ANALYSIS OF EROSIVITY INDICES WITH SPECIAL REFERENCE TO KERALA

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DECLARATION

We hereby declare that this project report entitled **"ANALYSIS OF EROSIVITY INDICES WITH SPECIAL REFERENCE TO KERALA"** is a bonafide record of project work done by us during the course of project and that the report has not previously formed on the basis for the award to us of any degree, diplomas, associateship, fellowship or other similiar title of any other University or Society.

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Certified that this project report, entitled **"ANALYSIS OF EROSIVITY INDICES WITH SPECIAL REFERENCE TO KERALA"** is a record of project work done jointly by Geetha, V., Prabhadevi, P.S. and Sudheer Narayanan under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to them.

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SYMBOLS AND ABBREVIATIONS

cm	centimetre
cm/h	centimetre per hour
CWRDM	Centre for Water Resources Development and Management
EI	erosivity index
EI 1440	erosivity index for 1440 minutes duration
EI 30	erosivity index for 30 minutes duratio
Fig	figure
h	hour
hrs	hours
IMD	Indian Meteorological Department
KE	kinetic energy
km^2	kilometers squared
Mg/ha	mega gram per hectare
min	minute
mm	millimeter
mm/h	millimeter per hour
M-t-cm/ha-h	metric tonne centimetere per hectare hour
%	per cent
PI 1440	precipitation index for 1440 minute duration
R	rainfall and run off factor
t/a	tonnes per acre
USLE	Universal Soil Loss Equation
viz.,	namely

INTRODUCTION

Of all the gifts of nature, none is more indispensible to man than soil. Lying over the rocky core of earth at different depths, this complex mixture of animal, vegetable and mineral matter is one of the four prime requisites for life. Along with sunlight, air and water, soil nourishes all plant life and supports human life. Today soil erosion is almost universally recognised as a serious threat to man's well-being. Soil erosion is the detachment and transportation of soil material from one place to another through the action of wind, water in motion or by the beating action of raindrop .

It has been estimated that in India about 81 million hectares of land out of the total geographical area of 328 million hectares suffer from soil erosion. The rate of top soil loss is about 16.32 t/ha/year. The main factors responsible for soil erosion in India are excessive deforestation, overgrazing and faulty agricultural practices. Consequently valuable top soil is lost and its fertility depleted resulting in poor crop yield.

In Kerala about 1.5 million hectares of land is affected by soil erosion. Out of the total geographical area of 38.86 lakh hectares in the state nearly 19 lakh hectares of land are highly vulnerable to soil erosion hazards. From many places of Western Ghats the fertile top soil is lost at a rate of 20 to 120 tonnes per year. The undulating topography and high intensity rainfall spread over two monsoon seasons and decreasing demand for arable lands and consequent denudation of forest have accentuated the problem of soil erosion in the state.

Removal of soil from land surface by water including runoff from melted snow and ice is termed as water erosion. Recognized types of water erosion are:

1. Raindrop erosion or splash erosion
2. Sheet erosion

3. Rill erosion
4. Gully erosion
5. Stream bank erosion

Collision of raindrops on bare soil results in splash which is the major cause of soil erosion by water. Soil loss due to splash erosion is considered to be 50 to 90 times greater than wash-off losses. Sheet erosion is the uniform removal of soil in thin layers caused by sheet or overland flow of water. Rill erosion occurs when soil is removed from small but well defined channels or stream lines by water when there is concentration of surface flow. In gully erosion rills combine subsequently to give channels or streamlets which cannot be removed by normal tillage operations. Stream bank erosion is caused by sediment laden flowing water scouring the banks of stream.

Wind erosion is the removal of soil by the action of wind. Arid and semi - arid regions are most effected by wind erosion, but it is not uncommon in subhumid and coastal regions where soils are lighter. In Indian subcontinent erosion caused by rainfall is more serious than that caused by wind.

The factor which most influences soil erosion by water is the rainfall. Raindrop impact on a soil surface has a pronounced effect on erosion. It causes soil splash, detach soil particles and makes them susceptible to erosion. The amount of soil detached by rain depends on intensity of rain or its detaching capacity, the character of soil or its detachability and the protective value of any cover present. Erosive capacity of raindrop results from three factors; amount and intensity of rainfall diameter of raindrops and the velocity of drops as they strike the soil.

The erosion rate at a given sight is determined by the particular way in which the levels of numerous physical and management variables are combined at that site. Soil loss equations were developed to enable conservation planners to project limited erosion data to many localities and conditions. The most accurate soil loss equation that is no field operational is the Universal Soil Loss Equation developed by Smith and

Wischmeier. This equation can be used to predict the long time average soil losses in run-off from specific field areas in specified cropping and management systems. It is also applicable for non - agricultural conditions as constructions sites.

The rainfall erosion index 'R' of the USLE is the best indicator of the power of a storm to erode soil. The erosion index quantifies the effect of raindrop impact on the soil based on storm intensities. Wischmeier showed that if all factors other than rainfall are held constant, annual erosion losses from cultivated areas are directly proportional to yearly values of erosion index. The quantification of this parameter has reflected a great significance for soil erosion control and prediction.

The rainfall factor 'R' is the product of kinetic energy of storm and its maximum 30 minutes intensity and is called the rainfall erosion index.

The actual determination of EI_{30} values for a given site requires a long term rainfall record from a recording rain gauge. The calculation is tedious and repetitious and is often placed at low priority. Also there are few stations in the state where such gauges are installed, however, there is a net-work of standard (non-recording) raingauges all over the state.

Very little efforts have been made to utilise the date for estimating erosion potential. In the present study, efforts have been made to correlate daily rainfall amounts with erosion indices in order to widen the scope of applicability of rainfall data in conservation planning. The specific objectives of this study are:

1. Procurement of rainfall data
2. Analysis of this data and calculation of erosivity index
3. Computation of precipitation index
4. Correlating precipitation index with erosivity index.

REVIEW OF LITERATURE

Extensive works on soil erosivity index has been done all around the world and the amount of literature on the subject is extensive. In India, especially in Kerala, the distribution and intensity of rainfall is different for different locations and from place to place the soil type also varies. Therefore the capacity of rain to erode soil will also be different. So it is necessary to calculate erosivity index for different places which is an indication of the capacity of rain to erode soil.

Each and every raindrop has some kinetic energy and as the raindrop impinges on the soil a part of this kinetic energy is exchanged to soil particles. This will ultimately result in soil splash. The falling raindrops breakdown the soil aggregates and detach soil particles from soil mass. Fine soil particles are taken into suspension and the splash thus becomes muddy. As the muddy water permeates the soil, the fine particles of silt filter out and form a thin film on the surface. This film chokes the pores of the soil and the continued impact of raindrops compact and further seal the surface. The higher run off in turn is able to transport more material.

2.1 Quantification of soil loss

The relationship of erosion to rainfall, momentum and energy is determined by the factors such as raindrop mass, size, size distribution , shape, velocity and direction. The method used for predicting the soil loss should consider each of the factors involved and can be easily applied to field conditions. The most accurate soil loss equation that is now field operational is the Universal Soil Loss Equation (USLE) developed by Smith and Wischmeier.

The USLE was developed from more than 40 years date measured from small plots. It is useful to determine the adequacy of conservation measures in farm planning and to predict non-point sediment losses in pollution control programmes. Despite its simplification of many variables involved, the USLE is the most widely accepted method of estimating sediment loss.

The average annual soil loss, as determined by Wischmeier(1959), can be estimated from the equation

$$A = 2.24\ RKLSCP$$

where,

A = average annual soil loss in Mg/ha.(Metric tons/ha)

R = the rainfall and runoff erosivity index by geographic location.

K = soil erodibility factor which is the average soil loss in t/a per unit of erosion index for a particular soil in cultivated continuous fallow with an arbitrarily selected slope length of 22m and slope steepness, of 9 per cent (if K is in Mg/ha change the constant 2.24 to 1)

LS = topographic factor .

C = cropping management factor, which is the ratio of soil loss for given conditions to soil loss from cultivated continuous fallow.

P = the conservation practice factor, which is the ratio of soil loss for a given practice to that for up and down the slope farming .

The index factor R was a product of the kinetic energy of the storm and the maximum 30 minutes intensity. This product was called the rainfall and runoff erosivity index.

In recognizing the inadequacy in EI 30 and on the basis of experiment with bare runoff and soil loss plots under natural rainfall, Kinnell (1983)proposed that the product of the runoff rate (Q) and the rate of expenditure of rainfall kinetic energy would provide a useful index of the erosive capacity of rainfall associated with sheet erosion. Kinnell also observed that the excess rainfall rate could be used as a surrogate for Q.

Snyder and Thomas (1987) and Snyder *et al.*, (1989) have used from -free sliding polynomial models to establish seasonal patterns of selected varieties. They investigated the seasonal variability of the relationship between monthly rainfall and runoff and then extended the model to include runoff of the antecedent month. Since information and understanding of the rainfall runoff relationships are extensive, these earlier studies served to confirm the utility of the form-free sliding polimonial approch in seasonally continuous analysis.

2.2. Correlation of the rain fall erosion index

Breve *et al.*, (1990) carried out a study on the distribution and correlation of the rain fall erosion index in Southern Louisiana. Rainfall erosion indices were calculated for Batonrouge, Louisiana from a 19 year record and for 4 additional locations in Southern Louisiana from a five year record. Results showed the erosion indices recommended by Wischmeier and Smith (1978) for the studied locations, were satisfactory for soil erosion control or prediction except for higher indices in Central Louisiana. Latitude and longitude highly significant in explainig the variation of erosion indices in South central Louisiana.

Kinnell (1991)presented a theory for RIFT that was based on the observation that material discharge immediately across any arbitrary boundary results from the impact of rain drops in a zone(called the active zone) upstream of that boundary. This theory leads to the equation,

$$Qsr\ (p,d) = 6R_dD_{pd}\,u_{tpd}\,(\pi d^3)^{-1}$$

where,

qsr- Mass or soil material discharged across a unit width of any arbitrary boundary in unit type.

Rd - Intensity of rain of drop sized,

D_{pd}- Mass of soil material of size p lifted in to the flow by a drop of size d impacting in the acting zone upstream of the boundary.

U - The flow velocity

t_{pd} - time for which particles of size p remains suspended in the flow following the impact of a drop of size d.

2. 3 Erosivity and erodibility

Erosivity is the capacity of the rainfall to erode soil and erodibility is the vulnerability or susceptibility of the soil to get eroded.

Kinnell *et al.*, (1992) tried to isolate the erosivity and erodibility components in erotion by rain - impacted flow. Erosion experiments were performed using 3.7mm rain drops impacting flows over various sized sands. The results from these experiments when compaind with data from previous experiments using other drop sizes, enabled the effects of flow and the rain to be isolated from the effect of eroding surfaces. Although the rate of decrease in erotion rate with flowdepth was observed to vary with drope sizes when drops impact flows deeper than about 4mm, rain drope size may not have a significant influence on the erotion rate when shallow flows are impacted by medium to large rain drops. However this is not the case for smaller drops and for medium to large drops traveling at much less than their terminal velocities.

The relationship between rainfall pattern and production of run off and sediment was studied by factorial analysis in three areas under semi arid, The relationship between rainfall pattern and production of run off and sediment was studied by factorial analysis in three areas under semi arid, mediterranean conditions by Sauchez, Belloc and Gonzalez (1994). Volume and intensity of rainfall had greatest effect on erosion followed by duration of rainfall events and the length of day period proceeding precipitation.

Mc Gregor *et al.,* (1995) computed erosivity index values for Northern Mississippi during 1982-92 from 29 standard recording rainguages in or adjacent to 21.3km^2. Goodwin Creek Watershed in Mississippi, using Broun-Foster, MC.Greoger-Mutchler,Agricultural Hand Book 282 and Agricultural Hand Book 537 procedures. Computed R values were substantially higher than interpolated values given in Agricultural Hand Book 282 and 537, for all storms with no limitations on storm size or intensity parameters.

2.4 Computation of EI_{30}

Wischmeier and Smith (1959) developed the universal soil loss equation which used the rainfall erosion as one of its variables . Wischmeier showed that if all factors other than rainfall are held constant , annual erosion losses from cultivated areas are directly proportional to the early values of the erosion index. Thus the rainfall erosion index of the ;USLE is the best indicator of the power of a storm to the erode soil. The erosion index quantifies the rain drop impact effect on the soil based on storm intensities.

Rainfall erosion indices have been estimated and presented on isoerodent maps for the entire United States based on rainfall intensity data from 181 locations. In Louisiana the isoerodents were interpolated using average values for only three locations.

Alishian (1974) proposed a method for computing EI30 based on Soil Conservation Service (SCS) standard storm Type-I and Type-II where each type represented a geographical area of the United States. He developed an isoerodent map from 2 year 6 hour rainfall for the area east of the Rockies and compared it with the map by Wischemeier and Smith. Renard (1975) and Renard and Simenton (1975) discussed the overall adiquacy of this approach when judged against the tremendous variation of storm patterns by climatic regions.

Lal (1976) suggested AI 7.5 , the product of rain fall amount and the maximum rainfall intensity measured over a 7.5 minute time interval was more appropriate than EI 30 in Nigeria. In effect because there is a reasonably high correlation between storm rainfall kinetic energy and the storm rainfall amounts, the AI 7.5 index differs from EI 30 mainly in the time base used to determine the peak rainfall rate parameter. All these indices are based on the empirical observation that soil loss increases with rainfall amount and the intensity of the rainfall event.

The USLE has had a tremendous impact as an effective technique to predict long term average soil losses. Most of the research work was directed towards adopting the USLE to estimate short term losses using individual storm erosion indices (Cooley,1980; Foster *et al.*, 1982) and implementing simpler and less tedious methods to approximate average annual rainfall erosion indices (Richardson *et al.*, 1983; Haith and Merrill, 1987) None of these approaches has had the impact of the original USLE. One the other area of research on erosion index has been a more detailed evaluation of geographic distribution of the index (Mc Gregor *et al.*, 1980; Simenton and Renard,1981; M.C. Coel, *et el.*, 1982 Bengtson and Carter, 1983).

Willams *et al.*, (1991) studied the effect of rainfall measurements , time and depth resolution on EI calculation. The rainfall erosion index EI is one of the primary factors in the USLE. Calculation of EI is based on breakpoint rainfall records where breakpoints seperate periods or constant rainfall intensity. Break point data are determined from continuously recording chart -type rain gauge records. This examined the use of rainfall records for EI determination where accumulated depth is recorded at determined from continuously recording chart -type rain gauge records. This examined the use of rainfall records for EI determination where accumulated depth is recorded at fixed time increments . Various time and depth resolutions were super imposed on breakpoint rainfall records from Tifton, GA to obtain equivalent non-breakpoint records. Results of statistical analysis relating non-breakpoint EI values to break point values are presented along with correlation factors for adjusting non breakpoint EI to breakpoint EI and a relationship defining optimum time and depth resolution combinations for accurate EI calculations.

