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Calibration of Operational Simplified Surface Energy Balance Model SSEBop with the Plant Need factor for Al-Husainiyah project in Wasit Governorate.

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Abstract

The process of evaporation-transpiration is one of the important processes in agricultural production, because they are related to the vital processes that take place in the plant. The study illustrates the measurement of the actual evapotranspiration coefficient for the HU2 / D3 distributed canal project (an earth canal that takes its water source from the Al-Husainya irrigation canal at 10,300 km and the length of the HU2 / D3 distributed canal is 6,800 km). Which is located in Wassit governorate/Central Iraq, using the operational simplified surface energy balance SSEBop, the study concluded that the SSEBop model is important in obtaining the actual evapotranspiration values in addition to the model's accuracy. The model results were compared with the ministry of agriculture metrological stations data. Agro-meteorology reference ETo coefficient, where the results of the actual evapotranspiration in the lands of the Al-Husainya project - the distributed canal HU2 / D3, the majority of the values refer to the number 62 mm / January of the wheat yield and when compared with the water requirement of the crop, which was calculated based on the value of ETo that obtained from the ministry of agriculture is 59.3 mm / month of January, the results are very close, and there are some agricultural lands that may indicate actual evaporation values less than 55 mm and this may be due to the health of the crop in that spots or the delay in the date of plant.

Keywords: Actual Evapotranspiration, Potential Evapotranspiration ETo, Basal crop coefficient Kc, SSEBop Model, The HU2 / D3 distributed canal.

معايرة موديل توازن الطاقة السطحي المبسط التشغيلي SSEBop مع معامل احتياج النبات لمشروع الحسينية في محافظة واسط

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المستخلص

تعتبر عملية التبخر - النتح من العمليات الهامة في الإنتاج الزراعي ، لأنها مرتبطة بالعمليات الحيوية التي تحدث في النبات. توضح الدراسة قياس معامل التبخر الفعلي لمشروع القناة الموزعة HU2 / D3 وهي قناة ترابية تأخذ مصدرها المائي من قناة الحسينية الاروائية عند الكيلو 10,300 كم ويبلغ طول القناة الموزعة 6,800 كم. والتي تقع في محافظة واسط / وسط العراق ، باستخدام موديل توازن الطاقة السطحي المبسط التشغيلي Operational Simplified Surface Energy Balance Model SSEBop ، خلصت الدراسة إلى أن نموذج SSEBop مهم في الحصول على قيم التبخر الفعلي بالإضافة إلى دقة النموذج. تمت مقارنة نتائج النموذج مع بيانات محطات القياس التابعة لوزارة الزراعة. معامل التبخر- نتح المرجعي ETo، حيث تظهر نتائج التبخر الفعلي في أراضي مشروع الحسينية - القناة الموزعة HU2 D3 / ، تشير غالبية القيم إلى الرقم 62 ملم / يناير من محصول الحنطة وتم مقارنتها بالاحتياجات المائية للمحصول والتي تم احتسابها على أساس قيمة ETo التي تم الحصول عليها من وزارة الزراعة 59.3 ملم / شهر من شهر يناير ، كانت النتائج متقاربة للغاية ، وهناك بعض الأراضي الزراعية التي قد تشير إلى ان قيم التبخر الفعلي أقل من 55 مم وهذا قد يكون بسبب صحة المحصول في تلك المناطق أو التأخير في تاريخ زراعة النبات.

