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Estimation of Water Consumption and Wheat's Crop Water Productivity in the Shikarpur District of Sindh by Remote Sensing

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INTRODUCTION

- Water scarcity is increasing globally, whereas the growing population requires more water for their food production.
- To understand the food-water relationship and assess water use efficiency, an estimation of crop water productivity (CWP) is essential (Kijne et al., 2003, Zwart and Bastiaanssen, 2004).

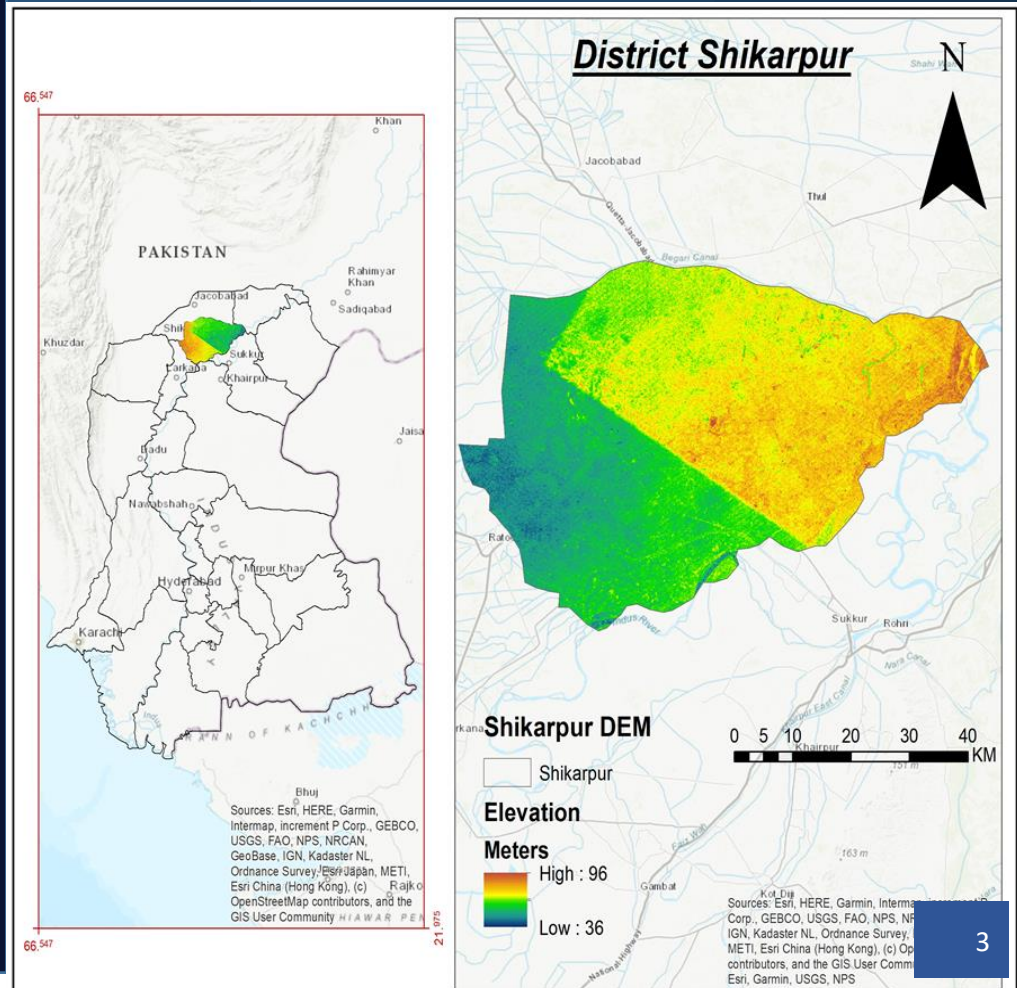
Crop water productivity is the relationship between the water used and the crop yield (or crop yield per accumulated actual evapotranspiration).

SCOPE OF STUDY

CWP of wheat, a Rabi (winter) season cash crop grown in the Sindh province of Pakistan, is observed in this study.

Shikarpur district is situated in upper Sindh within the Begari Canal Command Area (CCA).

Wheat area in Shikarpur was 36,007 Hectares with 100,623 Metric Tons production during Rabi 2013-14 (Bureau of Statistics, 2017).