2.5 Alternatives to EI $_{30}$

Hudson (1965) proposed an index that differs in principle from EI_{30} index. Hudson's index considers only the rainfall KE that occurs when the rainfall intensity exceeds 25 mm/h . This index was based on the observation that splash erosion of sand surfaces placed under natural rainfall did not occur when the rainfall rate was low. He also noted that, even if a little splash erosion does occur, there is usually no run off to carry away the splashed particles when the rainfall rate is low. From this experiments Hudson concluded that 25mm/h can be taken as the practical threshold between non-erosive and erosive rains in Zimbabwe.

Later Morgan (1997) suggested that threshold should be lowered to 10mm/h in England.

Istok *et al.*, (1986) indicated a highly significant linear correlation between EI calculated from 15 minutes time interval records and EI calculated from the same records by assuring a 60 minute time interval.

The computation of single storm erosion index which is the base to determine the rainfall factor R of the universal soil loss equation (USLE), is tedious and time consuming and requires a continuous record of rainfall intensities.

Baggarello *et al.*, (1994) developed simplified methods for estimating the single storm EI in the Mediterranean area. In particular data from 32 Sicilian locations and 3 additional locations in continental south Italy were at first used to derive and list a regionalised relationship for estimating EI index from only storm amount data. A potential relationship with an exponent equal to 1.54 is obtained, Regionalised relationship for estimating the kinetic energy and EI for an event as a function of rain storm amount and maximum 30 minutes intensity were also developed and tested. Since in the Mediterranean area an erosive event may generally last several days, a rule of grouping daily rainfall data in order to reproduce the amount of each erosive event may finally developed and tested.

The EI_{30} index used for rainfall run off factor in the USLE modelling environment was originally developed from empirical observation that soil loss increases with rainfall amount and intensity of rainfall event. Modern understanding of erosion processes provide for more process based indices. In an analysis of erosion data from non-vegetated plots at Holly Springs Mississippi. The I_X E_A index , an index that is based on the product of excess rainfall rate(I_X)and the rate of expenditure of rainfall kinetic energy (E_A) is shown to be superior to the EI_{30} index. Apart from accounting for process of detachment and transport better than EI_{30} index, the index provides an opportunity to consider the effects of hydrology more directly within USLE environment than is currently possible. However, including more direct considerations of hydrology within R is likely to affect a number of other USLE factors. These have yet to be evaluated.

2.5.1 Erosivity index from daily rainfall data

A general equation for estimating the erosivity term in the USLE from daily rainfall data was proposed by Richardson *et al.*, (1983). The equation provides a simple model for calculating event soil losses from daily rather than hourly precipitation data . Since daily weather records are more commonly available than hourly records, the equation is potentially a valuable tool for erosion, sediment yield hourly records, the equation is potentially a valuable tool for erosion, sediment yield and non-point source pollution studies. It was subsequently tested by Haith and Merril(1987) for 23 locations in the eastern and central US. Long term synthetic daily rainfall records were generated at each location, and these were used in the Richardson *et al.,* model to compute erosivities. The testing involved comparisons of these model results with rainfall erosivities reported by Wischmeier and Smith(1978).

Adequate information on the seasonal distribution of rainfall erosivity required to predict rainfall erosion losses was not available previously for Peninsular Florida.

Daily precipitation data from selected locations in Florida were analyzed by Sheridan J.M. *et al.,* (1989) to determine seasonal variation in the rainfall erosion index. rainfall, long term seasonal rainfall erosivity index distributions were used to delineate erosivity index distributions regions, thereby extending applicability of the USLE for erosion modelling in Peninsular Florida. Design values for annual total and maximum one day erosivity index , and a revised map of average annual rainfall erosivity were presented.

A general procedure is presented by Selker. A.S., (1990) for calibrating a model for rainfall erosivity based on daily rainfall. The approach is based on probability distributions of wet day precipitation amount and monthly erosivities which are inferred from published data summaries. The calibrated model was tested by comparisons with erosivities computed from hourly precipitations datas. Model results were generally consistent with values based on hourly data and explained over 85 per cent and 70 per cent respectively, of the variations in annual and event erosivities. Model results for extreme values (annual erosivities exceeded in 5 per cent of the years and 1 in 20 year event erosivities) often substancially exceeded values computed for hourly data. To facilitate general use of the daily model, calibration coefficients were calculated for 33 sites in the eastern and central US.

A model for computing monthly erosion index for the USLE from daily rain fall records is developed and tested by Thomas, A.W.*et al.*,(1990). The prediction was based on month of year, maximum one day rainfall during month and extended rainfall. The predictive capability was evaluated by comparing model results with measured data.

Seven years daily rainfall date recorded by automatic recording type rainguage were collected by Taley, S.M. *et al.*, (1992) for Akola and Buldana districts of Vidarbha. Data were analysed for computing EI_{1440} and PI_{1440} using the procedure suggested by Raghunath and Erasmus(1971). The models were developed between EI_{1440} and PI_{1440}. By using these models, EI_{1440} values were found for varying amount of rainfall as a ready Reckner for stations understudy.

MATERIALS AND METHODS

Universal Soil Loss Equation is a unique tool for estimating the soil loss and the soil loss during each storm is mainly influenced by the nature of the rain. A degree of correlation exists between erosive power and the amount of rainfall. The main objective of this study is to develop a correlation between EI_{30} and EI_{1440} and then to correlate the EI_{1440} values with daily rainfall records for different locations of Kerala. This chapter describes the method adopted for the calculation of erosivity indices.

3. 1 Description of study Area

The Kerala region comprises of a narrow strip of land with a total area of 39, 000 km^2 extending between north latitudes 8^O 04' and 12^O 44' and east longitudes 74^O 54' and 77^O 12'. and is bounded by the Western Ghats on the east and the Arabian Sea on the west.

3.1.1 Climate

The climate over the state is tropical monsoon with seasonally excessive rainfall and hot summer except over the extremely southern district viz., Thiruvananthapuram where the climate falls under the type tropical savanna with seasonally dry and hot summer weather .

The year may be divided into three seasons . The period from March to the end of May is the hot season . This is followed by the south-west monsoon season which continues till the middle of October. From the middle of October begins the North - East monsoon season which lasts up to the end of February although the rains associated with North - East mansoon ceases by December.

3.1.2 Rainfall pattern

The total annual rainfall in the state varies from 380 cm over the extreme northern part to about 180cm in the southern part. Table I gives the district -wise mean monthly and annual rainfall and number of rainy days & Fig.1 shows the annual rainfall distribution.

The south-west monsoon is the principal rainy season when the state receives about 73 per cent of its annual rainfall. Rainfall in the north-east monsoon season and hot weather season constitute 7 to 25 per cent and 10 to 20 per cent. The south-west monsoon rainfall as a percentage of annual rainfall decreases from north to south and increases in the case of north-east monsoon rainfall . The thunder storm rains in the monsoon months of June to October is locally known as "EDAVAPATHI" . Rainfall during north-east monsoon is known as "THULAVARSHAM" in local language.

The south-west monsoon sets over the southern part of the state by about Ist June and extends over the entire state by 5th June. June and July are the rainiest months, each accounting individually to about 23 per cent of annual rainfall . In each of this months, the number of rainy days varies from 27 towards the north to 15 towards the south. South-West monsoon withdraws from the state by 15th October.

3.1.3 Rainfall variability

Coefficient of variation of rainfall in the three seasons namely hot season, South-West and North-East monsoon seasons is least over the state, in general. The same for annual rainfall is less than 15 per cent over the Northern district like Kannur, Kozhikode and Malappuram and less than 20 per cent over the rest districts of the state. But coefficiant of variation of mansoon rainfall over the state is a little higher and this is evident from the fact that the same for mansoon rainfall is more than 20 per cent over the districts Kannur, Kozhikode and Malappuram and less than 30 per cent over

Table 1. District-wise mean monthly and annual rainfall distribution

DISTRICT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL
Alapuzha													
*a	29.6	27.2	57.4	130.2	298	661.6	545.3	360.3	265.8	332.9	220.5	63.9	2992.7
**b	1.6	1.6	3.4	7.2	12.2	23.8	22.8	18.6	14.3	15	11.1	3.7	135.4
Ernakulam													
a	16.8	22.6	51.6	129.5	308.4	796.1	785.3	518	293.9	359.7	216.6	54.2	3548.7
b	0.8	1.1	2.9	7.2	12	25.1	25.7	21.8	15.1	14.9	9.9	2.7	139.2
Idukki													
a	32.6	21.7	42.8	109.4	188.5	501.7	614.1	405	241.2	284.7	191	69.4	2702.1
b	1.9	1.5	2.9	7.7	9.8	19.1	20	17.7	13.5	15.1	10.9	4.3	125.4
Kannur													
a	5.3	4.8	11.2	58.6	200.6	923	1063.5	584.7	239.4	218	106	22.8	3437.9
b	0.4	0.3	0.7	3.4	8	24.3	27.5	22.9	14	10.7	5.4	1.3	118.9
Kollam													
a	24.7	32.1	82.9	163.8	265.4	542.3	460.2	315.5	230.1	351.4	247.5	62.9	2778.8
b	1.5	1.8	4.5	8.9	11.5	21.9	21.3	16.9	12.6	15.2	11.1	3.5	130.7
Kottayam													
a	28.7	30.3	87.4	176.9	324.1	713.3	657.7	447.5	296.5	383.7	244.7	73.6	3462.4
b	1.6	1.6	4.5	9.5	12.8	24.3	24.2	24.5	14.7	15.7	11.1	3.7	134.2
Kozhikkode													
a	10.4	7.6	20	92.4	254.1	944.5	1117.4	599.2	262.4	290.2	163.7	34.2	3796.1
b	0.7	0.4	1.3	5.5	9.9	24.5	27.2	22	14	12.6	7.5	2	127.6
Malappuram													
a	6.7	6.5	19.3	78.7	211	702.4	787	405	198.8	290	163.8	13.9	900.1
b	0.5	0.4	1.3	4.6	8.7	23.2	25.6	19.2	12	12.9	7.5	1.7	117.6
Palakkad													
a	9.7	9.2	26.9	79.3	157.9	503.4	649.9	363	169.5	257.2	140.9	29.7	2396.6
b	0.5	0.5	1.5	4.4	7.1	20.6	24.5	18	11	12.4	6.9	1.5	108.9
Tiruvana													
nthapuram													
a	24.1	18.9	45.7	117.2	201.9	351.1	22	149.3	137.6	283.2	213	69.9	1833.9
b	1.7	1.2	2.8	6.8	9	17	14.6	10	8.4	12.5	10.3	4	98.3
Thrissur													
a	10.1	9.2	28.4	91.1	283.5	800.3	747.6	441.7	245.5	305.7	163.5	328	3159.4
b	0.5	0.6	1.6	4.8	10.9	24.8	25.5	20	13.3	13	7.5	1.6	124.1

*a Normal Rain fall **b Average number of rainy days (days with rain of 2.5mm or more)

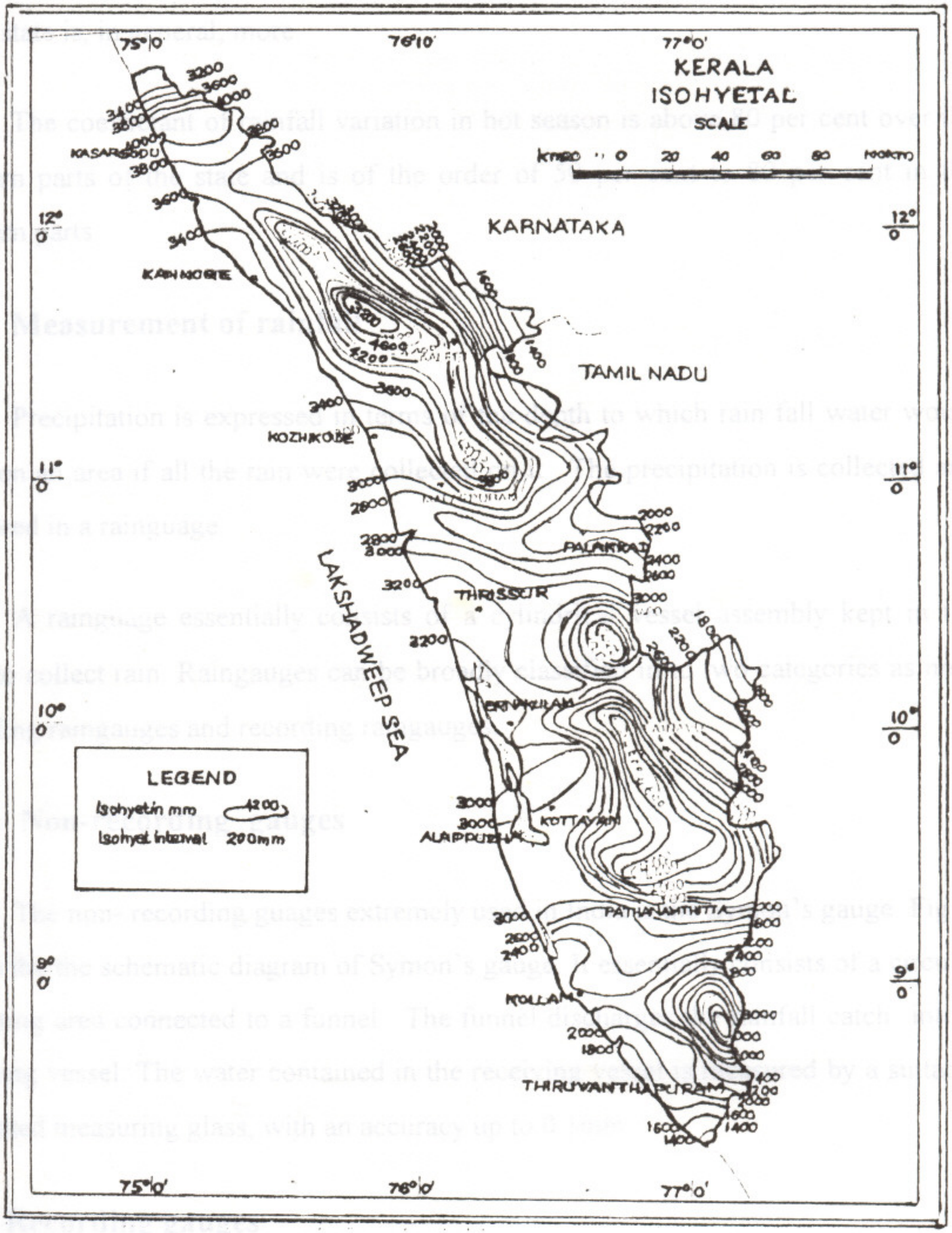


Fig.1 The annual rainfall distribution for Kerala

the rest of the districts of the state. Rainfall variability in the southern and interior parts of the state is, in general, more.