الكلمات المفتاحية: التبخرنتح الفعلي، التبخر نتح الكامن، معامل تبخر المحصول Kc, موديل SSEBop, القناة الموزعة HU2/D3

1.Introduction

Estimation of the actual evapotranspiration AET over large areas with appropriate time intervals is an effective tool in the optimum management of water resources and agricultural management to determine the optimum culture for different regions. The highest accuracy can be obtained from ET using special equipment and accurate measurement of physical factors or soil water balance through multiple devices such as Lysimeter, but these methods are expensive and need high accuracy, and they are only applicable by well-trained ones. Accordingly, and because of the difficulty of measuring accurate in the field, ET is generally estimated using weather data with remote sensing data such as satellite imagery. There are many empirical equations for estimating ET using the aforementioned data. Some of the methods are only valid in special climatic and agricultural conditions and extending them to various conditions is not possible (Rahimi, et al., 2014). The Operational Simplified Surface Energy Balance SSEBop is a simpler model, having reduced data requirements and greater ease of implementation without a substantial loss of accuracy in estimating AET. The SSEBop model has been used to produce maps of AET over very large extents (the conterminous United States) using lower spatial resolution (1 kilometer) (MODIS) and Landsat (30, 100 m) data. Model accuracies ranging from 80 to 95 percent on daily to annual time scales have been shown in numerous studies that validated AET estimates from SSEBop against eddy covariance measurements. (McShane, et al., 2017).

The main objective of this study was calibrate SSEBop model results with data obtain from field.

2. The study area

Wassit governorate is considered one of the agricultural governorates in the country whose irrigation systems depend on regulated irrigation, as the total arable area in the governorate is around four million dunam, including fertile Al-Gharaf lands and the border strip, whose lands are characterized by lack of fertility, horticultural lands and forests. The irrigation process is carried out by surface and pumping systems throughout the governorate area. (Odeh, 2006). Al-Husainya Irrigation Project is one of the most important irrigation projects, as the distributed channel represents HU2 / D3 (an earth canal that takes its water source from the Al-Husainya irrigation canal at 10,300 km and the length of the HU2 / D3 distributed canal is 6,800 km) as shown in Figure (1).

