## Application of Satellite Remote Sensing to Regional Agriculture and Water Resource Management

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#### 1. Importance of Evapotranspiration Estimation in Agricultural Water Management



Source: Conditions for Survival, 2009, The Asahi Glass Foundation



Actual ET versus yield for wheat, Central Great Plains, USA (Data from Hanks et al., 1967)

*Source: Water Requirements for Irrigation and the Environment, Bos, M.G. et al., 2009, Springer* 

#### 2. Evapotranspiration Estimation using Satellite Imagery



Food and Agriculture Organization of the United Nations





#### WEBINAR SERIES

#### REMOTE SENSING DETERMINATION OF EVAPOTRANSPIRATION

Algorithms, strengths and weaknesses, uncertainty and best fit-for-purpose

A regional application example of METRIC model Masahiro Tasumi University of Miyazaki (Japan)



NOT

### **SEBAL/METRIC Model**

#### Surface energy balance to compute ET



Visible, NIR and thermal bands for radiation balance.

Thermal infrared is a key to determine the distribution between sensible and latent heat flux.

#### 3. Application Example: Assessment of Irrigation Requirements (ADB)



Source: Takaku, R. et al. 2020. Irrigation Performance Assessment Using Satellite Remote Sensing: Insights from Tajikistan. ADB Briefs No.152.

Water Use Ratio explains water sufficiency in irrigated agriculture.

- Enables quantification of location, timing, and water requirement.
- Provides scientific information for infrastructure investment.

# 3. Application Example: Impact assessment of climate change to agricultural water management (the World Bank)



Identification of current agricultural status by satellite enables analysis of future agricultural water demand.

Source: Jami et al., 2019. Evaluation of the effects of climate change on field-water demands using limited ground information: a case study in Balkh province, Afghanistan. Irrigation Science 37:583-595.



#### 4. Urmia Project by JICA, with ULRP and Sharif U.Tech.(RSRC)

Data collection survey on improvement of the hydrological cycle model in Urmia Lake basin in the Islamic Republic of Iran (~ 2020)







#### Analysis of regional hydrology



Use satellite-based ET as one of the inputs (MODIS, from 2000 – 2019). Develop a hydrological model  $\rightarrow$  Use for scenario analysis to achieve sustainable development in the region.

#### **Field survey**

Taking a traditional agricultural engineering approach: Visit the field to study the crops, field management, local weather data collection, etc.)

Land subsidence



Visit meteorological stations, talk with people.



rrigation





Apples with forage crop underneath.

#### Model refinements and accuracy assessment

Questions: (1) ET model calibration. (2) ET estimation accuracy.



FAO56 approach to

#### Accuracy assessment (image acquisition dates)

RMS of difference:  $\sim 0.75 \text{ mm/day}$ 



Comparison between FAO-56 and METRIC-estimated ET for the satellite image acquisition dates.

#### Accuracy assessment (monthly)



Estimated monthly ET with reference values for apples, grapes, and bare soil-no data was available for comparison for grape cultivated areas in 2014 and 2015.

#### Accuracy assessment (annual)



Estimated annual ET with reference values for apples, grapes, and bare soil.

Even in good rainfed wheat fields, yield is lower than in irrigated fields. 3-3.5 t/ha vs. 4-5t/ha. Rainfed field average is 1.3 t/ha

Stress-free wheat =  $670 \text{ mm yr}^{-1} \text{ of ET}.$ 



Estimated annual ET for rain-fed wheat, irrigated short crops, city centers, and Urmia Lake.

Communication with non-satellite communities is also important.

difference: ~ 50 mm/yr

> A typical amount of irrigation for apple cultivations is about 1800 mm yr<sup>-1</sup>.



#### Accuracy assessment (rainfed wheat compare with NDVI)



Fig. 12. NDVI and ET<sub>METRIC</sub> of the satellite image dates for three rain-fed wheat sample fields.

## FYI: GCOM-C, a JAXA's new satellite applicable to energy balance computation.

- 250 m resolution VIS/NIR/thermal.
- Observation frequency = Once every two days or more frequent.



Example ET from GCOM-C ETindex algorithm