The coefficiant of rainfall variation in hot season is above 80 per cent over the northern parts of the state and is of the order of 50 per cent to 80 per cent in the southern parts.

3.2 Measurement of rainfall

Precipitation is expressed in terms of the depth to which rain fall water would stand on an area if all the rain were collected on it . The precipitation is collected and measured in a rainguage.

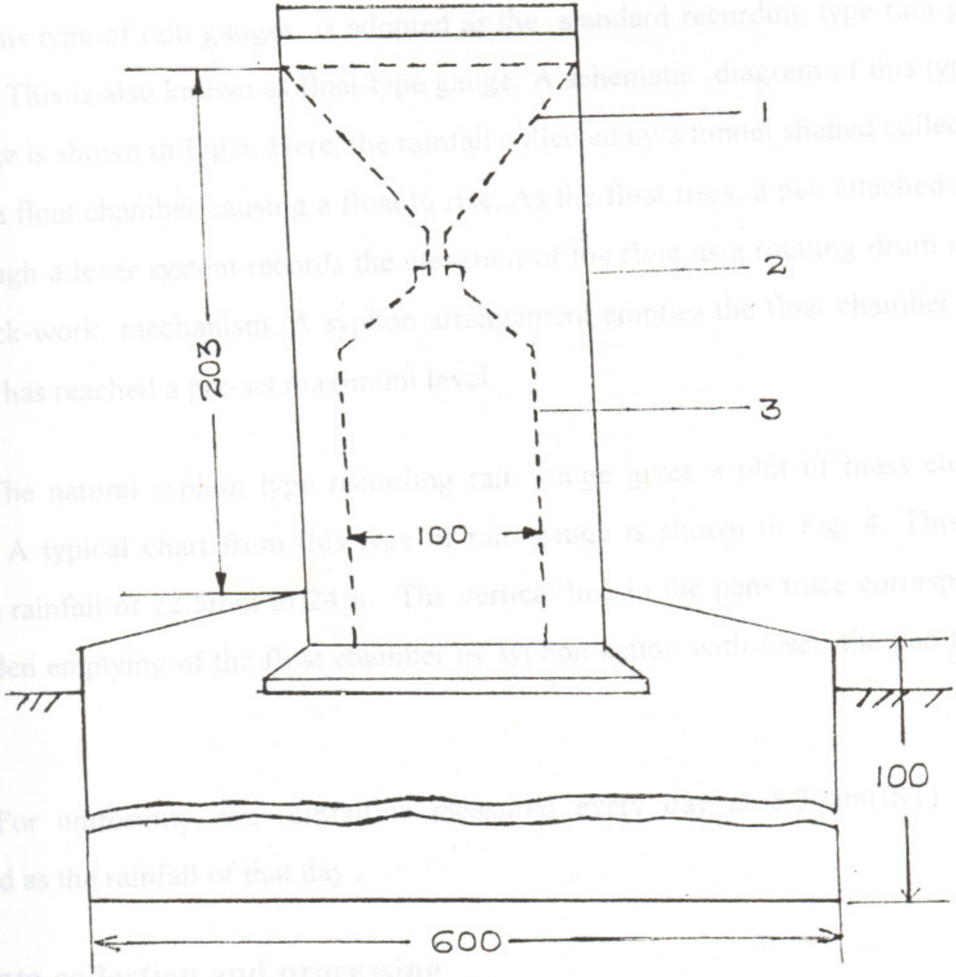
A rainguage essentially consists of a cylindrical vessel assembly kept in the open to collect rain. Raingauges can be broadly classified in to two categories as non-recording raingauges and recording raingauges.

3.2.1 Non-recording gauges

The non- recording guages extremely used in India is the Symon's gauge. Fig. 2 shows the the schematic diagram of Symon's gauge. It essentially consists of a circular collecting area connected to a funnel . The funnel discharges the rainfall catch into a receiving vessel. The water contained in the receiving vessel is measured by a suitably graduated measuring glass, with an accuracy up to 0.1mm.

3.2.2 Recording gauges

Recording gauges produce a continuous plot of rainfall against time and provide valuable data of intensity and duration of rainfall for hydrological analysis of storms. Some of the commonly used recording raingauges are Tipping-Bucket type, Weighing-Bucket type, and Natural Syphon type.



1. Funnel
2. Metal container
3. Collecting bottle

ALL DIMENSIONS ARE IN mm

Fig.2 Schematic diagram of Symon's raingauge

3.2.2.1 Natural Syphon type

This type of rain gauges is adopted as the standard recording type rain gauge in India. This is also known as float-type gauge. A schematic diagram of this type of rain gauge is shown in Fig.3. Here, the rainfall collected by a funnel shaped collector is led into a float chamber causing a float to rise. As the float rises, a pen attached to the float trough a lever system records the elevation of the float as a rotating drum driven by a clock-work mechanism. A syphon arrangement empties the float chamber when the float has reached a pre-set maximum level.

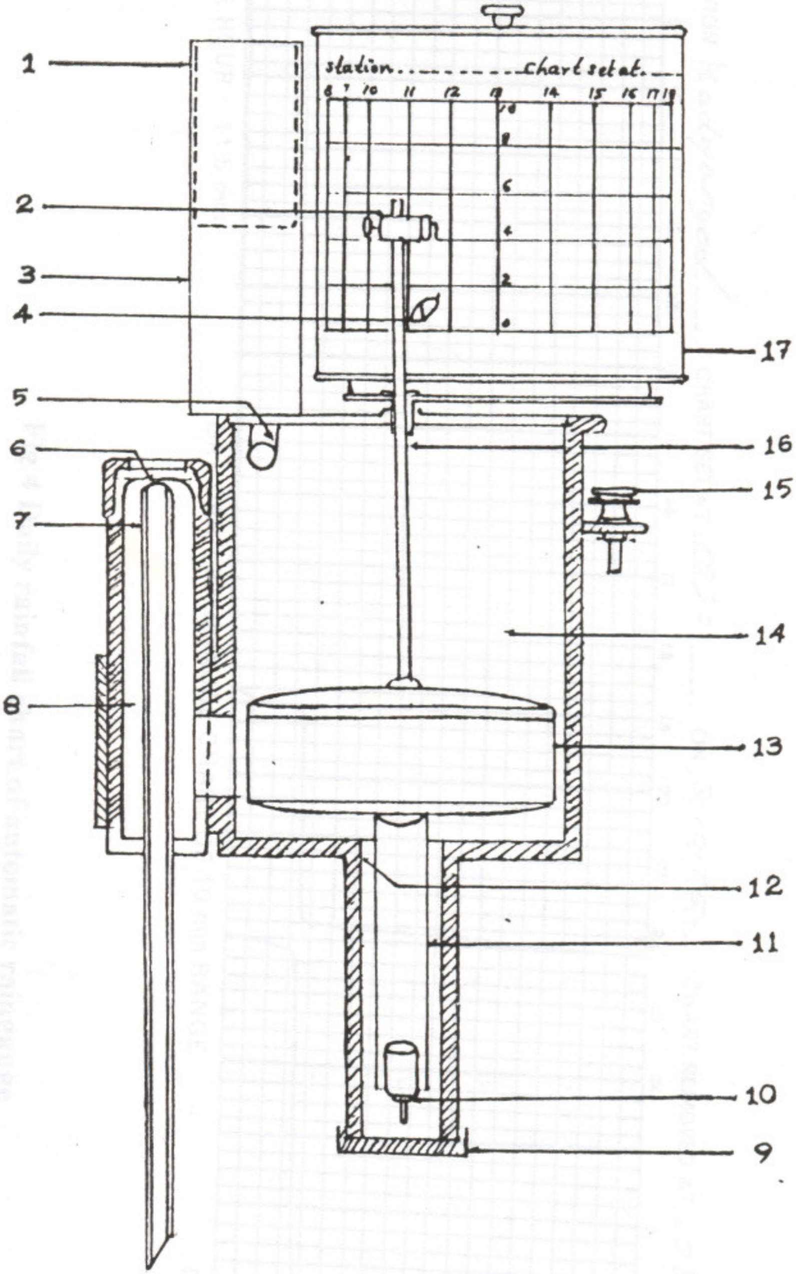
The natural syphon type recording rain gauge gives a plot of mass curve of rainfall. A typical chart from this type of rain gauge is shown in Fig. 4. This chart shows a rainfall of 22.5mm in 24 h. The vertical line in the pen- trace correspond to the sudden emptying of the float chamber by syphon action with reset the pen to zero level .

For uniformity, the rainfall is measured every day at 8.30am(IST) and is recorded as the rainfall of that day .

3.3 Data collection and processing

Based on the availability of automatic rain gauge data, 8 rain gauge stations were selected for this study . The selected rain gauge stations are listed below:

1. Alappuzha - Alappuzha district
2. Cochin - Ernakulam district
3. Kadiangadu - Kozhikode district
4. Kottamparambu - Kozhikode district
5. Manjeri - Malappuram district
6. Ottappalam - Palakkad district
7. Thiruvananthapuram - Thiruvananthapuram district
8. Vettilappara - Thrissur district



1. Filter	7. Discharge tube	13. Float
2. Pen carrier	8. Syphon chamber	14. Float chamber
3. Entrance tube	9. Hexagonal nut	15. Thumb nut
4. Pen	10. Nut	16. Float rod
5. Small opening	11. Strip	17. Drum
6. Glass cap	12. Guide	

Fig.3 Schematic diagram of Natural Syphon type raingauge

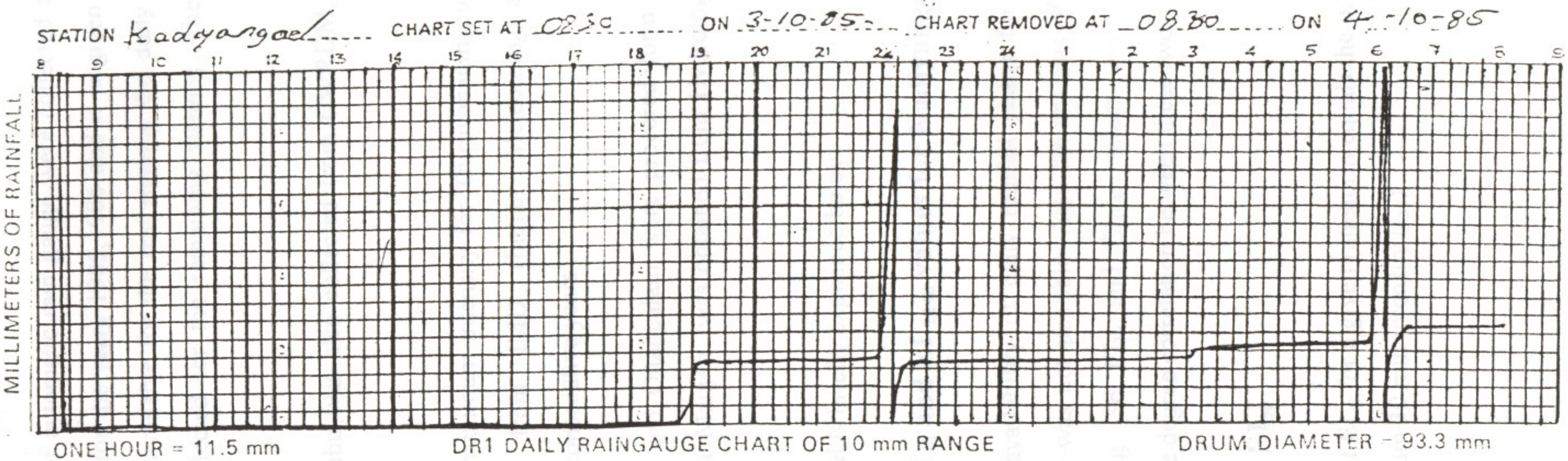


Fig.4 Daily rainfall chart of automatic raingauge

Daily rain fall charts of automatic rain gauge were collected from CWRDM, Kozhikode , for Kadiangadu for the years 1985,1986 and it is given in Appendix I. Daily rainfall chart were not available for the rest stations. So daily rainfall and its maximum intensity were collected for the remaining stations. They are given in Appendix II.

Data for Kottamparambu was also collected from CWRDM, Kozhikode for two consecutive years.

Daily rainfall and its maximum intensity for Thiruvananthapuram, Cochi and Alappuzha were procured from IMD (Indian Meteorological Department) Thiruvananthapuram for two consecutive years .

Data for Vettilappara and Ottappalam were procured form Hydrologic sub division, Thrissur and that for Manjeri was obtained from Hydrologic sub division, Kozhikode .

The procedure involved is briefly explained below .

3.3.1 Computation of EI_{30} and EI_{1440} values for Kadiyangadu

Because of the non-availability of daily rainfall charts for the rest of the stations, computation of EI_{30} was not possible. Also the analysis of the charts were tedious and time consuming. So EI_{30} and EI_{1440} values were worked out for kadiangadu in order to test the degree correlation between these two.

3.3.1.1 Computation of EI_{30}

By definition, the value of EI_{30} for a given rainstorm equals the product,total storm energy (KE)times the maximum 30 min intensity (I_{30}), i.e., $EI_{30} = \frac{KE \times I_{30}}{100}$

where EI_{30} is the maximum 30 min intensity in cm/h and it indicates the prolonged peak rates of detachment and runoff. KE is storm energy which is a function of the amount of rain and of all the storms component intensities.

Since the energy of a given mass in motion is proportional to the square of the velocity, rainfall energy is directly related to rainfall intensities. The relationship is expressed by the equation.

$$KE = 210.3 + 89 \log I$$

where,

I = the intensity of rainfallin cm/h

I_{30} = maximum 30 minute intensity in cm/h and it indicates the prolonged peak rates of detachment and runoff.

Even though this is an accurate method, it is tedious and time consuming. So in the present study, efforts have been made to correlate daily rainfall amounts with erosion indices in order to widen the scope of applicability of rainfall data in conservation planning.

3.3.1.2 Computation of EI_{1440}

Erosivity index for each storm was computed for 1440 minutes duration as suggested by Raghunath and Erasmus (1971).

$$EI_{1440} = \frac{KE \times I_{1440}}{100}$$

where,

EI_{1440} = the erotion index for the day, in m-t-cm/ha-h.

KE = the total kinetic energy of the storm in m-t/ha.

I_{1440} = the average storm intensity in cm/h.

The average intensity in cm/h for the day was worked out by dividing the total rainfall for the day by 24 and termed as I_{1440} .

3.3.2 Correlating EI_{1440} values with EI_{30} for Kadiyangadu

EI_{30} and EI_{1440} for Kadiangadu were computed and the correlation between these two was tested using Karl Pearson`s method.

$$\text{i.e.,}\quad r = \frac{\Sigma x_i y_i - \Sigma x_i \times \Sigma y_i / n}{\sqrt{[\Sigma(x_i)^2 - (\Sigma x_i)^2/n]\,[\Sigma(y_i)^2 - (\Sigma y_i)^2/n]}}$$

in which,

r is the correlation coefficient between x_i and y_i

x_i represents the EI_{30} values

y_i represents the EI_{1440} values and

n is the total number of rainy days .