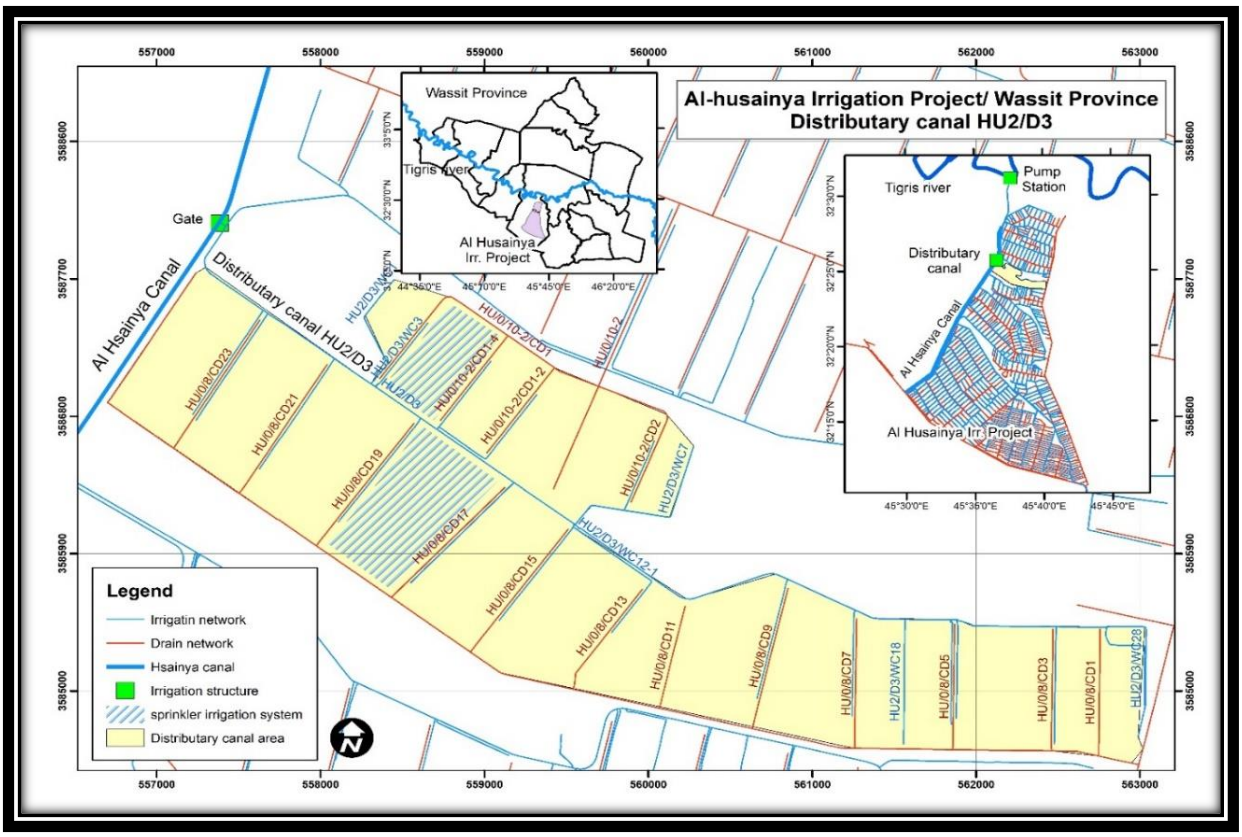

Figure 1: the geographical location of the study area

3. The data used in the study.

A satellite image was downloaded from the USGS website from the website *https://earthexplorer.usgs.gov/* from satellite Landsat-8 for the month of January of year 2020 for the 28th of the month and there were no clouds over the project (distributed canal HU2 / D3) visual capture time as shown in the Figure (2)

