JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

COMPUTATION OF CROP WATER REQUIREMENTS OF NOA DIHING RIVER BASIN

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Abstract : The computation of crop water requirements plays a vital role in ensuring efficient and sustainable water management in agricultural systems. This abstract presents a study conducted on the computation of crop water requirements specifically for the Noa Dihing River Basin. The Noa Dihing River Basin, located in a region of significant agricultural activity, faces challenges in water availability and efficient water allocation. Understanding the crop water requirements is crucial for optimizing irrigation practices, reducing water stress, and maximizing crop productivity. In this paper the Crop Water Requirement is evaluated for the commonly grown crops in the study area i.e. Noa-Dihing river basin. The factors that affect the crop water requirement are also discussed in this paper. CROPWAT was used to compute the crop water requirements of crops such as banana, mango, orange, maize, millets, pulses, kharif rice, rabi rice and tobacco. The rainfall data was computed using CLIMWAT

***Index Terms* - CLIMWAT, CROPWAT, ET, FAO**

1. INTRODUCTION

Water in earth is a very scarce resource. The percentage of Earth's surface covered by water is about 71%. Where, 96.5% of all earth's water is held by the oceans and fresh water only accounts for 2.5% of the total which needs to be used sustainably and efficiently. As we know India is an agricultural-based economy therefore efficient and sustainable irrigation systems must be implemented. In this study, the focus is to calculate the required amount of water needed by the crops after considering all the facts affecting crop water requirements. This is a term given to the depth of water (in mm) required by a crop for some given conditions to achieve full yield for the given conditions. Crop water requirements may be defined as the required depth of water used by a crop including irrigation losses. Also included in it are other aspects of beneficially used water i.e. the water required for land preparation, leaching of salts and toxic substances, and for temperature control.

This paper is divided into 6 sections where Section 1 gives the introduction of the topic, Section 2 defines the different terms used in the research analysis, Section 3 is all about the place and river on which research is done, Section 4 discusses various factors affecting the crops, Section 5 is all about results and discussion which is followed by Conclusion.

2. DEFINATION OF TERMS

Some of the important terms that are used in the research work are elaborated below:

a. Crop Water Requirement[1]: This is a term given to the depth of water (in mm) required by a crop for some given conditions to achieve full yield for the given conditions. This can be found out using CROPWAT software.

b. Evapotranspiration (ET)([2]-[5]): The water that evaporates due to the heat of sun and other factors is known as evaporation and the water that evaporates from the leaves of plants through the stomata is called transpiration. Thus, the cumulative of water from the Earth's surface that evaporates due to evaporation and transpiration is called evapotranspiration.

c. Crop Co-efficient ([2]-[4]): It is a property of a particular crop that is employed to calculate the evapotranspiration of that crop. This value of crop co-efficient depends on type of crops, stage of crop, climatic conditions, soil type, geographical location etc.

d. River Basin([5]-[8]): When the water of an area cumulates in a single river or its tributaries then that area will be called a river basin of that river.

e. Watershed([2]-[8]: A watershed is an area that drains a particular area. It generally denotes a small area that drains into smaller streams.

3. STUDY AREA

The Noa-Dihing River is located at Deban, Miao sub-division, Changlang district of Arunachal Pradesh. It is located about 25km from Assam border. The Miao is located in a region where it gets one of the heaviest rainfalls in the north-east India. According to the population census 2011, the total population of the Miao circle is 25,921 out of which 13,198 are males and 12,723 are females The Noa-dihing is the most important river flowing through Miao. The Noa-Dihing River is a tributary of Lohit River whose parent river is Brahmaputra. The Noa-Dihing River derives from the Patkai range and proceeds east to west throughout the whole of north eastern and northern part of the Changlang. The basin lies between latitudes 27°5′24.152″N to 27°39′38.169″N and longitudes 93°13′34.710″E to 97°10′9.588″E. The length of Noa-Dihing River from its source to its outfall is 123.829 km in total. Entire geographical area of basin is 2404.45 sq. km.

