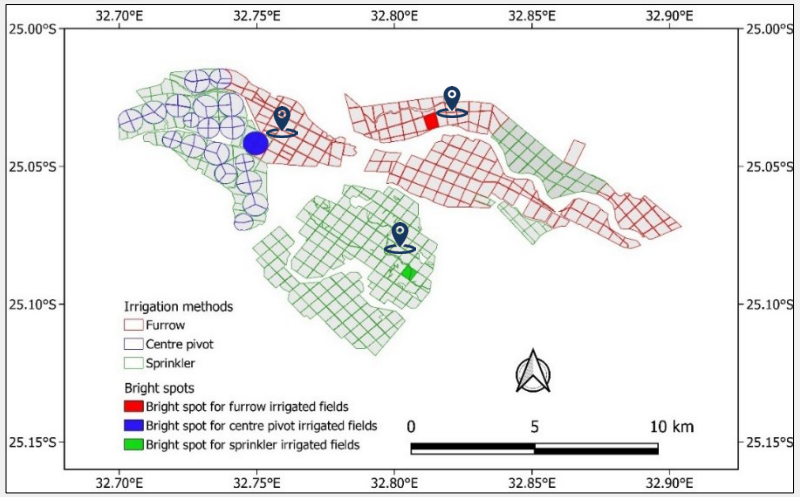
We can take 95 percentile of the population as Target

Setting targets, identifying bright spots (based on field level)





Productivity targets



Bright spots: 2015-2018

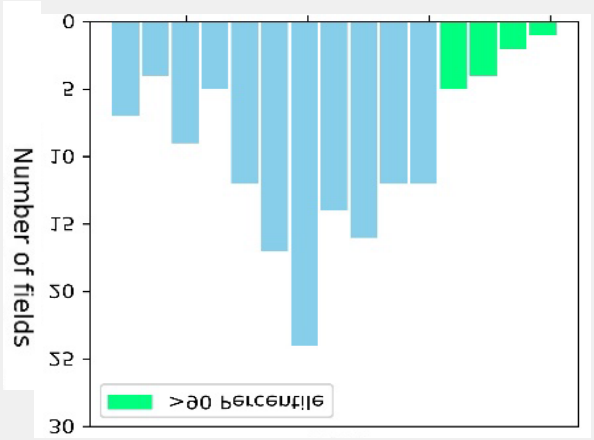


Figure. Frequency distribution of furrow irrigated fields at Xinavane sugar estate harvested in 2018

Performance Assessment Using RS data

Data

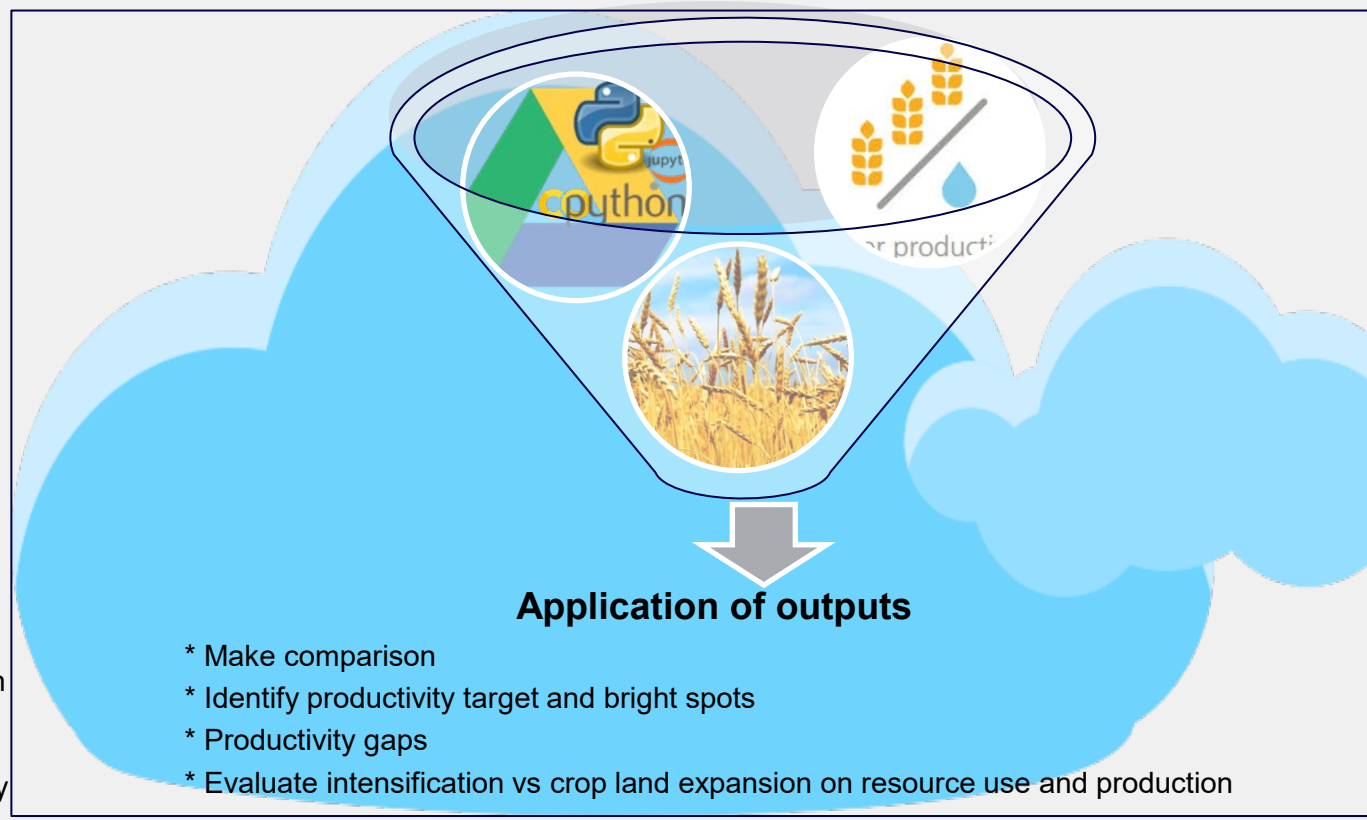
- RS derived data: E, T, ETref, Biomass etc..
- Other data: Yield, Cropping season, kc, HI, AOT, θ
- Data validation