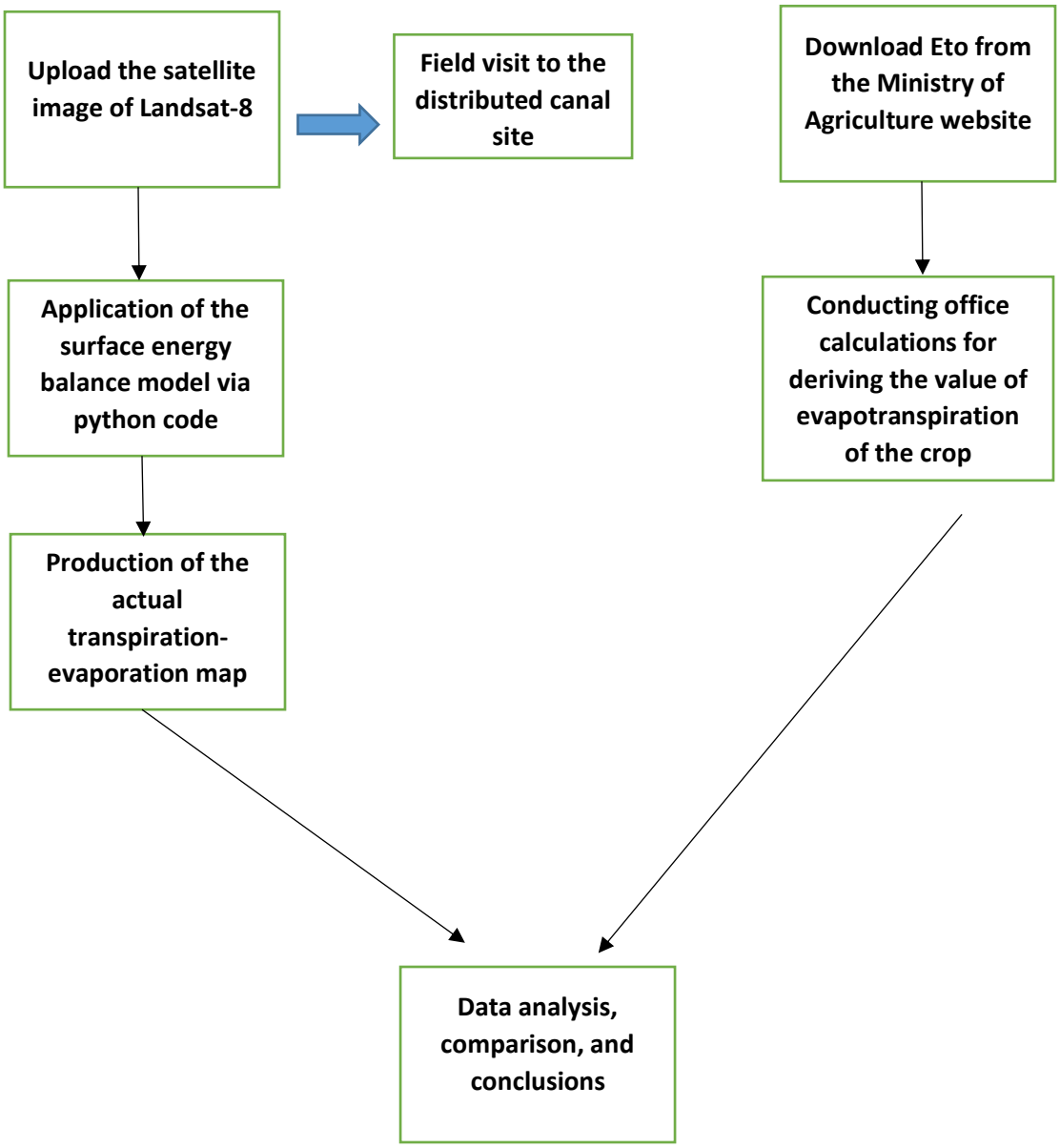

Figure 2: flowchart illustrating the study methodology

4. Field visit.

The time is very important parameters in the study therefore the field visit represents an important component of any study because it provides a comparison of the results obtained with the ground

truth. The study area was visited on February 15, 2020 and that the currently cultivated crop is wheat plant with an area estimated at 2757 dunam. Shown in Figure (3)**.**

Figure 3: the field visit to the project

5. Operational Simplified Surface Energy Balance Model SSEBop.

The operational Simplified Surface Energy Balance (SSEBop) model is a mathematical model using thermal remote sensing method that ingests Landsat imagery and generates daily total actual evapotranspiration (AET). (Senay, 2018). The primary product of the method is the ET fraction, driven by land surface temperature (Ts) from the Landsat thermal band. The SSEBop model was applied to the data of Landsat 8 image satellite for January month of 2020, where Figure (4) was obtained.