The correlation was found to be significant to substitute EI_{30} by EI_{1440}. A graph was also plotted between EI_{30} and EI_{1440} values for quantifying erosion.

3.3.3 Computation of erosivity index and precipitation index for the other locations

EI_{1440} and PI_{1440} were computed for Alappuzha, Thrissur, Ernakulam, Kozhikode, Malappuram, Palakkad and Thiruvananthapuram .

3.3.3.1 Computation of EI_{1440}

EI_{1440} for the above 7 locations were computed as explained above .

3.3.3.2 Computation of precipitation index

The product of daily rainfall in cm and I_{1440} which is obtained by dividing the daily rainfall in cm by 24 was worked out and designated as PI_{1440}. Thus precipitation index for each storm was computed for 1440minutes duration .

3.3.4 Development of models

PI_{1440} values were plotted against EI_{1440} and then the line of best fit was drawn which is represented by the equation of the form .

$$y = a+bx$$

where y and x represent EI_{1440} and PI_{1440} respectively and a and b are constants .

To know the over all spectrum of EI_{1440} distribution with in a year for the 7 stations under study, EI_{1440} distribution curves were developed by plotting cumulative EI_{1440} against month.

RESULTS AND DISCUSSION

Rainfall erosion index implies the numerical evaluation of a rainstorm and describes its capacity to erode soil from an unprotected field. Computation of EI needs daily rainfall charts of automatic rain gauge, but the computation is tedious and time consuming. So here efforts are made for the determination of erosivity index from daily rainfall data which are easily available from non recording gauges. The results obtained from the study are discussed in this chapter.

4.1 Computation of EI_{30} and EI_{1440} for Kadiyangadu

Daily rainfall charts of automatic rain gauge were procured for the station Kadiyangadu for two consecutive years from CWRDM, Kozhikode. These charts were available only for very few locations, and the computation of EI_{30} values from these charts were tedious and time consuming. So the individual values of EI_{30} and EI_{1440} were worked out for Kadiyangadu. The relationship between these two were studied and a correlation coefficient of 0.9297 was obtained by Karl Pearson's method. The values of EI_{30} and EI_{1440} and the calculation involved in the determination of correlation coefficient are given in Appendix III. As a significant positive correlation was found to exist between these two, EI_{1440} can be substituted for EI_{30} even though EI_{1440} values are less than the corresponding EI_{30} values.

The monthly values of- EI_{30} and EI_{1440} were also calculated and it is given in table 2. From this table it is obvious that as EI_{30} increases EI_{1440} also increases and these two values are maximum for the month of June because of the south-west monsoon.

Table 2. Monthly values of EI_{30} and EI_{1440} for Kadiyangadu

Month	EI_{30}	EI_{1440}
January	18.06517	0.284876
February	0	0
March	34.60066	0.391082
April	0	0
May	0	0
June	480.0568	8.331306
July	122.40092	3.037027
August	193.16871	4.464429
September	155.7098	2.28917
October	0.75979	0.0471044
November	0	0
December	0	0
Annual	1004.76184	18.849964

Correlation Coefficient = 0.92965

The variation of this EI_{30} and EI_{1440} values is shown in Fig. 5 by plotting EI_{1440} against EI_{30}. From the graph it is clear that as EI_{30} increases EI_{1440} also increases. The straight line graph obtained indicates that their relationship is linear.

4.2 Computation of EI_{1440} for the remaining stations

EI_{1440} values were calculated for the stations Alappuzha, Kottamparambu, Thiruvananthapuram, Vettilappara, Ottappalam, Cochin and Manjeri for two consecutive years .

4.3 Computation of PI_{1440}

PI_{1440} values for the stations under study are worked out for two consecutive years. The average monthly values of EI_{1440} and PI_{1440} are given in Table 3. From the table, it is seen that the maximum rainfall EI_{1440} and PI_{1440} values have appeared in the month of June, July and August for all the stations and hence these months should be treated as most erosive months. Therefore, adoption of proper crop management and soil conservation practices during these months is important to minimize the erosive effect of rainstorms. PI values are not only higher than the EI values but also PI increases as EI increases.

EI_{1440} distribution curves developed by plotting cumulative EI_{1440} values against month for each of these stations are shown in Fig. 6. The graphs are S-shaped and the shape can be explained in terns of low rainfall experienced during the earlier months and the thunderstorm rains in the monsoon months of June to October followed by north-east monsoon season.

The average annual EI_{1440} values are presented in the Table 4. Distribution of EI_{1440} values for the stations under study are shown in Fig.7 Comparing these values we can say that erosion is more serious in Kozhikode region and it is least in Thiruvananthapuram.

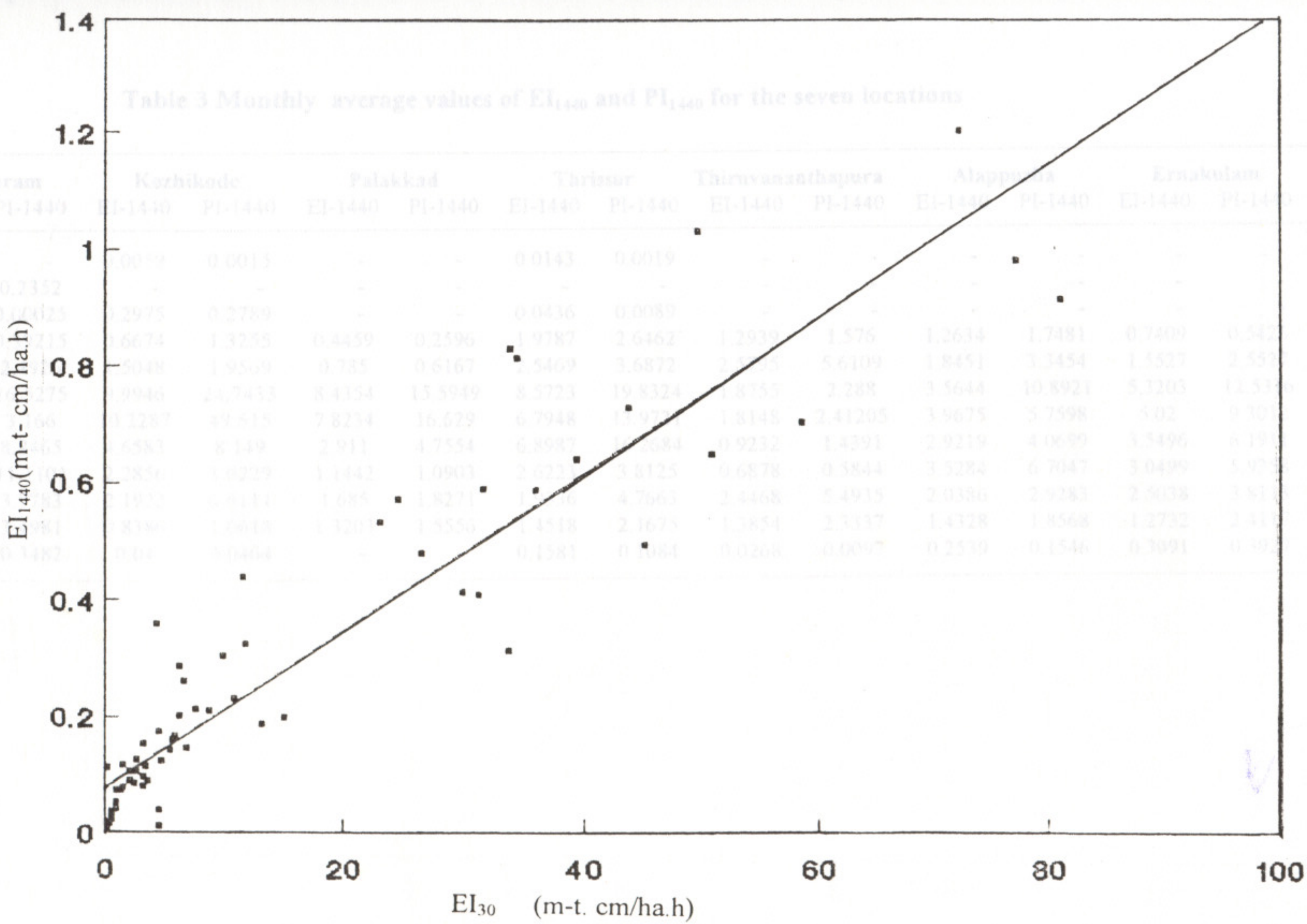


Fig.5 Variation of $EI_{.1440}$ with EI_{30}(m-t- cm/ha.h)

Table 3 Monthly average values of EI_{1440} and PI_{1440} for the seven locations

Month	Malappuram		Kozhikode		Palakkad		Thrissur		Thiruvananthapura		Alappuzha		Ernakulam	
	EI-1440	PI-1440	EI-1440	PI-1440	EI-1440	PI-1440	EI-1440	PI-1440	EI-1440	PI-1440	EI-1440	PI-1440	EI-1440	PI-1440
January	-	-	0.0059	0.0015	-	-	0.0143	0.0019	-	-	-	-	-	-
February	0.25015	0.2352	-	-	-	-	-	-	-	-	-	-	-	-
March	0.00435	0.00025	0.2975	0.2789	-	-	0.0436	0.0089	-	-	-	-	-	-
April	0.3692	0.39215	0.6674	1.3255	0.4459	0.2596	1.9787	2.6462	1.2939	1.576	1.2634	1.7481	0.7409	0.5426
May	1.6035	2.4926	1.5048	1.9569	0.785	0.6167	2.5469	3.6872	2.5795	5.6109	1.8451	3.3454	1.5527	2.5527
June	7.60535	16.5275	9.9946	24.7433	8.4354	15.5949	8.5723	19.8324	1.8755	2.288	3.5644	10.8921	5.3203	12.5316
July	3.0166	3.166	10.2287	49.615	7.8234	16.629	6.7948	13.9721	1.8148	2.41205	3.9675	5.7598	5.02	9.3012
August	5.06135	8.8465	4.6583	8.149	2.911	4.7554	6.8987	16.2684	0.9232	1.4391	2.9219	4.0699	3.5496	6.1911
September	4.284	11.1101	2.2856	3.0229	1.1442	1.0903	2.6223	3.8125	0.6878	0.5844	3.5284	6.7047	3.0499	5.9358
October	2.6621	3.7783	2.1922	6.6111	1.685	1.8271	1.9336	4.7663	2.4468	5.4935	2.0386	2.9283	2.5038	3.8113
November	2.1457	3.4981	0.8386	1.0618	1.3203	1.5556	1.4518	2.1675	1.3854	2.3337	1.4328	1.8568	1.2732	2.4117
December	0.4813	0.3482	0.04	0.0404	-	-	0.1581	0.1084	0.0268	0.0097	0.2539	0.1546	0.3091	0.3927