The Noa-Dihing basin is named after the Noa-Dihing River which is the main river of Changlang district of Arunachal Pradesh. The Noa-Dihing is a huge tributary, about 380 km and 240 m in length of the Brahmaputra River in Upper Assam in northeast India. The river derives at 2,375 metres or 7,792 feet above sea level in the Eastern Himalayas called the Patkai Hills in Arunachal Pradesh and extend to Tinsukia and Dibrugarh Districts in Assam to its joining the Brahmaputra. The famous reserve forest Namdapha national park is also situated in the Noa-Dihing basin. Namdapha national park covers the area of 1,956.23 sq. km with more than 1,000 floral and about 14,000 faunal species. The whole basin is hilly area, hills ranging from 200 to 4500 m in height. Its watershed covers about 6,000 square kilometers. The location of the river and basin is shown in the Figure-1 and figure-2.

It is the remotest area of the district. The place is laid with thick tropical wet ever green forests. The valley is a ‘V’ shaped valley. The study area is a small part of north eastern India. The entire north east is situated along the margin zone of two tectonic plates. This zone has the Indo Australian plate on one side and the Europe Asian plate on the other side. The area is tectonically active.

FIGURE 1 : Noa-Dihing River

4. CLIMATIC FACTORS AFFECTING CROP WATER REQUIREMENTS

The climatic factors that influence the crop water needs are:

a. Temperature
b. Humidity
c. Wind speed
d. Sunshine

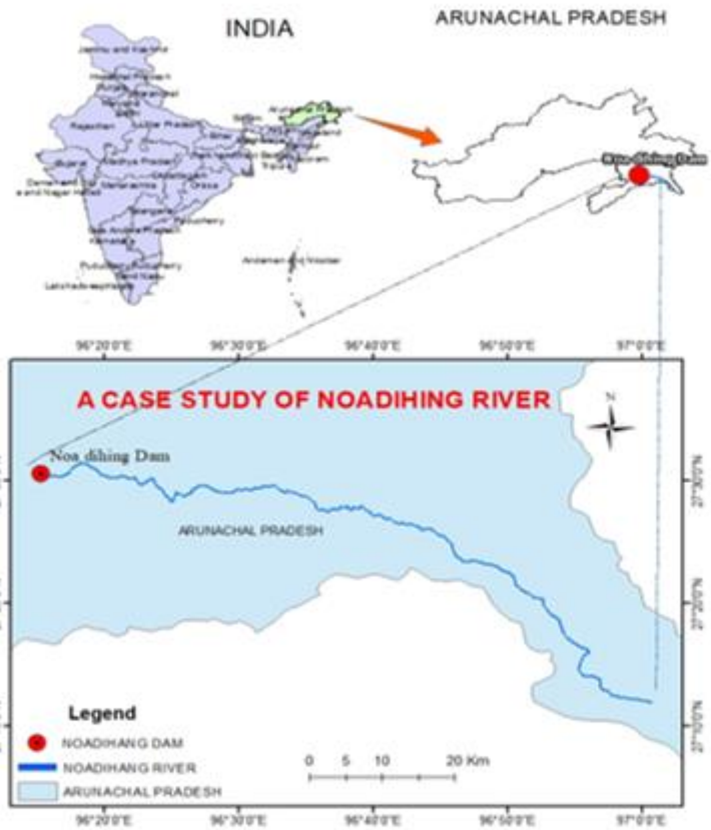

FIGURE 2 : Location of Noa-Dihing River in India

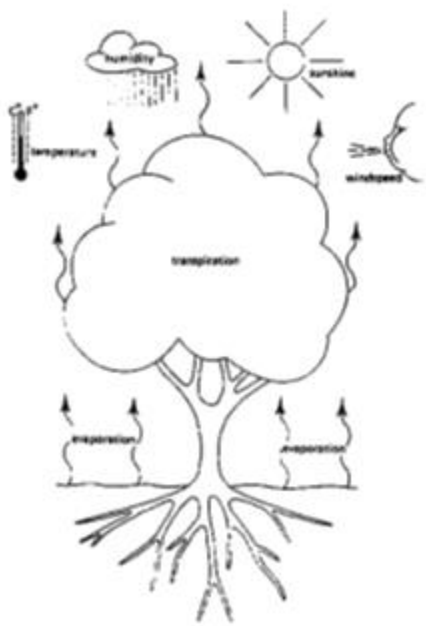

FIGURE 3: Major climatic factors influencing Crop water needs (Image credit: FAO)