Performance Assessment Indicators

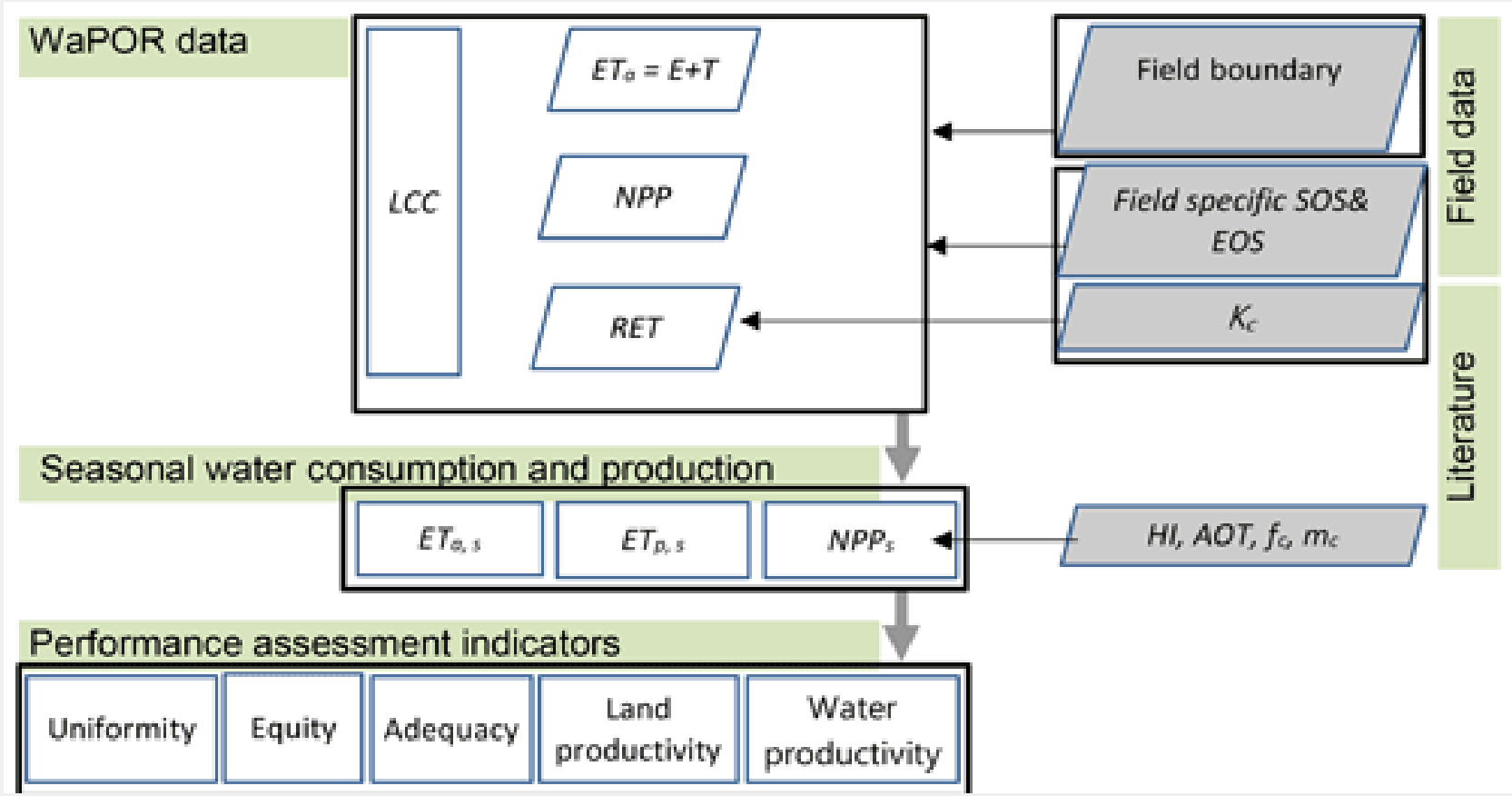
- Uniformity
- Equity
- Beneficial fraction
- Adequacy
- Land productivity
- Water productivity