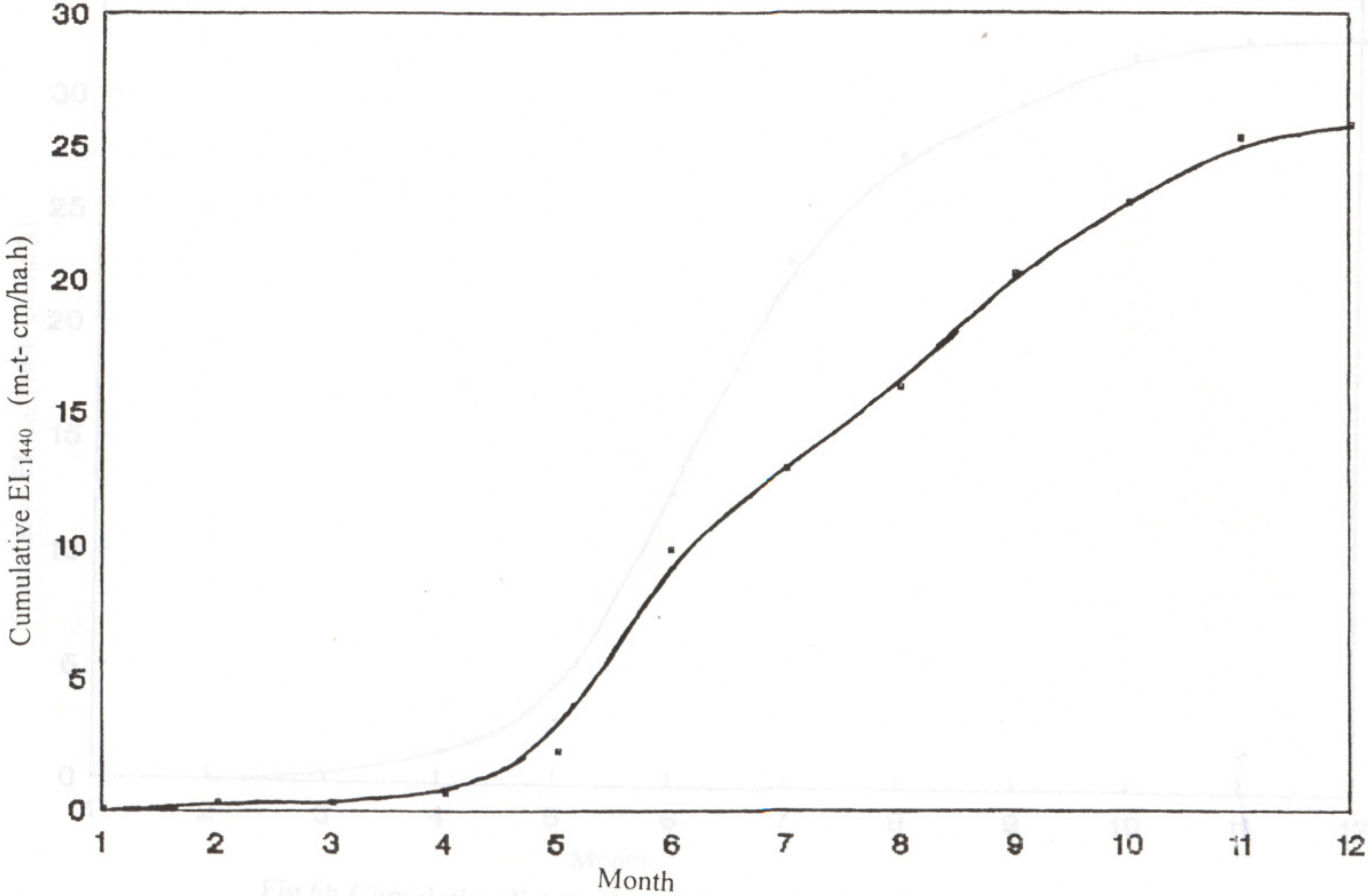


Fig 6a. Cumulative Distribution of EI $_{1440}$ for Malappuram

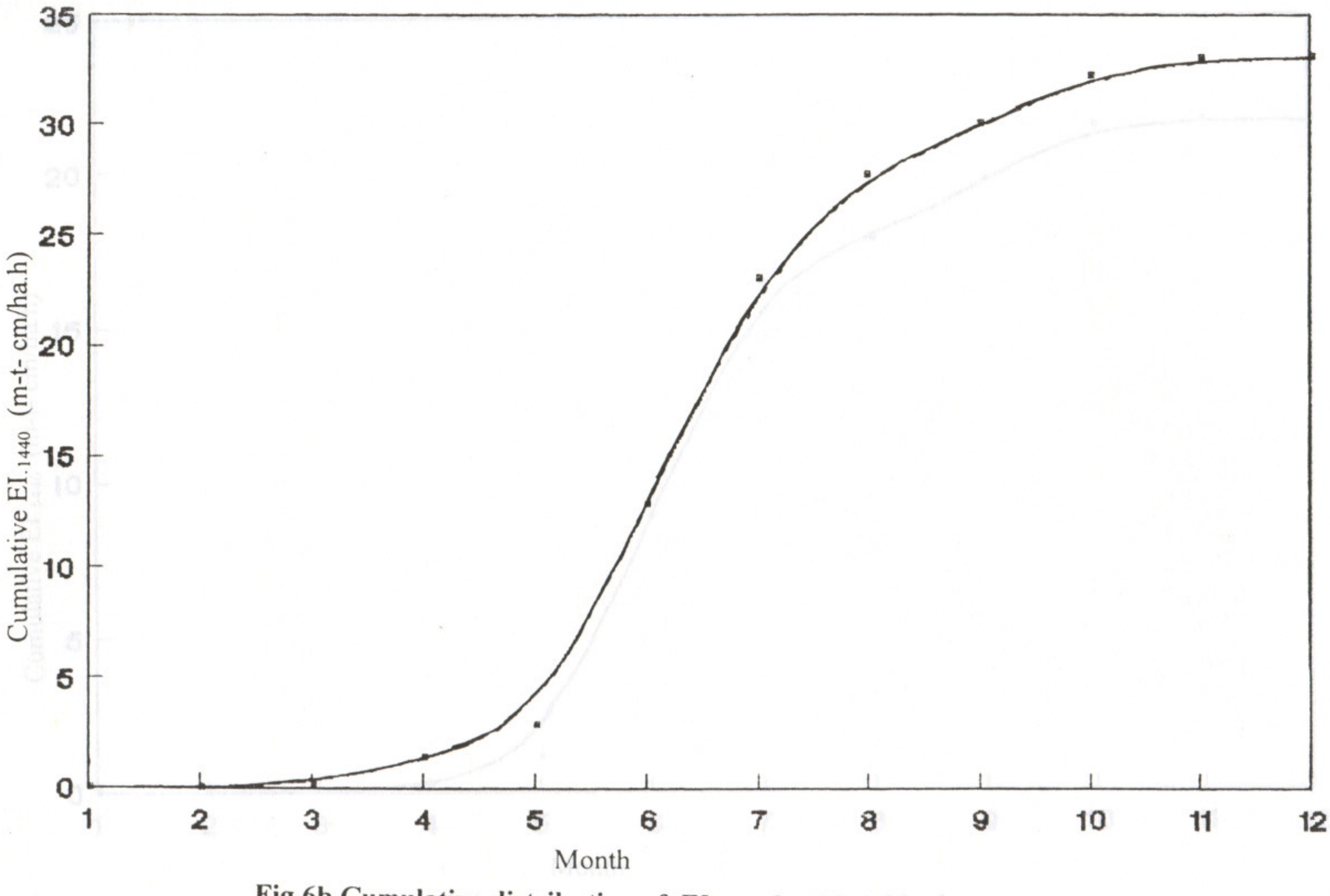


Fig 6b Cumulative distribution of $EI_{.1440}$ for Kozhikkode

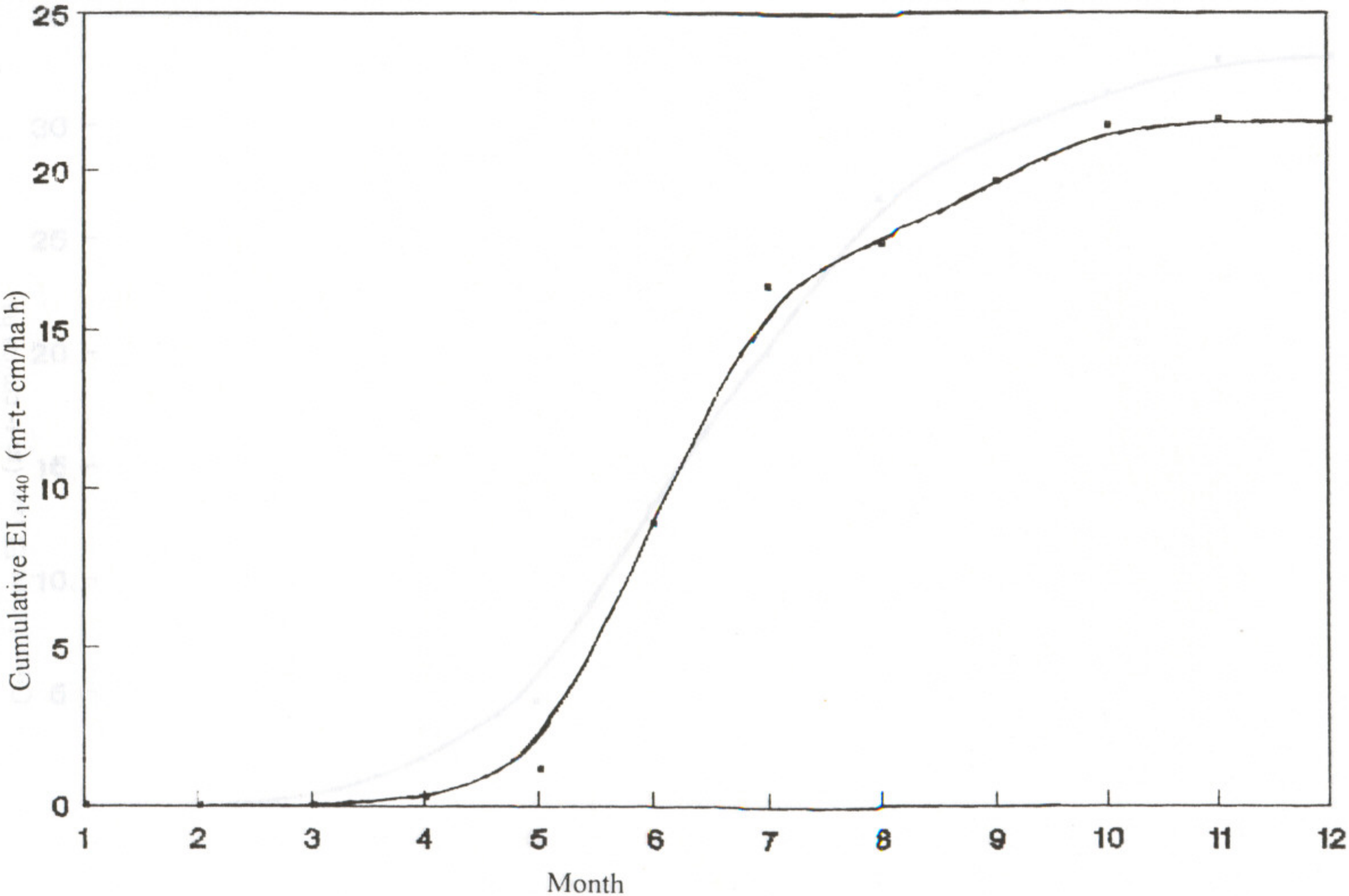


Fig 6c Cumulative distribution of EI.$_{1440}$ for Palakkad

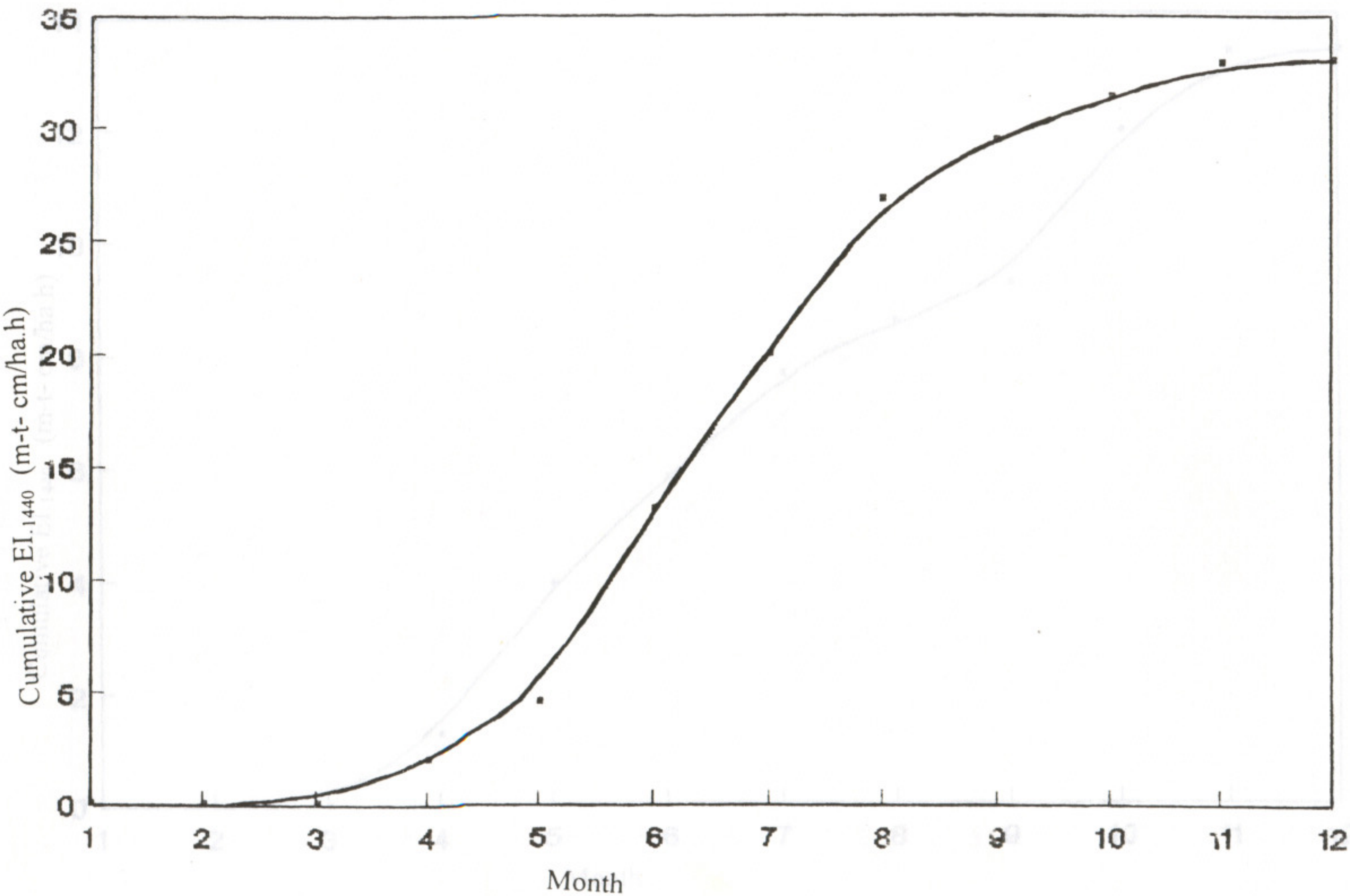


Fig 6d Cumulative distribution of EI_{1440} for Thrissur

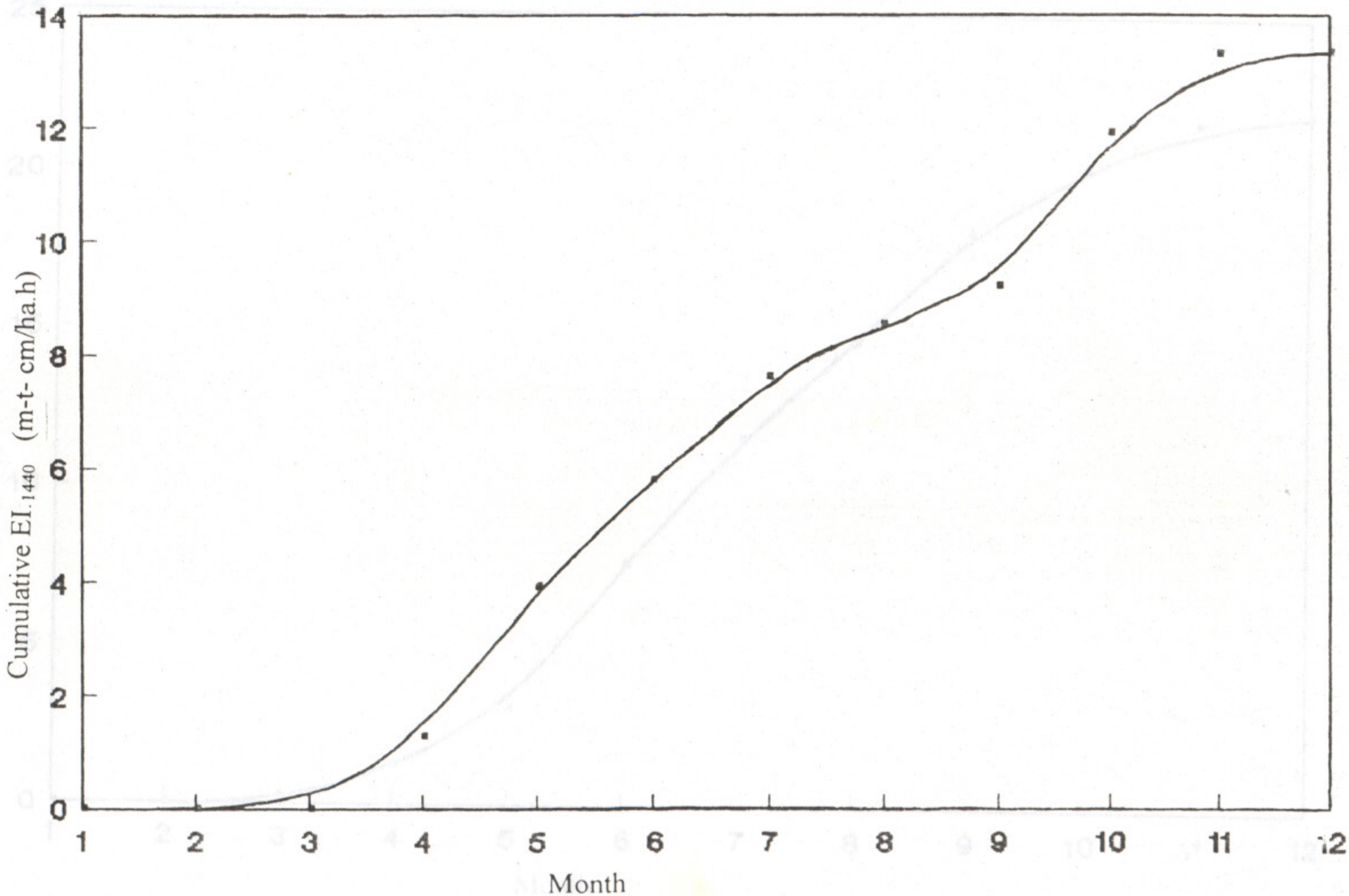


Fig 6e Cumulative distribution of EI.$_{1440}$ for Thiruvananthapuram

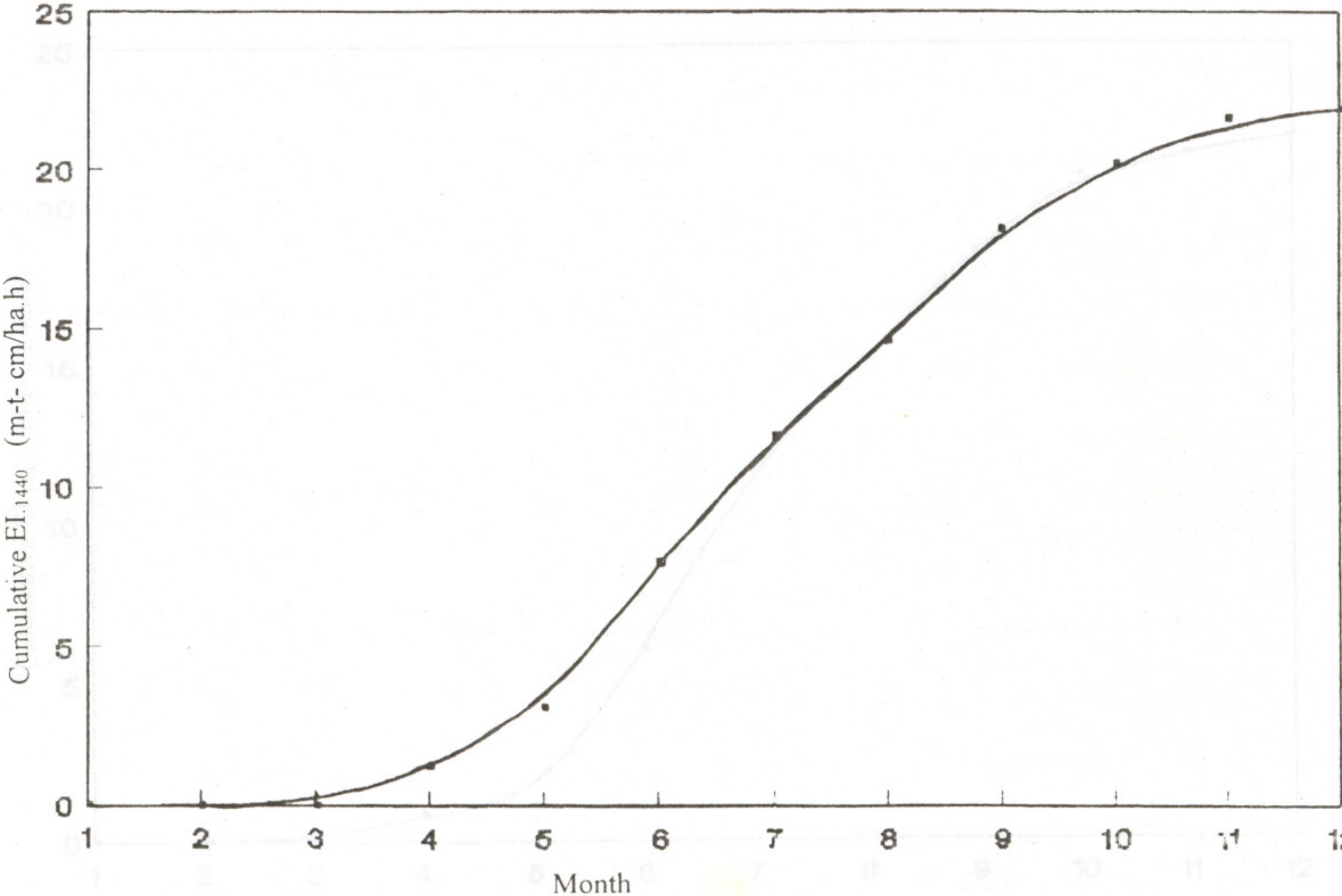


Fig 6f Cumulative distribution of EI.$_{1440}$ for Alappuzha

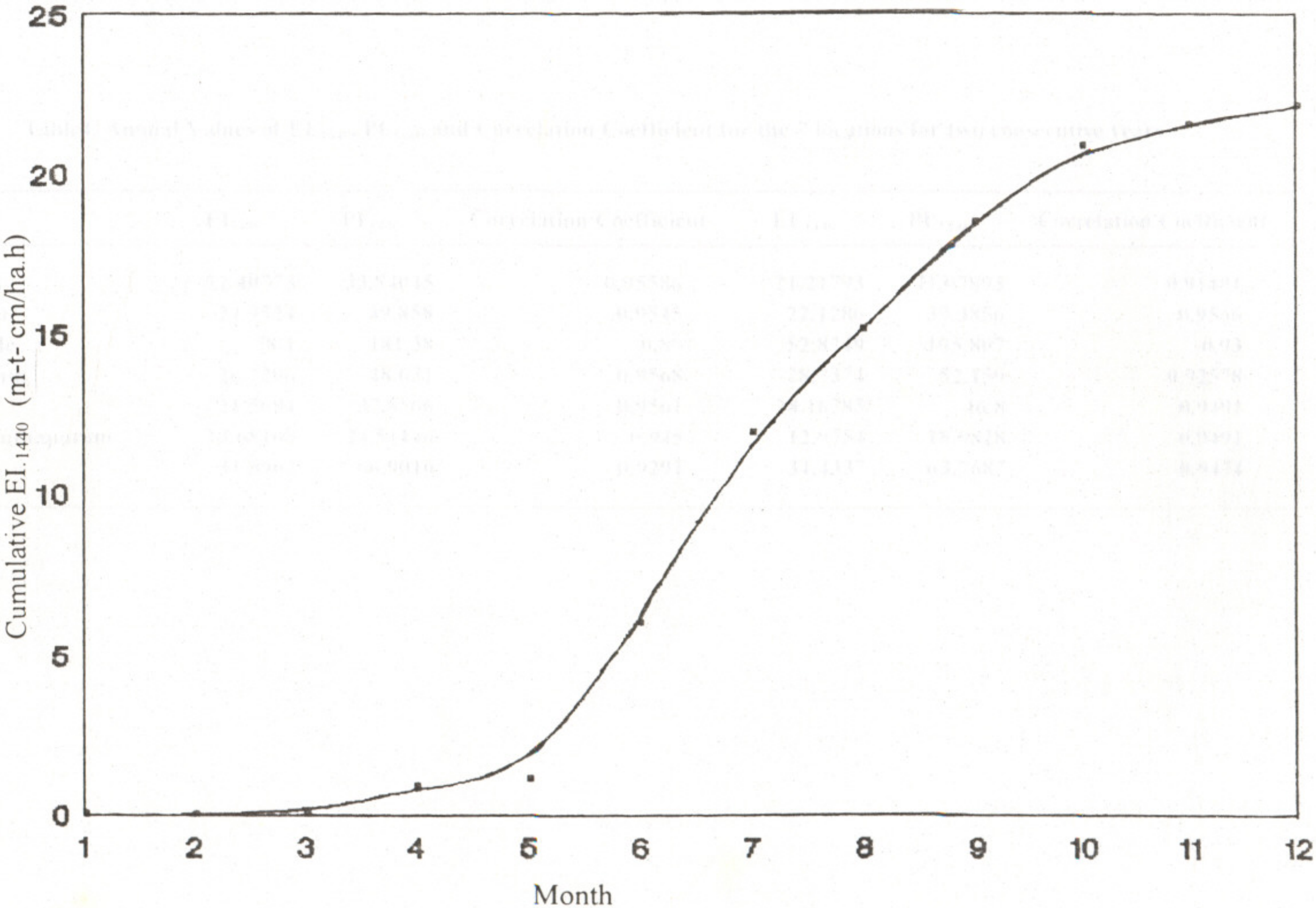


Fig 6g Cumulative distribution of EI.$_{1440}$ for Ernakulam

Table4. Annual Values of EI_{1440}, PI_{1440} and Correlation Coefficient for the 7 locations for two consecutive years

Place	EI_{1440}	PI_{1440}	Correlation Coefficient	EI_{1440}	PI_{1440}	Correlation Coefficient
Alappuzha	22.40773	33.84045	0.95586	21.21793	41.07893	0.91491
Ernakulam	24.9524	49.858	0.9545	22.1286	39.3856	0.9566
Kozhikkode	78.1	181.38	0.89	52.8749	105.807	0.93
Malappuram	26.2296	48.631	0.9568	28.7374	52.159	0.92578
Palakkad	21.5694	37.8566	0.9561	28.16785	46.8	0.9491
Thiruvananthapuram	13.68168	24.51146	0.945	12.9754	18.9828	0.9491
Thrissur	31.5962	66.9016	0.9291	34.4337	63.7687	0.9474

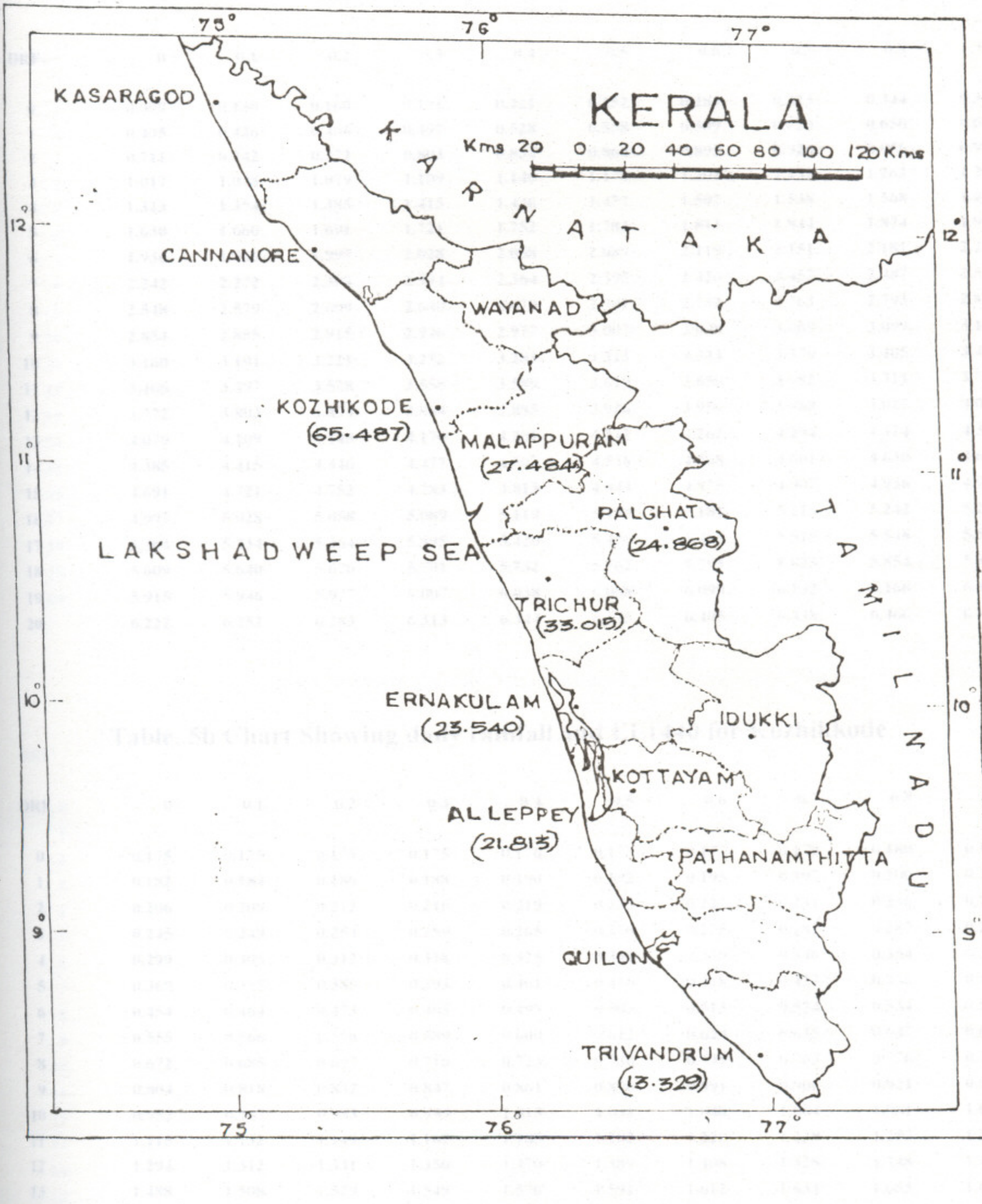


Fig.7 Distribution of EI_{1440} values for the stations under study