TABLE 1: Effect of major climactic factors on crop needs

Climatic Factor	Crop water Requirement	
	High	Low
Temperature	High	Low
Humidity	Dry	Humid
Wind Speed	High	Low
Sunshine	Sunny	Not Sunny

A. CALCULATION OF REFERENCE CROP EVAPOTRANSPITARION (ETo)

There are numerous methods to calculate Evpotranspirtion (ETo). They are either of the two types:

- Experimental method like pan evaporation method
- Theoretical methods like the modified Penman method or Blaney-Criddle Method

B. AGRO-CLIMATIC CONDITIONS

a) RAINFALL

The Noa-Dihing river basin falls in the climatic zone No.-1 Which consists of North and North eastern part of India, sharing borders with Nepal, Bhutan, Bangladesh and North Myanmar.

In this zone-

- June to September- Monsoon rainfall
- November to January- Dry.
- May and October- Occasional rainfall
- June to September. Tropical storms
- April to May-
- In eastern parts of longitude 85°E- Pre-monsoon thunderstorm
- In western parts of longitude 85°E- Day temperature up to 30°C

b) CLIMWAT DATA

TABLE 2: Monthly rain data of Dibrugarh- Mohanbari station

Monthly rain - E:\DIBRUGARH-MOHANBARI.cli

Station DIBRUGARH-MOHANBA   Eff. rain method USDA S.C. Method

	Rain	Eff rain
	mm	mm
January	28.0	26.7
February	54.0	49.3
March	96.0	81.3
April	239.0	147.6
May	262.0	151.2
June	393.0	164.3
July	539.0	178.9
August	449.0	169.9
September	332.0	158.2
October	125.0	100.0
November	27.0	25.8
December	20.0	19.4
Total	2564.0	1272.6

Hence, we can say that more crop water is required in areas that are hot, dry, windy, and sunny.

c) TEMPERATURE (Reference- CLIMWAT 2.0)

Table 3: AVERAGE MONTHLY MAXIMUM TEMPERATURE FROM 1901 TO 2002

AVERAGE MONTHLY MAXIMUM TEMPERATURE FROM 1901 TO 2002

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	18.4858	19.52572	22.65437	24.49367	25.79571	26.69616	27.05317	27.17109	26.92258	25.32545	22.4145	19.55756

Table 4: AVERAGE MINIMUM MONTHLY TEMPERATURE FROM 1901 TO 2002

		AVERAGE MINIMUM MONTYHLY TEMPERATURE FROM 1901 TO 2002										
Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	4.9820891	7.26296	10.55626	13.37299	16.42799	19.06856	19.81775	19.74233	18.86314851	15.68616	10.33575	6.12698

Table 5: AVERAGE MONTHLY DIURINAL TEMPERATURE CHANGE FROM 1901 TO 2002

		AVERAGE DIURINAL TEMPERATURE CHANGE FROM 1901 TO 2002										
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	13.4919	12.2498	12.0901	11.1148	9.36148	7.62194	7.22635	7.41975	8.053337	9.63323	12.0704	13.4193

Table 6: MONTHLY AVERAGE RAINFALL FROM 1901 TO 2001

		MONTHLY AVERAGE RAINFALL FROM 1901 TO 2001										
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	11.721	13.38	16.588	18.916	21.091	2.866	23.418	23.439	22.872	20.485	16.358	12.827

Table 7: AVERAGE MONTHLY REFERENCE CROP EVAPOTRANSPIRATION FROM 1901 TO 2002

		AVERAGE MONTHLY REFERENCE CROP EVAPOTRANSPIRATION FROM 1901 TO 2002										
Monthly	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	2.253465	2.72505	3.641386	4.325248	4.559703	4.435149	4.328316832	4.136534653	3.766435644	3.23039604	2.63297	2.198812

Table 8: AVERAGE MONTHLY WET DAY FREQUENCY FROM 1901 TO 2002

		AVERAGE MONTHLY WET DAY FREQUENCY FROM 1901 TO 2002										
Monthly	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	4.45402	4.85744	6.92516	8.04143	10.4346	15.2419	17.3112	15.3821	12.3536	8.01802	3.86002	2.77137