Application of output

- Make comparisons
- Productivity target and bright spots
- Evaluate the land, water and production implication of intensification vs crop land expansion strategy
- Look for causes and provide corrective action for identified level of performance



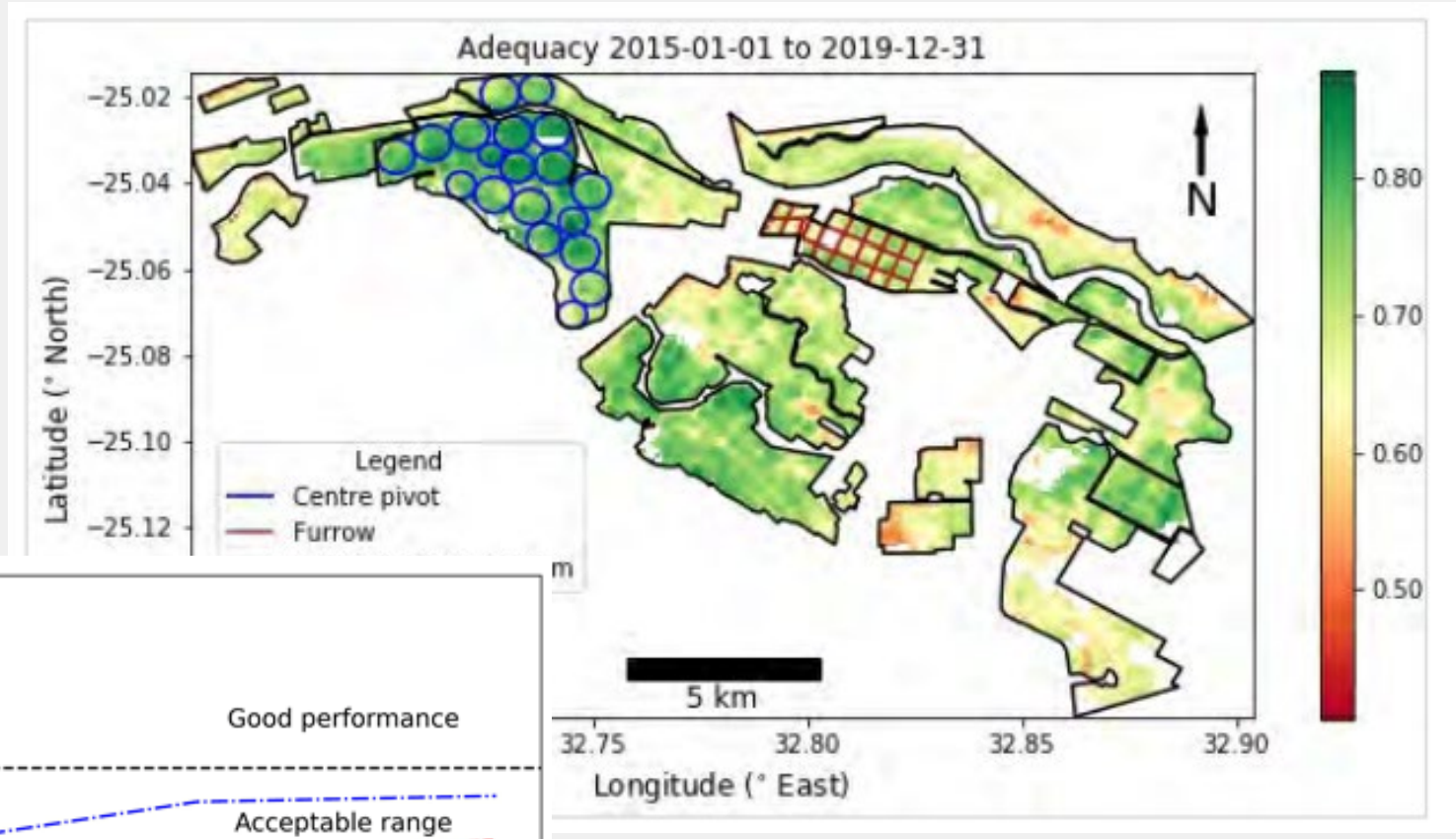
Standardised protocol

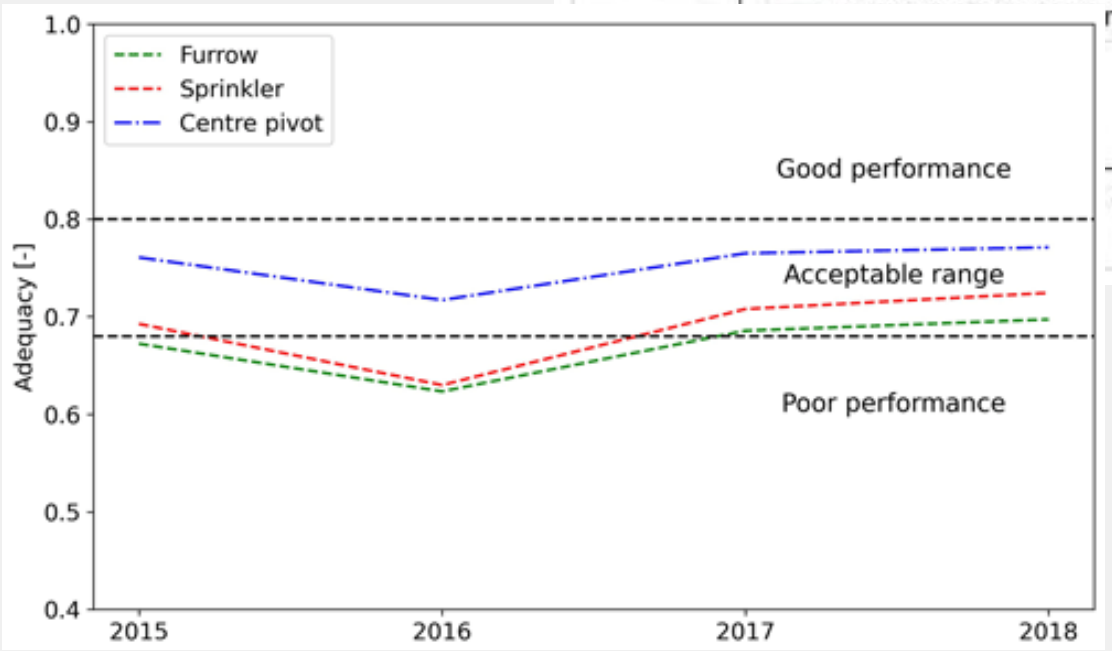


https://github.com/wateraccounting/WaPORIPA

Application Irrigation Performance Assessment

Xinavane Irrigation Scheme





Overview of the equations for calculating indicators using remote sensing

Overview

Criteria	Indicator	Equation*	Reference
Uniformity	CV of ET	CV of seasonal average ET_a per pixel in a field	Karimi et al. (2019)
Equity	CV of ET	CV of seasonal average ET_a per field inside the scheme/block	Karimi et al. (2019)
Adequacy	The ratio of $ET_{a,s}$ over $ET_{a,p}$ or relative evapotranspiration (RET)	$RET = \frac{ET_{a,s}}{ET_{p,s}}$ $ET_{a,s} = \sum_{SOS}^{EOS} ET_a$ $ET_{p,s} = \sum_{SOS}^{EOS} ET_{p,m}$ $ET_{p,m} = \sum_{SOS}^{EOS} k_{c,m} \cdot RET_m$	Karimi et al. (2019)
Land productivity	Biomass production (B)	$B = AOT \cdot f_c \cdot \frac{NPP_s \cdot 22.222}{(1-MC)}$ AOT is above over total biomass, f_c is light use efficiency correction factor, and MC is moisture content in fresh biomass.	Mul and Bastiaanssen (2019)
	Yield	$Yield = B \cdot HI$ HI is harvest index.	FAO 66
Water productivity	Biomass WP (WP_b)	$WP_b = \frac{B}{ET_{a,s}}$	
	Crop yield WP (WP)	$WP = \frac{Y}{ET_{a,s}}$	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