Table. 5a Chart showing daily rainfall EI - 1440 for Malappuram

DRF	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.099	0.130	0.160	0.191	0.221	0.252	0.283	0.313	0.344	0.374
1	0.405	0.436	0.466	0.497	0.528	0.558	0.589	0.620	0.650	0.681
2	0.711	0.742	0.772	0.803	0.834	0.864	0.895	0.926	0.956	0.987
3	1.017	1.048	1.079	1.109	1.140	1.170	1.201	1.232	1.262	1.293
4	1.323	1.354	1.385	1.415	1.446	1.477	1.507	1.538	1.568	1.599
5	1.630	1.660	1.691	1.721	1.752	1.783	1.813	1.844	1.874	1.905
6	1.936	1.966	1.997	2.028	2.058	2.089	2.119	2.151	2.181	2.211
7	2.242	2.272	2.303	2.334	2.364	2.395	2.426	2.457	2.487	2.517
8	2.548	2.579	2.609	2.640	2.670	2.701	2.732	2.763	2.793	2.823
9	2.854	2.885	2.915	2.946	2.977	3.007	3.038	3.069	3.099	3.130
10	3.160	3.191	3.221	3.252	3.283	3.313	3.344	3.376	3.405	3.436
11	3.466	3.497	3.528	3.558	3.589	3.619	3.650	3.682	3.711	3.742
12	3.772	3.803	3.834	3.864	3.895	3.926	3.956	3.988	4.017	4.048
13	4.079	4.109	4.140	4.170	4.201	4.232	4.262	4.294	4.324	4.354
14	4.385	4.415	4.446	4.477	4.507	4.538	4.568	4.601	4.630	4.660
15	4.691	4.721	4.752	4.783	4.813	4.844	4.875	4.907	4.936	4.966
16	4.997	5.028	5.058	5.089	5.119	5.150	5.181	5.213	5.242	5.273
17	5.303	5.334	5.364	5.395	5.426	5.456	5.487	5.519	5.548	5.579
18	5.609	5.640	5.670	5.701	5.732	5.762	5.793	5.825	5.854	5.885
19	5.915	5.946	5.977	6.007	6.038	6.068	6.099	6.132	6.160	6.191
20	6.222	6.252	6.283	6.313	6.344	6.375	6.405	6.438	6.466	6.497