PROBLEM STATEMENT

- Some of the challenges to Pakistan's water and food security are increasing water demand and decreasing water availability due to the fast-growing population, inefficient irrigation practices, and lack of implementation of policies.
- In such conditions, the knowledge of crop water productivity is necessary for managing water resources and food production.

PRIMARY DATASETS

- Satellite dataset of ET_{rf} (November 1, 2017 – April 10, 2018) was downloaded from EEFlux (Earth Engine Evapotranspiration Flux) https://eeflux-level1.appspot.com/
- The wheat crop mask was acquired from SUPARCO (Space and Upper Atmosphere Research Commission) of Pakistan. http://www.fao.org/3/a-i5554e.pdf
- And secondary data were collected from different sources and literature review.

METHODOLOGY

1. Estimation of Etrf

ETrF represents ET as a fraction of reference Etr (Eq 1). In EEFlux, ETr is calculated using the "tall" alfalfa reference as defined with the ASCE Standardized Penman-Monteith equation.

$$ETrF = \frac{Actal\ ET}{Refernce\ ET} \qquad (1)$$

2. Estimation of Reference ET (ETr)

Reference ET is obtained from Ullah, M. K.; Habib, Z.; Muhammad, S. (2001), which used the Penman-Monteith method to calculate the Reference ET of all the Canal Command Areas of Indus Basin.

Reference ET values in the Rabi season are shown in Table 1 for Shikarpur District.

Table 1

Months	Reference ET (mm/month)
November	92
December	69
January	77
February	96
March	167
April	218

3. Estimation of Eta

Equation 2 estimates actual ET per day—Etrf is multiplied with ETr per day and number of days according to Table 2. (crop mask is ued for extracting ET of wheat area).

$$Eta = ETrF * \frac{ETr}{day} * \text{No. of days} \qquad (2)$$

1. Crop Water Productivity

Crop water productivity in Eq. 3 is defined as crop yield (kg) per accumulated actual evapotranspiration for the crop's entire growing season (m^3).

$$CWP\left(\frac{kg}{m^3}\right) = \frac{Yield\ (Kg)}{Area\ (m^2)\ x\ ET\ (mm)} \qquad (3)$$

Table 2 shows the number of days for different crop stages and DOY (Day of Year).

Wheat Stages Upper Sindh			
No. Days	DOY	Date	Stages
0	305	November 1, 2017	Initial
20	325	November 21, 2017	
60	365	December 31, 2017	Crop Development
70	375	January 10, 2018	
71	376	January 11, 2018	Mid
119	424	February 28, 2018	
130	435	March 11, 2018	
160	465	April 10, 2018	Late