Table 9: AVERAGE MONTHLY VAPOUR PRESSURE FROM 1901 TO 2001

		AVERAGE MONTHLY VAPOUR PRESSURE FROM 1901 TO 2002										
Monthly	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	11.07415	11.87997	13.97385	16.86433	20.4415	24.44714	25.50289	25.68196	24.6107	20.57276	15.32964	12.09085

Table 10: MONTHLY AVERAGE GROUND FROST FREQUENCY FROM 1901 TO 2002

		MONTHLY AVERAGE GROUND FROST FREQUENCY FROM 1901 TO 2002										
Monthly	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	8.10747	5.58639	3.95486	2.73104	1.5391	0.41049	0.1789	0.25633	0.50538	1.62922	3.98353	6.8137

Table 11: MONTHLY AVERAGE CLOUD COVER FROM 1901 TO 2002

		AVERAGE MONTHLY CLOUD COVER FROM 1901 TO 2002										
Monthly	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	28.41324	36.21597	43.54943	55.95413	65.01379	80.66775	84.92882	82.59146	75.47974	54.78142	36.82926	28.798

Table 12: MONTHLY AVERAGE POTENTIAL EVAPOTRANSPIRATION FROM 1901 TO 2002

	MONTHLY AVERAGE POTENTIAL EVAPOTRANSPIRATION FROM 1901 TO 2002											
Monthly	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	4.285346535	4.613564	5.47604	5.965941	5.947426	5.432277	5.23505	5.085743	4.886238	4.84960396	4.65604	4.286733

5. RESULTS AND DISCUSSION

The data required to determine crop water requirement is rainfall, maximum and minimum temperature, relative humidity, wind speed, etc. The data is collected from 1990 to 2004. The data required for the determination of Evapotranspiration is from the meteorological station as mentioned in the study area and fortnightly rainfall from 56 rain gauge stations all over the zone. Crop coefficients are offered to relate reference evapotranspiration ET_o to crop evapotranspiration ET_c in order to take crop coefficient characteristics into consideration when calculating the crop's water requirement. When a crop is being grown on sizable fields under ideal conditions, ETcrop is calculated by

$$ETcrop= Kc \times ETo \qquad (1)$$

TABLE 14: Kc values

Sl No.	CROPS	Kc values at different Stages				
		INITIAL			MID	LATE
1	BANANA	0.50			1.10	1.00
2	MANGO	0.90			1.10	0.90
3	ORANGE	0.70			0.65	0.70
4	MAIZE	0.30			1.20	0.35
5	MILLETS	0.30			1.00	0.30
6	PULSES	0.40			1.15	0.35
7	KHARIF RICE	0.70	0.30	0.50	1.05	0.70
8		1.20	1.05	1.10	1.20	1.05
9	RABI RICE	0.70	0.30	0.50	1.05	0.70
10		1.20	1.05	1.10	1.20	1.05
11	TOBACCO	0.50			1.15	0.80

TABLE 15: Crop Water and Irrigation Requirements

Sl. No	CROPS	IRRIGATION REQUIRED (mm/day)
1	BANANA	125.3
2	MANGO	168.4
3	ORANGE	44.9
4	MAIZE	0
5	MILLETS	0
6	PULSES	2.8
7	KHARIF RICE	180
8	RABI RICE	417.3
9	TOBACCO	0

Table 16: Soil Profile of the basin suitable for crops

Sl. NO.	Crop	Sowing Date	Harvesting Date	Soil Type	Total available moisture (FC-WP) (mm/meter)	Initial Total available moisture (mm/meter)
1.	Banana	27/02	22/01	Red Sandy Loam	140	140
2.	Mango	30/07	29/07	Red Sandy Loam	140	140
3.	Orange	27/03	26/03	Red Sandy Loam	140	140
4.	Maize	15/06	17/10	Red Sandy Loam	140	140
5.	Millets	15/07	27/10	Red Sandy Loam	140	140
6.	Pulses	30/03	17/07	Red Sandy Loam	140	140
7.	Kharif Rice	30/06	27/10	Black Clayey Soil	200	100
8.	Rabi Rice	30/11	29/03	Black Clayey Soil	200	100
9.	Tobacco	27/02	16/06	Red Sandy Loam	140	140

6. Conclusion

This study utilized a combination of remote sensing data, meteorological data, and crop-specific parameters to estimate the crop water requirements in the Noa Dihing River Basin. Remote sensing data, such as satellite imagery, were used to assess the vegetation indices and obtain information on crop growth patterns and water stress levels. Meteorological data, including temperature, humidity, wind speed, and solar radiation, were integrated to calculate reference evapotranspiration using established models such as the Penman-Monteith equation. Crop-specific parameters, such as crop coefficients and root depth, were considered to determine the actual crop water requirements.