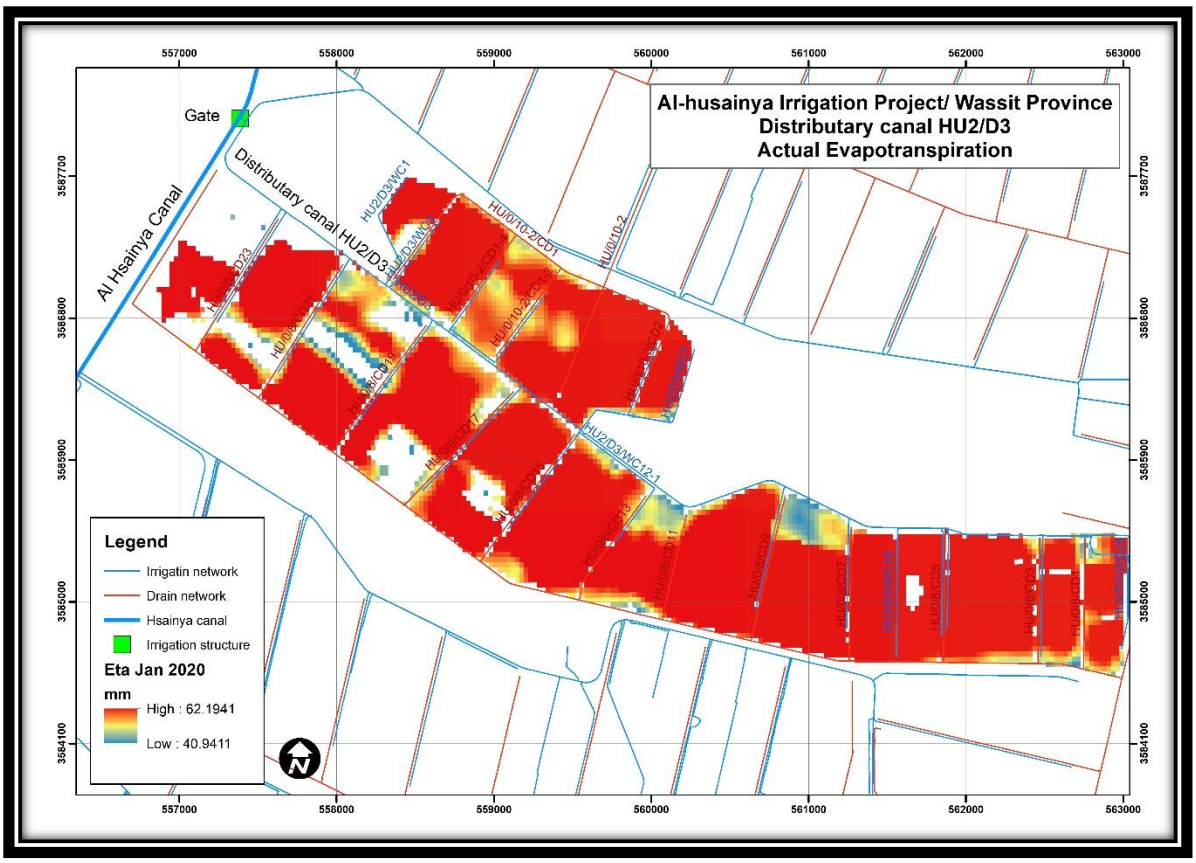

Figure 4: Actual evaporation-transpiration of the study area

6. Evaporation-transpiration coefficient-crop.

The crop evapotranspiration ETc differs from the potential evapotranspiration (ETo) coefficient in crop properties, in particular the aerodynamic resistance of the crop different from that of the reference grass (FAO56,1998). This difference in characteristics between crops and grass is reflected in the yield factor, which can be double: the basal crop coefficient Kcb plus the Ke soil evaporation factor can be represented by the equation:

$$ETc = Kc \times ETo \quad (1)$$

According to the strategic study (SWLRI.2014), 34 strategic crops were identified in Iraq, and it was clarified according to the study, which depended on the outputs of the Food and Agriculture Organization (FAO 56,1998; FAO CROPWAT Database, 2006; FAO 156,2005), which mentioned that it is difficult to determine the values of Evaporation coefficient - yield Kc

measured in Iraq. The Kc parameter includes three main stages: the initial, mid and end stage, shown in Table (1).

Table (1) represents the Kc factor for some types of agricultural crops according to (SWLRI.2014)

Crop	Kc_Ini	Kc_mid	Kc_end
Barley	0.3	1.15	0.25
Berseem	0.4	1.15	1.1
Broad bean	0.5	1.15	1.1
Cabbage	0.7	1.05	0.95
Wheat	0.7	1.15	0.25
Potato (spring)	0.5	1.15	0.75
Cauliflower	0.7	1.05	0.95
Kidney Beans	0.5	1.05	0.9

To verify the validity of the results, data from the ministry of agriculture was used by the agricultural meteorological network, as these data gave the evapotranspiration reference coefficient ETo for the distribution areas of their agricultural stations throughout the various parts of Iraq, (http://www.agromet.gov.iq/all_et.php,2020). As shown in Figure (5).

Figure 5: ETo value in Numaniyah metrological station (http://www.agromet.gov.iq/all_et.php,2020)

Many references mention the stages of growth of plants in detailed, for instant the main stages such as sowing, germination, growth and harvesting, wheat's growth cycle has the following divisions: germination, seedling establishment and leaf production, tillering and head differentiation, stem and head growth, head emergence and flowering and grain filling and maturity. (Bongard, et al., 2018).