Table. 5b Chart Showing daily rainfall and EI 1440 for Kozhikkode

DRF	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.175	0.175	0.175	0.175	0.176	0.177	0.177	0.179	0.180	0.181
1	0.182	0.184	0.186	0.188	0.190	0.192	0.195	0.197	0.200	0.203
2	0.206	0.209	0.212	0.216	0.219	0.223	0.227	0.231	0.236	0.240
3	0.245	0.249	0.254	0.259	0.265	0.270	0.275	0.281	0.287	0.293
4	0.299	0.305	0.312	0.318	0.325	0.332	0.339	0.346	0.354	0.361
5	0.369	0.377	0.385	0.393	0.401	0.410	0.418	0.427	0.436	0.445
6	0.454	0.464	0.473	0.483	0.493	0.503	0.513	0.524	0.534	0.545
7	0.555	0.566	0.578	0.589	0.600	0.612	0.624	0.635	0.647	0.660
8	0.672	0.685	0.697	0.710	0.723	0.736	0.749	0.763	0.776	0.790
9	0.804	0.818	0.832	0.847	0.861	0.876	0.891	0.906	0.921	0.936
10	0.952	0.967	0.983	0.999	1.015	1.031	1.048	1.064	1.081	1.098
11	1.115	1.132	1.149	1.167	1.185	1.202	1.220	1.238	1.257	1.275
12	1.294	1.312	1.331	1.350	1.370	1.389	1.408	1.428	1.448	1.468
13	1.488	1.508	1.529	1.549	1.570	1.591	1.612	1.633	1.655	1.676
14	1.698	1.720	1.742	1.764	1.786	1.809	1.831	1.854	1.877	1.900
15	1.923	1.947	1.970	1.994	2.018	2.042	2.066	2.090	2.115	2.139
16	2.164	2.189	2.214	2.239	2.265	2.290	2.316	2.342	2.368	2.394
17	2.420	2.447	2.474	2.500	2.527	2.555	2.582	2.609	2.637	2.665
18	2.692	2.721	2.749	2.777	2.806	2.834	2.863	2.892	2.921	2.951
19	2.980	3.010	3.039	3.069	3.099	3.130	3.160	3.190	3.221	3.252
20	3.283	3.314	3.346	3.377	3.409	3.440	3.472	3.504	3.537	3.569

Table 5c Chart showing daily rainfall and EI 1440 for Palakkad

DRF	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
1	0.134	0.137	0.140	0.143	0.147	0.150	0.155	0.155	0.164	0.168
2	0.174	0.179	0.185	0.191	0.197	0.203	0.210	0.210	0.224	0.232
3	0.240	0.248	0.256	0.265	0.274	0.283	0.292	0.292	0.312	0.322
4	0.333	0.343	0.354	0.366	0.377	0.389	0.401	0.401	0.426	0.439
5	0.452	0.465	0.479	0.493	0.507	0.521	0.536	0.536	0.566	0.582
6	0.597	0.614	0.630	0.646	0.663	0.680	0.698	0.698	0.733	0.751
7	0.770	0.788	0.807	0.827	0.846	0.866	0.886	0.886	0.927	0.947
8	0.968	0.990	1.011	1.033	1.055	1.078	1.100	1.100	1.146	1.170
9	1.194	1.218	1.242	1.266	1.291	1.316	1.341	1.341	1.393	1.419
10	1.445	1.472	1.499	1.526	1.553	1.581	1.609	1.609	1.666	1.694
11	1.723	1.753	1.782	1.812	1.842	1.872	1.903	1.903	1.965	1.996
12	2.028	2.060	2.092	2.125	2.157	2.190	2.224	2.224	2.291	2.325
13	2.359	2.394	2.429	2.464	2.499	2.535	2.571	2.571	2.643	2.680
14	2.717	2.754	2.792	2.829	2.867	2.906	2.944	2.944	3.022	3.061
15	3.101	3.141	3.181	3.221	3.262	3.303	3.344	3.344	3.427	3.469
16	3.512	3.554	3.597	3.640	3.683	3.727	3.771	3.771	3.859	3.904
17	3.949	3.994	4.039	4.085	4.131	4.177	4.224	4.224	4.317	4.365
18	4.412	4.460	4.508	4.557	4.605	4.654	4.703	4.703	4.802	4.852
19	4.902	4.953	5.004	5.055	5.106	5.157	5.209	5.209	5.314	5.366
20	5.419	5.472	5.525	5.579	5.633	5.687	5.742	5.742	5.851	5.907

Table. 5d Chart showing daily rainfall and EI 1440 for Thrissur

DRF	0	1	2	3	4	5	6	7	8	9
0	0.118	0.149	0.180	0.211	0.242	0.273	0.304	0.335	0.366	0.397
1	0.428	0.459	0.489	0.520	0.551	0.582	0.613	0.644	0.675	0.706
2	0.737	0.768	0.799	0.830	0.861	0.892	0.923	0.954	0.985	1.015
3	1.046	1.077	1.108	1.139	1.170	1.201	1.232	1.263	1.294	1.325
4	1.356	1.387	1.418	1.449	1.480	1.511	1.541	1.572	1.603	1.634
5	1.665	1.696	1.727	1.758	1.789	1.820	1.851	1.882	1.913	1.944
6	1.975	2.006	2.036	2.067	2.098	2.129	2.160	2.191	2.222	2.253
7	2.284	2.315	2.346	2.377	2.408	2.439	2.470	2.501	2.532	2.562
8	2.593	2.624	2.655	2.686	2.717	2.748	2.779	2.810	2.841	2.872
9	2.903	2.934	2.965	2.996	3.027	3.058	3.088	3.119	3.150	3.181
10	3.212	3.243	3.274	3.305	3.336	3.367	3.398	3.429	3.460	3.491
11	3.522	3.553	3.583	3.614	3.645	3.676	3.707	3.738	3.769	3.800
12	3.831	3.862	3.893	3.924	3.955	3.986	4.017	4.048	4.079	4.109
13	4.140	4.171	4.202	4.233	4.264	4.295	4.326	4.357	4.388	4.419
14	4.450	4.481	4.512	4.543	4.574	4.605	4.635	4.666	4.697	4.728
15	4.759	4.790	4.821	4.852	4.883	4.914	4.945	4.976	5.007	5.038
16	5.069	5.100	5.130	5.161	5.192	5.223	5.254	5.285	5.316	5.347
17	5.378	5.409	5.440	5.471	5.502	5.533	5.564	5.595	5.626	5.656
18	5.687	5.718	5.749	5.780	5.811	5.842	5.873	5.904	5.935	5.966
19	5.997	6.028	6.059	6.090	6.121	6.152	6.182	6.213	6.244	6.275
20	6.306	6.337	6.368	6.399	6.430	6.461	6.492	6.523	6.554	6.585

Table5e Chart showing daily rainfall and EI 1440 for Tiruvananthapuram

DRF	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.056	0.056	0.056	0.057	0.058	0.060	0.062	0.064	0.066	0.069
1	0.072	0.075	0.079	0.083	0.087	0.092	0.097	0.102	0.107	0.113
2	0.119	0.126	0.133	0.140	0.147	0.155	0.163	0.172	0.180	0.189
3	0.199	0.209	0.219	0.229	0.239	0.250	0.262	0.273	0.285	0.297
4	0.310	0.323	0.336	0.350	0.363	0.378	0.392	0.407	0.422	0.437
5	0.453	0.469	0.485	0.502	0.519	0.536	0.554	0.572	0.590	0.609
6	0.628	0.647	0.666	0.686	0.706	0.727	0.748	0.769	0.790	0.812
7	0.834	0.857	0.879	0.902	0.926	0.949	0.973	0.998	1.022	1.047
8	1.072	1.098	1.124	1.150	1.177	1.204	1.231	1.258	1.286	1.314
9	1.343	1.371	1.400	1.430	1.459	1.489	1.520	1.550	1.581	1.613
10	1.644	1.676	1.708	1.741	1.774	1.807	1.841	1.874	1.909	1.943
11	1.978	2.013	2.048	2.084	2.120	2.157	2.193	2.230	2.268	2.305
12	2.343	2.382	2.420	2.459	2.498	2.538	2.578	2.618	2.658	2.699
13	2.740	2.782	2.824	2.866	2.908	2.951	2.994	3.037	3.081	3.125
14	3.169	3.214	3.259	3.304	3.350	3.396	3.442	3.488	3.535	3.582
15	3.630	3.678	3.726	3.774	3.823	3.872	3.922	3.971	4.021	4.072
16	4.122	4.173	4.225	4.276	4.328	4.380	4.433	4.486	4.539	4.593
17	4.646	4.701	4.755	4.810	4.865	4.920	4.976	5.032	5.089	5.145
18	5.202	5.260	5.317	5.375	5.434	5.492	5.551	5.611	5.670	5.730
19	5.790	5.851	5.912	5.973	6.034	6.096	6.158	6.220	6.283	6.346
20	6.410	6.473	6.537	6.602	6.666	6.731	6.797	6.862	6.928	6.994

Table. 5f Chart showing daily rainfall and EI 1440 for Alappuzha

DRF	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.079	0.079	0.079	0.079	0.080	0.081	0.082	0.083	0.085	0.086
1	0.088	0.090	0.092	0.095	0.097	0.100	0.103	0.106	0.109	0.113
2	0.116	0.120	0.124	0.128	0.133	0.137	0.142	0.147	0.152	0.158
3	0.163	0.169	0.175	0.181	0.187	0.194	0.201	0.207	0.215	0.222
4	0.229	0.237	0.245	0.253	0.261	0.269	0.278	0.287	0.295	0.305
5	0.314	0.323	0.333	0.343	0.353	0.363	0.374	0.384	0.395	0.406
6	0.417	0.429	0.440	0.452	0.464	0.476	0.489	0.501	0.514	0.527
7	0.540	0.553	0.567	0.580	0.594	0.608	0.622	0.637	0.651	0.666
8	0.681	0.696	0.711	0.727	0.743	0.759	0.775	0.791	0.808	0.824
9	0.841	0.858	0.875	0.893	0.910	0.928	0.946	0.964	0.983	1.001
10	1.020	1.039	1.058	1.077	1.097	1.116	1.136	1.156	1.176	1.197
11	1.218	1.238	1.259	1.280	1.302	1.323	1.345	1.367	1.389	1.412
12	1.434	1.457	1.480	1.503	1.526	1.549	1.573	1.597	1.621	1.645
13	1.669	1.694	1.719	1.744	1.769	1.794	1.820	1.845	1.871	1.897
14	1.923	1.950	1.977	2.003	2.030	2.058	2.085	2.113	2.140	2.168
15	2.196	2.225	2.253	2.282	2.311	2.340	2.369	2.399	2.428	2.458
16	2.488	2.518	2.549	2.579	2.610	2.641	2.672	2.704	2.735	2.767
17	2.799	2.831	2.863	2.896	2.928	2.961	2.994	3.027	3.061	3.094
18	3.128	3.162	3.196	3.231	3.265	3.300	3.335	3.370	3.405	3.441
19	3.477	3.512	3.548	3.585	3.621	3.658	3.695	3.731	3.769	3.806
20	3.844	3.881	3.919	3.957	3.996	4.034	4.073	4.112	4.151	4.190

Table.5g Chart showing daily rainfall and EI1440 for Ernakulam

DRF	0	1	2	3	4	5	6	7	8	9
0	0.0744	0.0745	0.075	0.0757	0.0768	0.0781	0.0797	0.0816	0.0839	0.0864
1	0.0892	0.0923	0.0957	0.0994	0.1034	0.1077	0.1123	0.1171	0.1223	0.1278
2	0.1336	0.1396	0.146	0.1526	0.1596	0.1668	0.1744	0.1822	0.1904	0.1988
3	0.2075	0.2165	0.2259	0.2355	0.2454	0.2556	0.2661	0.2769	0.288	0.2994
4	0.3111	0.323	0.3353	0.3479	0.3608	0.3739	0.3874	0.4011	0.4152	0.4295
5	0.4442	0.4591	0.4744	0.4899	0.5057	0.5218	0.5383	0.555	0.572	0.5893
6	0.6069	0.6248	0.643	0.6615	0.6803	0.6993	0.7187	0.7384	0.7584	0.7786
7	0.7992	0.82	0.8412	0.8626	0.8844	0.9064	0.9288	0.9514	0.9743	0.9975
8	1.0211	1.0449	1.069	1.0934	1.1181	1.1431	1.1684	1.194	1.2199	1.246
9	1.2725	1.2993	1.3264	1.3537	1.3814	1.4093	1.4376	1.4661	1.495	1.5241
10	1.5536	1.5833	1.6133	1.6436	1.6743	1.7052	1.7364	1.7679	1.7997	1.8318
11	1.8642	1.8969	1.9299	1.9631	1.9967	2.0306	2.0648	2.0992	2.134	2.169
12	2.2044	2.24	2.276	2.3122	2.3488	2.3856	2.4227	2.4601	2.4979	2.5359
13	2.5742	2.6128	2.6517	2.6909	2.7304	2.7702	2.8103	2.8506	2.8913	2.9323
14	2.9736	3.0151	3.057	3.0991	3.1416	3.1843	3.2274	3.2707	3.3144	3.3583
15	3.4025	3.447	3.4919	3.537	3.5824	3.6281	3.6741	3.7204	3.767	3.8139
16	3.8611	3.9085	3.9563	4.0044	4.0528	4.1014	4.1504	4.1996	4.2492	4.299
17	4.3492	4.3996	4.4504	4.5014	4.5527	4.6043	4.6563	4.7085	4.761	4.8138
18	4.8669	4.9203	4.974	5.028	5.0823	5.1368	5.1917	5.2469	5.3024	5.3581
19	5.4142	5.4705	5.5272	5.5841	5.6414	5.6989	5.7568	5.8149	5.8733	5.932
20	5.9911	6.0504	6.11	6.1699	6.2301	6.2906	6.3514	6.4125	6.4739	6.5355

4.4 Computation of EI from daily rainfall data from non-recording type rain gauge

The mathematical models developed between EI_{1440} and PI_{1440} values showed significant linear relationship of the form Y=bx + a with high correlation co-efficient for all the stations under study. The corresponding equations are given below.

