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WATER BALANCE AND GROUND WATER RESOURCES ASSESSMENT OF THE RAYALASEEMA REGION, ANDHRA PRADESH, INDIA.

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ABSTRACT

The seasonal and annual water balance elements of Rayalaseema region covering an area of about 67,293 km^2 have been studied using Thornthwaite and Mather (1955) water balance technique. From the seasonal analysis it is found that the mean rainfall is high (403.70mm) during southwest monsoon followed by northeast monsoon (246.48mm), summer (73.66mm) and winter (9.33mm). The mean annual rainfall of the Rayalaseema region is 728.28mm. The average potential evapotranspiration is high (602.78mm) in southwest monsoon followed by summer, northeast monsoon and winter periods. The average annual potential evapotranspiration is 1654.42mm. The average actual evapotranspiration is high (394.32mm) in southwest monsoon followed by northeast monsoon, summer and winter periods. The average annual actual evapotranspiration is 899.23mm. The water deficit is highest (395.78mm) in summer period followed by southwest monsoon, winter and northeast monsoon periods. The average annual water deficit is 755.19mm. There is no water surplus in the Rayalaseema region. The average moisture adequacy is high (91%) in northeast monsoon period followed by southwest monsoon (65%), winter (46%) and summer (25%) the annual moisture adequacy is 54%. The average annual recharge is 119.417mm. The ground water resources of Rayalaseema region is estimated through rainfall recharge method. The

total ground water potential is estimated to be 8,032 million m^3. The total surface water resource of the Rayalaseema region is estimated to be 49,335 million m^3. Out of this 10% is stored in the ponds, lakes, tanks and reservoirs, 16.28% is recharged to ground water, 20% is lost in the form of surface run-off and 53.72% is lost in the form of evaporation and evapotranspiration.

INTRODUCTION:

Water balance is a basic concept in applied climatology and has been gaining importance in various fields of Agriculture and water management. With increasing population and decreasing per capita availability of water, optimum utilization and conservation of water has become a problem of vital importance in which water balance plays a major role. It is well established that water supply to a region is primarily through precipitation and the water loss is almost entirely due to evapotranspiration. The wetness and dryness of a place is determined by the relative magnitudes of precipitation and potential evapotranspiration. The water balance elements are precipitation, potential evapotranspiration, actual evapotranspiration, water deficit, water surplus, moisture adequacy, Aridity Index, Humidity Index and Moisture Index. Thornthwaite and Mather (1955), Penman (1956), Van Bavel (1956) and Christinan (1970) have developed formula for estimation of potential evapotranspiration. In India the formula devised by Thornthwaite and Mather (1955) has been intensively used for evaluation of water balance studies at national, state, regional, basin, district and micro level by Subrahmanyam (1956,1957,1958,1963,1967,1982 and 1983) Subrahmanyam and

Murthy (1968)) Subrahmanyam and Sastri (1969 a and b 1971) Subrahmanyam and Sharma (1974) Subrahmanyam et . al (1964 and 1970) Subrahmanyam and Subramaniam (1964 and 1965) Subramaniam (1961) Sastri (1969) Ramasastri (1973) Sharma (1974) Bora (1976) Ram mohan (1978), Hema malini (1979), Viswanadham (1981) Sambasiva Rao (1983 and 1986) Sambasiva Rao and Kalavathi (1983) Subrahmanyam and Venkatesh (1983), Sambasiva Rao and Rajeswari (1985), Kalavathi (1985), Vasthala (1987), Sambasiva Rao et al. (1987), Rajeswari (1990), Krishna Reddy (1990), Madhuramma (1992). The above said researchers have carried out extensive studies on water balance application in agriculture, water resources development and drought climatology.

STUDY AREA:-

The Rayalaseema region covers in an area about 67,293sq.km. The region covers Anantapuramu, Chittoor, Kadapa and Kurnool districts. Geographically the districts is located in between 12^0 – 37^1 to 16^0 – 18^1 northern latitudes, and 76^0 -50^1 to 79^0 – 59^1 eastern longitudes. There are about 234 revenue mandals and 4395 revenue villages in Rayalaseema region. The total population of the Rayalaseema region 1, 55, 04,738 (2O11 census). The density of population is 230 persons per sq.km.

OBJECTIVES:

The main objectives of the study are

1. **to study the distribution of seasonal and annual water balance elements like potential evapotranspiration (PE), actual evapotranspiration (AE), water deficit (WD),**

water surplus (WS), moisture adequacy (Ima), Aridity Index (Ia), and Moisture Index (Im).