Al-Numaniyah metrological station data where used because it is the nearest to the study area , the results were matched to the actual evapotranspiration values of AET derived from the (SSEBop) model of the agricultural season, and the location of the distribution canal HU2 / D3 irrigation was chosen from the Al-Husainya irrigation project in Wassit governorate, the date of planting wheat in the HU2 / D3 distributed canal was 5 October in most of its regions, as the period of wheat cultivation in the region is approximately 150 days, so the first 30 days are considered the initial phase for the growth of the wheat , the 90 days after that are the developmental phase and the last 30 days are considered the final phase according to the FAO guide (table (1)), The crop coefficient (Kc) has a value of 0.7 for the initial stage, a value of 1.15 for the developmental stage, and a value of 0.25 for the final stage.

The evapotranspiration according to the equation:

ETc = Kc * ETo **(2)**

Whereas,

ETc is the water requirement of the wheat crop (evaporation-crop transpiration)

ETo is reference evapotranspiration

Kc is crop coefficient

As for the reference evapotranspiration value, it was obtained from the data of Al-Numaniyah metrological station from the web for the month of January 2020, whose value was (51.5 mm) for the meteorological station in Numaniyah closest to the selected site (figure 5).

And by using the above equation with choosing the Kc value of 1.15, given that the crops in the study area are in the development stage, the result will be as follows:

ETc = 1.15 x 51.5 = 59.3 mm

When comparing the results of actual evapotranspiration in the territory of the HU2 / D3 distributed canal, the majority of the numbers refer to the number 62 mm / month of January (figure no.4 the red color) and when compared with the water requirement of the crop is 59.3 mm / month of January, the results are very close. Some agricultural lands may indicate their actual evapotranspiration values of less than 55 mm, and this may be due to the health of the crop in that spot or the delay in the date of planting.

7. Conclusions

The current study shows that the simplified surface balance model SSEBop is important in obtaining the actual evapotranspiration values in addition to the accuracy of the model. Distributed canal HU2 / D3 to show that the majority of the values refer to the number 62 mm / month of January of the wheat crop, which was calculated based on the value of ETo obtained from the ministry of agriculture metrological stations and calculated is 59.3 mm / month in January. The results are very close, there are some agricultural lands may indicate their actual evapotranspiration values of less than 55 mm, and this may be due to the health of the crop in that spot or the delay in the date of planting**.**

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References

Bongard, P.M., Oelke, E.A. & Simmons, S.R. (2018). Spring barley growth and development guide.

Food and Agriculture Organization FAO56. (1998). Irrigation and Drainage Paper No.56. Crop evapotranspiration. Guidelines for computing crop water requirements. FAO, Rome, 300pp.ISSN 1020-4261.

Food and Agriculture Organization FAO. (2006). CROPWAT Software Database.

Food and Agriculture Organization FAO 156. (2005). Data palm Cultivation. Plant production and protection paper number 156.

http://www.agromet.gov.iq/all_et.php,2020. Ministry of Agricultural.

McShane, Ryan, Driscoll, Katelyn and Sando, Roy. (2017). A Review of Surface Energy Balance Models for Estimating Actual Evapotranspiration with Remote Sensing at High Spatiotemporal Resolution over Large Extents. *USGS Scientific Investigations Report*, 2017–5087.

Rahimi, S, Gholami, M, Sefidkouhia, A, Raeini-Sarjaza, S and Valipourb, M. (2014). Estimation of actual evapotranspiration by using MODIS images (a case study: Tajan catchment). http://www.tandfonline.com/loi/gags20.

Senay, G. (2018). Satellite psychometrics formulation of the operational simplified surface energy balance (Ssebop) model for quantifying and mapping evapotranspiration. *Appl. Eng. Agric*. P-p. 555–566.

Strategy for Water and Land Resources in Iraq SWLRI. (2014). Agricultural Water Demand Crop Water Requirements. *Report F.3,* 466p.

Odeh, Bakhit. (2006). Study a geographic evaluation of the irrigation network in Wasit Governorate. *University of Kufa - College of Education for Girls*, page 135.