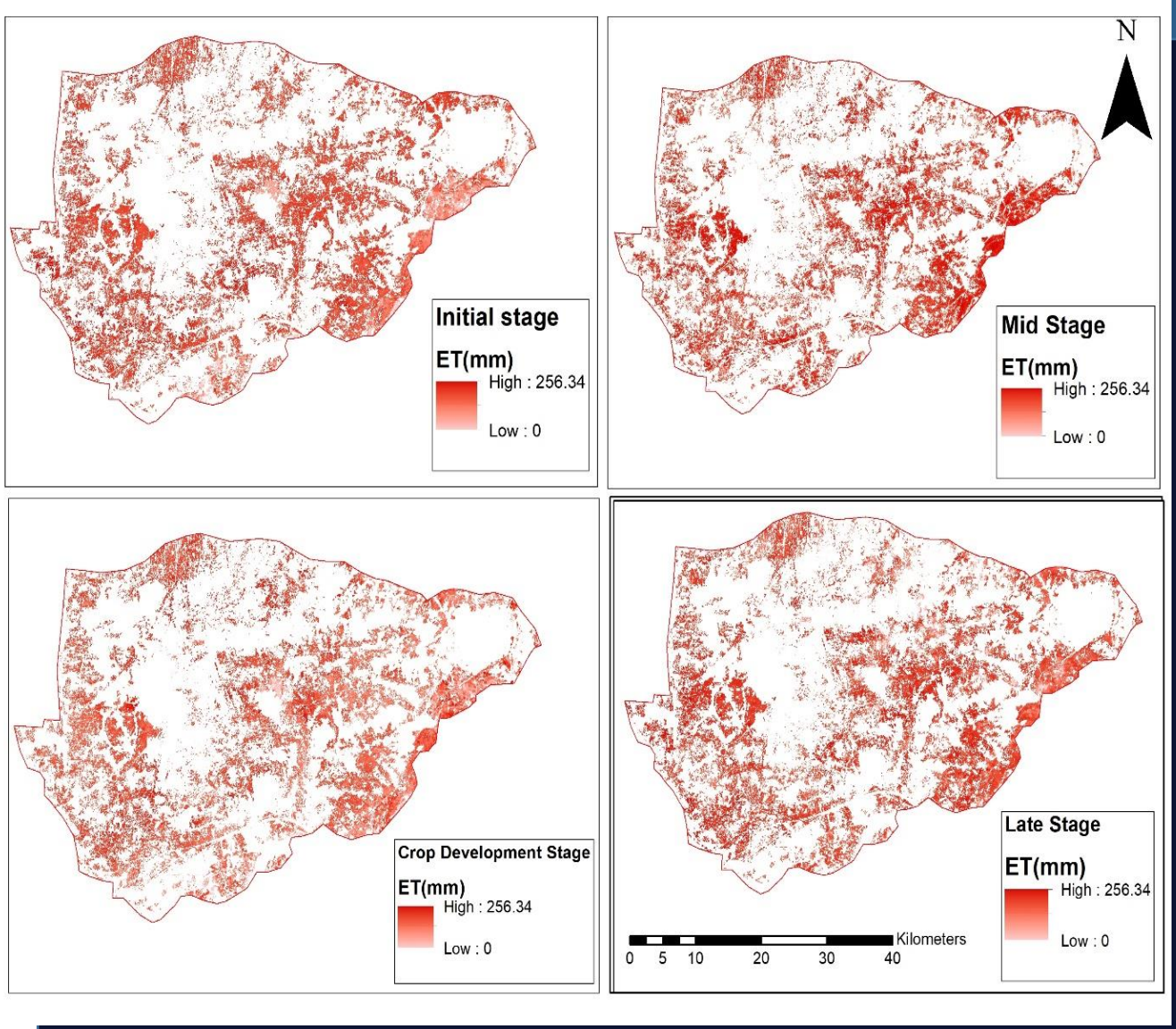
RESULTS AND DISCUSSIONS

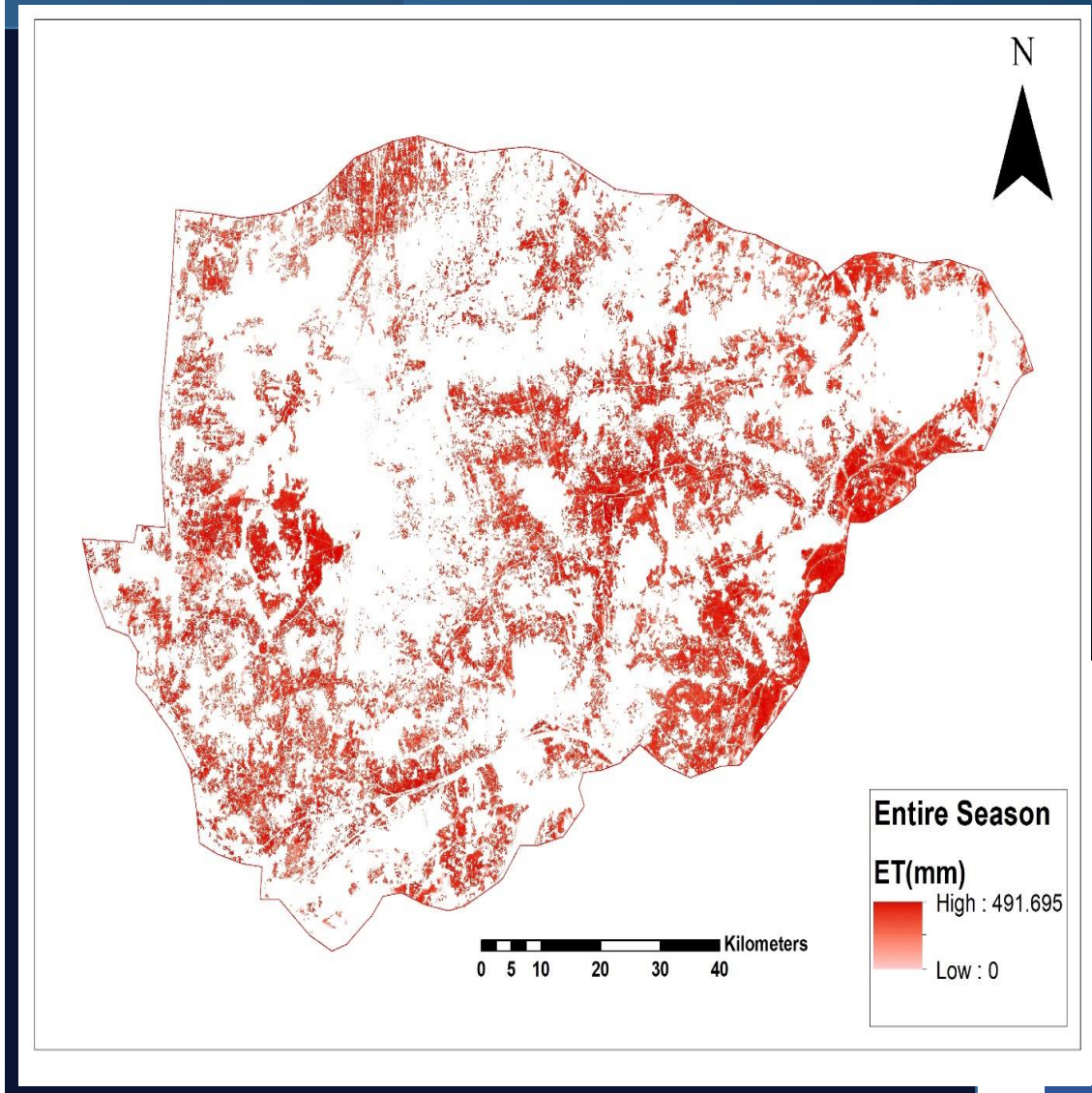
- The average crop water productivity of Shikarpur, Begari CCA was **0.81 kg/m^3** in the year 2017-18 with an area and production of 36,007 Hectares and 100,623 Metric Tons, respectively.
- The reported CWP of wheat in Sindh is 0.32 to 1.088 kg/m^3, lower than the Punjab CWP of wheat due to waterlogging and salinity problems (F Van, Lashari, et al., 2015).

Table 3

Stages	Average Eta (mm)
Initial	29.44
Crop Development	75.89
Mid	131.17
Late	107.11
Entire	343.62

RESULTS


Initial stage
ET(mm)
High : 256.34
Low : 0
N
Mid Stage
ET(mm)
High : 256.34
Low : 0
Crop Development Stage
ET(mm)
High : 256.34
Low : 0
Late Stage
ET(mm)
High : 256.34
Low : 0
Kilometers
0 5 10 20 30 40


N
Entire Season
ET(mm)
High : 491.695
Low : 0
Kilometers
0 5 10 20 30 40

CONCLUSIONS

- The study results summarize that the estimation of actual ET is vital for the management of irrigation water and crop stress conditions.
- The remote sensing techniques used for calculating ETa in this study are more efficient than the other conventional field-based methods. Also, data availability is affordable to all users.

References in Presentation

1. Kijne, J.W., Barker, R., Molden, D., 2003. Water productivity in Agriculture: limits and opportunities for improvement. CAB International, Wallingford, UK.
2. Zwart, S.J., Bastiaanssen, W.G.M., 2004. Review of measured crop water productivity values for irrigated wheat, rice, cotton and maize. Agric. Water Manage. 69, 115–133.
3. The report of development statistics of Sindh 2017 by Bureau of Statististics, Planning and Development department of Sindh.
4. Ullah, M. K.; Habib, Z.; Muhammad, S. 2001. *Spatial distribution of reference and potential evapotranspiration across the Indus Basin Irrigation Systems*. Lahore, Pakistan: International Water Management Institute (IWMI working paper 24).
5. Van Steenbergen, F., Basharat, M., & Lashari, B. K. (2015). Key challenges and opportunities for conjunctive management of surface and groundwater in mega-irrigation systems: Lower Indus, Pakistan. *Resources*, *4*(4), 831-856.