The results of this study provide valuable insights into the spatial and temporal variations of crop water requirements within the Noa Dihing River Basin. The computed crop water requirements can assist policymakers, water resource managers, and farmers in making informed decisions regarding irrigation scheduling, water allocation, and drought management strategies. By aligning irrigation practices with the actual water needs of crops, water use efficiency can be improved, water resources can be conserved, and agricultural productivity can be enhanced.

Overall, this study highlights the significance of accurately estimating crop water requirements for effective water resource management in the Noa Dihing River Basin. The findings contribute to the understanding of the region's agricultural water demands and provide a basis for implementing sustainable irrigation practices. Further research and monitoring efforts are recommended to continually refine and update the crop water requirement estimations to account for changing climatic conditions, crop varieties, and land use patterns.

Acknowledgments

The authors would like to acknowledge and thank Mr Techi Radh, Benjamin Debbarma, Techi Tayo Tara who are Students of B. Tech, Department Of Civil Engineering, Assam Down Town University, Guwahati for their help and contribution in collecting data and information.

References

1. Abdelhadi, A. W., Hata, T., Tanakamaru, H., Tada, A., & Tariq, M. A. (2000). Estimation of crop water requirements in arid region using Penman–Monteith equation with derived crop coefficients: a case study on Acala cotton in Sudan Gezira irrigated scheme. Agricultural Water Management, 45(2), 203-214.

2. Adekanmbi, O., & Olugbara, O. (2018). Multiobjective Optimization of Crop-mix Planning Us ing Generalized Differential Evolution Algorithm.”

3. Allen, R. G., Jensen, M. E., Wright, J. L., & Burman, R. D. (1989). Operational estimates of reference evapotranspiration. Agronomy journal, 81(4), 650-662.

4. Bai, D., & Liang, W. (2012, October). Optimal planning model of the regional water saving irrigation and its application. In 2012 International symposium on geomatics for integrated water resource management (pp. 1-4). IEEE.

5. Coleman, G., & De Coursey, D. G. (1976). Sensitivity and model variance analysis applied to some evaporation and evapotranspiration models. Water Resources Research, 12(5), 873-879.

6. Kamal, D. K. (2018). Assessments of Crop Water Requirements for Kulsi River Basin.

7. Daghighi, A., Nahvi, A., & Kim, U. (2017). Optimal cultivation pattern to increase revenue and reduce water use: application of linear programming to arjan plain in fars province. Agriculture, 7(9), 73.

8. Droogers, P., & Allen, R. G. (2002). Estimating reference evapotranspiration under inaccurate data conditions. Irrigation and drainage systems, 16, 33-45.

9. Gotardo Javkeline T., Rodrigues Lineu N., Gomes Benedito M. (2016), “Comparison of methods for estimating reference evapotranspiration: An approach to the management of water resources with an experimental basin in the Brazilian Cerrado”

10. Hajare H.V., Raman N.S., Dharkar ER Jayant (2008), “New Technique for evaluation of crop water requirement”

11. Igbadun Henry E., Salim Baanda A.3, Tarimo Andrew K.P.R.3, Mahoo Henry F. 4 (2008), “Effects of deficit irrigation scheduling on yields and soil water balance of irrigated maize”

12. Mandal Raju (2014), “Flood, cropping pattern choice and returns in agriculture:A study of Assam plains, India”

13. Naik Pradeep K., Lamsoge Bhushan, Sirsikar Deepak Y. (2004), “Planning conjunctive use practices - a prerequisite for irrigation development in India”

14. Pandeya B., Mulligan M. (2013), “Modelling crop evapotranspiration and potential impacts on future water availability in the Indo-Gangetic Basin”