2. **to describe the Climatic Classification of the Rayalaseema region based on the values of Moisture Index and Aridity Index,**
3. **to study the surface water resources of the Rayalaseema region and to assess the sub-surface water resources based on rainfall recharge method at mandal level of the region and**
4. **to suggest appropriate measures for optimum utilization of surface and sub-surface water resources.**

METHODOLOGY:

1. **The data pertaining to monthly rainfall period of 100 years has been collected for about 47 stations of the Rayalaseema region. The rainfall data is analyzed to describe the seasonal and annual rainfall distribution in the Rayalaseema region,**
2. **The temperature data over a period of 50 years has been collected for the Rayalaseema region for available stations. The data is analyzed to study the thermal efficiency. Based on book keeping procedure of Thornthwaite and Mather (1955) method the monthly potential evapotranspiration, actual evapotranspiration, water deficit and water surplus are worked out,**
3. **Based on the values of PE, AE and WD the moisture adequacy, Aridity Index and Moisture Index are worked out and mapped on seasonal, annual basis of the Rayalaseema region. The water balance of region is worked out,**
4. **The surface water resources of the Rayalaseema region is worked out basing on average annual rainfall and total geographical area of the Rayalaseema region. The annual recharge of the Rayalaseema region is worked out using U.S. Geological methods (1985) Seghal method (1970), Krishna Rao method (1970) and Radhakrishna method (1974). The average of the four methods is taken as annual recharge of the Rayalaseema region. The ground water potential is worked out at mandal level taking average annual recharge and geographical area of each mandal.**

RESULTS AND DISCUSSIONS:

During the months of winter the mean rainfall varies from 4mm in Gooty station to a maximum 22mm in G.Bramheswaram station (Table-1). The average rainfall of the Rayalaseema region is 9.23mm. The potential evapotranspiration value varies from 150mm in Bangarupalem station to a maximum of 287mm in Badvel, Kadapa, Rajampet and Sidhavatam stations. The average potential evapotranspiration value of the Rayalaseema region is 212.08mm. The potential evapotranspiration values are more than 200mm in Allagadda, Anantapuramu, Atmakur, Badvel, Chandragiri, Chittoor, Kadapa, Dharmavaram, Jammalamadugu, Kalahasti, Kamalapuram, Kurnool, Nandikotkur, Nandyal, Proddutur, Pulivendula, Puttur, Rajampet, Rayachoti, Satyavedu, Sidhavatam, Tadipatri, Vayalpadu and Yadiki stations. In other stations the potential evapotranspiration is less than 200mm.

The actual evapotranspiration value varies from 36mm in Dharmavaram station to a maximum of 158mm in Satyavedu station. The average actual evapotranspiration value of the Rayalaseema region is 96.89mm. The actual evapotranspiration values are more than 100mm in Badvel, Bangarupalem, Chandragiri, Chittoor, Kadapa, G.Bramheswaram, Kalahasti, Kamalapuram, Kuppam, Madanapalli, P. Ahobilam, Palamaneru, Pulivendula, Punganuru, Puttur, Rajampet, Satyavedu, Sidhavatam, Srisailam and Vayalpadu stations. In other stations the actual evapotranspiration value is less than 100mm.

The water deficit ranges from 41mm in Srisailam station to a maximum of 193mm in Jammalamadugu station. The average water deficit of the Rayalaseema region is 115.19mm. The water deficit values are less than 100mm in Aluru, Bangarupalem, G.Bramheswaram, Gooty, Kalahasti, Kuppam, Madakasira, Madanapalli, P. Ahobilam, Palamaneru, Penukonda, Punganuru, Puttur, Satyavedu and Srisailam stations. In other stations it exceeds in 100mm. There is no water surplus in any station during winter period in the Rayalaseema region.

The moisture adequacy values range from 17% in Dharmavaram station to a maximum 76% in Srisailam station. The average moisture adequacy of the Rayalaseema region is 46%. The moisture adequacy values are more than 50% in Bangarupalem, Chandragiri, Chittoor, Yemmiganur, Kalahasti, Kuppam, Madanapalli, P. Ahobilam, Palamaneru, Punganuru, Satyavedu, Sidhavatam, Srisailam, and Vayalpadu stations. In other stations it is less than 50%.

The Aridity Index value varies from 24% in Srisailam station to a maximum of 83% in Dharmavaram station. The average of the Rayalaseema region is 54%. In Adoni, Allagadda, Anantapuramu, Atmakur, Badvel, Bukkapatnam, Kadapa, Dharmavaram, Dhone, Yemmiganur, Gooty, Hindupur, Jammalamadugu, Kadiri, Kalyanadurgam, Kamalapuram, Koilakuntla, Kurnool, Madakasira, Nandikotkur, Nandyal, Pathikonda, Penukonda, Proddutur, Pulivendula, Rayachoti, Rayadurgam, Tadipatri, Uravakonda, and Yadiki stations the Aridity Index value is more than 50%. In other stations it is less than 50%.

The Moisture Index values show dry sub humid type of climate in Aluru, Badvel, Bangarupalem, Chandragiri, Chittoor, Yemmiganur, G. Bramheswaram, Hindupur, Kalahasti, Kuppam, Madakasira, Madanapalli, P. Ahobilam, Palamaneru, Penukonda, Punganuru, Puttur, Rajampet, Satyavedu Sidhavatam, Srisailam, and Vayalpadu stations. In other stations the semi-arid type of climate is found. (Table-1 and Fig.2)