Malappuram	Y	=	0.3061 X + 0.0989
Kozhikode	Y	=	0.1865 X + 0.1747
Palakkad	Y	=	0.3179 X + 0.1206
Thrissur	Y	=	0.3094 X + 0.1182
Thiruvananthapuram	Y	=	0.3812 X +0.0559
Ernakulam	Y	=	0.355 X + 0.0744
Alappuzha	Y	=	0.2259 X + 0.0786

Here $Y = EI_{1440}$ and $X = PI_{1440}$

These models are useful for computing EI 1440 values from daily rainfall amounts recorded by non-recording rain gauges. Thus the daily EI1440 values for varying amount of rainfall can be calculated using these models.

The developed models are useful for quick computation of erosion index of the rain which is required in prediction of soil loss from the watersheds. The daily EI_{1440} values for varying amount of rainfall were calculated for all the 7 locations and are given in Table 5. Referring these tables, EI_{1440} values corresponding to any amount of rainfall can be read directly. This widened the scope of applicability of rainfall data recorded from non-recording type of rain gauges in soil conservation planning.

SUMMARY AND CONCLUSION

Out of the total geographical area of 38.86 lakh hectares in the state nearly 19 lakh hectares of land are highly vulnerable to soil erosion hazards. In Kerala, the distribution and intensity of rainfall is different for different locations. Therefore the erosivity index which is an indication of capacity of rain to erode soil will also be different. In this study the aim was to compute the erosivity index for different locations. Computation of 30 minute erosivity index (EI_{30}) for all the locations is tedious and combersome. More over the rainfall data from automatic raingauges was also not available for all these locations. Hence Kadiyangadu was taken as the representative location where daily automatic rain gauges data was available and EI_{30} and EI_{1440} was computed for that particular location. A significant correlation was found to exist between EI_{30} and EI_{1440}. So EI_{1440} can substitute EI_{30} for which only daily total rainfall and maximum daily rainfall intensity is needed.

The daily total rainfall and maximum daily rainfall intensity data was collected for Thiruvananthapuram, Alapuzha, Ernakulam, Thrissur, Malappuram, Kozhikode and Palakkad and computed the EI_{1440}. The monthly variation of EI_{1440} was also studied which resulted in the development of S- shaped curves.

The product of daily rainfall in cm and EI_{1440} was worked out and designated as PI_{1440} and models for estimating erosion index for 1440 minute duration were developed between EI_{1440} and PI_{1440} values from daily rainfall amount recorded by non-recording type raingauges. The daily EI_{1440} values for varying amount of rainfall were calculated by these models for all the stations under study. By referring these tables EI_{1440} values corresponding to any amount of rainfall can be read directly.

These developed models widened the scope of applicability of rainfall data recorded from non - recording type of raingauges in soil conservation planning.

The results of these study can be concluded as :

1 Erosivity index has a direct relationship with the intensity of rainfall.

2 There exists a significant positive correlation of 0.92965 between EI_{30} and EI_{1440}, so EI_{1440} can substitute EI_{30}.

3 There exists a linear relationship between EI_{1440} and PI_{1440}.

4 An equation on for EI_{1440} in terms of PI_{1440} was also developed for each location from which charts have been prepared to determine EI_{1440} using daily rainfall data from non-recording gauges.

Further scope of this study

If long term rainfall data are available for adequate number of location an iso erodent map can be prepared which provide a better picture of the erosivity index distribution in Kerala. The plotted lines on the map are called the iso-erodents because they connect points of equal erosivity index. Erosion index values for locations between the lines are obtained by linear interpolation. Thus local values of the rainfall erosion index may be taken directly from this map.

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APPENDIX - I

15 min rainfall data for Kadiyangadu for two consecutive years

		1986				1985	
	Date	RF mm	INT cm/h		Date	RF mm	INT cm/h
JAN				JUNE			
	14	0.5	0.2		1	0.25	0.1
		7.75	3.1			0.5	0.2
	15	12	4.8			0.25	0.1
		4.5	1.8			0.75	0.3
		0.75	0.3			0.25	0.1
		0.25	0.1			0.5	0.2
MAR						0.25	0.1
	15	0.5	0.2			0.75	0.3
		3.25	1.3			0.25	0.1
		0.5	0.2			1	0.4
	16	0.25	0.1			1.5	0.6
		0.25	0.1			1	0.4
		2.5	1			0.25	0.1
	20	8	3.2		2	0.5	0.2
		16	6.4			0.25	0.1
		1.25	0.5			0.75	0.3
		0.5	0.2			0.25	0.1
		0.75	0.3			0.25	0.1
	29	1.75	0.7			0.25	0.1
JUNE						0.25	0.1
	3	0.25	0.1		3	0.25	0.1
		0.25	0.1			1.25	0.5
	5	2	0.8			6.5	2.6
		0.5	0.2			2.75	1.1
		0.5	0.2			0.25	0.1
		1.5	0.6			2	0.8
		3	1.2		4	0.5	0.2
		3	1.2			0.25	0.1
		4	1.6			1	0.4
		4	1.6			0.5	0.2
		0.5	0.2		5	4	1.6
		1	0.4			1	0.4
		1.7	0.68			1.5	0.6
		0.5	0.2			1.5	0.6
	6	0.5	0.2			1	0.4
		0.5	0.2			6	2.4
		1.5	0.6			1	0.4
		0.5	0.2			0.5	0.2
		1.5	0.6			0.5	0.2
	10	2	0.8			0.25	0.1
	11	0.5	0.2			0.25	0.1
		1.5	0.6			0.25	0.1
		0.5	0.2			0.25	0.1
		0.5	0.2			0.25	0.1
		0.5	0.2			1	0.4
		1	0.4			0.25	0.1
		0.5	0.2			7	2.8
		4	1.6			3	1.2
		0.5	0.2			7.5	3
		1.5	0.6			1.25	0.5

12	6	2.4		1	0.4
	1.5	0.6		0.25	0.1
	0.75	0.3		0.25	0.1
	0.75	0.3		0.25	0.1
	0.25	0.1		0.25	0.1
13	3.5	1.4		5	2
	4.5	1.8		1	0.4
14	1	0.4		0.25	0.1
	0.5	0.2		0.25	0.1
	0.5	0.2	6	6	2.4
	1	0.4		0.25	0.1
	1.5	0.6		0.25	0.1
	3	1.2		0.25	0.1
	0.5	0.2		0.25	0.1
	1	0.4		0.5	0.2
	3.75	1.5		0.5	0.2
	6.5	2.6	7	0.5	0.2
	4.75	1.9		0.5	0.2
	1.5	0.6		6	2.4
	1.25	0.5		.0.25	0.1
	3	1.2		0.25	0.1
	3	1.2		0.25	0.1
	5	2		1.25	0.5
	2.5	1	8	0.5	0.2
	1.5	0.6		0.5	0.2
	1	0.4		0.75	0.3
	1.5	0.6	9	3	1.2
	1.5	0.6		0.25	0.1
	1	0.4		1.25	0.5
	1	0.4		0.25	0.1
	1	0.4		1	0.4
	2	0.8		1.5	0.6
	3.5	1.4	11	0.5	0.2
	4	1.6		0.25	0.1
	6	2.4		0.25	0.1
	7	2.8		2.5	1
	13	5.2		1.75	0.7
15	5	2		1.5	0.6
	2.5	1		0.75	0.3
	2	0.8		0.75	0.3
	1.75	0.7		0.5	0.2
	0.5	0.2		2.5	1
	5	2		0.25	0.1
16	1	0.4	14	4	1.6
	3.5	1.4		4.5	1.8
	3	1.2		1.75	0.7
	8	3.2		1	0.4
	9	3.6		2.5	1
	2	0.8		0.25	0.1
	1.75	0.7	15	0.75	0.3
	0.25	0.1		2.25	0.9
	0.25	0.1		7.5	3
	0.25	0.1		2.75	1.1
	0.25	0.1		0.5	0.2
	0.25	0.1		1.75	0.7
	0.5	0.2		1.75	0.7

	1.25	0.5
	2	0.8
	2.5	1
	1.75	0.7
	1.5	0.6
17	0.5	0.2
	0.75	0.3
	0.75	0.3
	0.25	0.1
	7.25	2.9
	8	3.2
18	4.5	1.8
	4	1.6
	7.5	3
	5.5	2.2
	4	1.6
	2.5	1
	1	0.4
	2	0.8
	2	0.8
	1	0.4
	0.25	0.1
	0.25	0.1
	0.5	0.2
	0.5	0.2
	0.5	0.2
	0.25	0.1
	0.5	0.2
	0.25	0.1
	1	0.4
	8	3.2
	3.75	1.5
	1.25	0.5
	1	0.4
	1	0.4
	0.25	0.1
	1	0.4
	0.5	0.2
19	1	0.4
	0.5	0.2
	0.75	0.3
	0.25	0.1
	0.5	0.2
	7	2.8
	8.5	3.4
	3.5	1.4
	0.5	0.2
	0.5	0.2
	1.25	0.5
	2	0.8
	2.5	1
	0.5	0.2
	0.5	0.2
	0.5	0.2
	0.25	0.1
	0.25	0.1
	5	2

	2.75	1.1
16	0.25	0.1
	3.5	1.4
	2	0.8
	2	0.8
	1	0.4
	4	1.6
	0.5	0.2
17	1	0.4
	1	0.4
	7	2.8
	2	0.8
	0.5	0.2
	0.5	0.2
	2.25	0.9
	2	0.8
	0.25	0.1
	6.5	2.6
	2	0.8
	0.75	0.3
	0.25	0.1
18	3	1.2
	6	2.4
	0.75	0.3
	0.25	0.1
	0.25	0.1
	0.25	0.1
	0.5	0.2
	1.25	0.5
	0.25	0.1
	1	0.4
	0.25	0.1
	0.5	0.2
	0.25	0.1
	0.25	0.1
	0.25	0.1
	0.75	0.3
19	0.25	0.1
	0.25	0.1
	5	2
	0.25	0.1
	0.25	0.1
	1	0.4
	2	0.8
20	0.5	0.2
	1.5	0.6
21	1	0.4
	2.5	1
22	10.5	4.2
	0.5	0.2
	8.5	3.4
	1	0.4
	0.5	0.2
	0.25	0.1
	2	0.8
	3.5	1.4
	3	1.2

	3.5	1.4
	1	0.4
	1	0.4
	0.5	0.2
	0.5	0.2
	0.25	0.1
	0.75	0.3
	1	0.4
	1.75	0.7
	2	0.8
	3	1.2
	2	0.8
	0.75	0.3
	1	0.4
	3	1.2
	1.25	0.5
	0.75	0.3
20	0.75	0.3
	0.5	0.2
	1	0.4
	0.5	0.2
	8.5	3.4
21	2	0.8
	2	0.8
	3	1.2
	8	3.2
	0.25	0.1
	2.5	1
	0.25	0.1
	1	0.4
	0.5	0.2
	2	0.8
	2.5	1
	1.5	0.6
	2.25	0.9
	0.25	0.1
	0.25	0.1
	0.75	0.3
	10	4
	4.5	1.8
	1.5	0.6
	8	3.2
	0.75	0.3
	0.25	0.1
22	3	1.2
	0.5	0.2
	2	0.8
	0.5	0.2
	3.5	1.4
	3.5	1.4
	1	0.4
	5.5	2.2
	0.5	0.2
	2.5	1
	6	2.4
	2.25	0.9
	5.5	2.2

	3.5	1.4
	2.5	1
	2	0.8
	0.5	0.2
	0.5	0.2
	0.25	0.1
	1	0.4
	0.5	0.2
	1	0.4
23	0.5	0.2
	4.5	1.8
	7	2.8
	3	1.2
	0.25	0.1
	1	0.4
	3.5	1.4
	7	2.8
	2.5	1
	2.5	1
	2.5	1
	8	3.2
	7	2.8
	4	1.6
	3.5	1.4
	2.5	1
	1	0.4
	1	0.4
	0.5	0.2
	0.25	0.1
	0.25	0.1
	2	0.8
	0.5	0.2
	1	0.4
	2	0.8
	0.5	0.2
	0.5	0.2
	0.75	0.3
	1.5	0.6
	0.5	0.2
	0.75	0.3
	0.25	0.1
	0.25	0.1
	0.25	0.1
	2	0.8
	1	0.4
	0.5	0.2
	2.25	0.9
	0.5	0.2
	0.5	0.2
	4	1.6
	4	1.6
	1	0.4
	0.5	0.2
	0.5	0.2
	1.5	0.6
	3.5	1.4
	5	2

	0.5	0.2
	7.5	3
	0.25	0.1
	2.5	1
	0.75	0.3
	1.5	0.6
	1	0.4
	9.75	3.9
	5.5	2.2
	0.5	0.2
	0.5	0.2
	0.25	0.1
	1	0.4
	0.75	0.3
	0.5	0.2
	0.25	0.1
	0.25	0.1
	1.25	0.5
	5.5	2.2
23	0.25	0.1
	3.75	1.5
	2	0.8
	5.5	2.2
	4	1.6
	0.75	0.3
	0.75	0.3
	1.25	0.5
	3	1.2
	7.5	3
	2	0.8
	7.5	3
	6.5	2.6
	0.25	0.1
	0.25	0.1
	1.25	0.5
	0.75	0.3
	0.75	0.3
	0.75	0.3
	0.25	0.1
	0.25	0.1
	0.25	0.1
	2.25	0.9
	0.25	0.1
	0.75	0.3
	1.5	0.6
	4.25	1.7
	5	2
	4	1.6
24	0.5	0.2
	13.5	5.4
	7.75	3.1
	0.25	0.1
	0.75	0.3
	0.25	0.1
	1.5	0.6
	0.25	0.1
	2.5	1
	0.5	0.2
	1	0.4
	1	0.4
24	5	2
	0.5	0.2
	0.5	0.2
	0.25	0.1
	0.25	0.1
	0.5	0.2
	0.5	0.2
	0.25	0.1
	0.25	0.1
	6.5	2.6
	0.25	0.1
	0.25	0.1
	0.25	0.1
	0.25	0.1
	0.5	0.2
	1.5	0.6
	0.5	0.2
	5.5	2.2
	0.5	0.2
	0.75	0.3
	5	2
	0.5	0.2
	0.5	0.2
	1	0.4
	1.5	0.6
	1.5	0.6
	1.5	0.6
	0.5	0.2
	1	0.4
25	2	0.8
	4	1.6
	0.5	0.2
	2	0.8
	0.5	0.2
	1	0.4
	1	0.4
	0.5	0.2
	2.5	1
	3.25	1.3
26.	1	0.4
	0.25	0.1
	1.5	0.6
	1	0.4
	2	0.8
	0.25	0.1
	0.5	0.2
	1.5	0.6
	1	0.4
	2	0.8
	0.5	0.2
	3	1.2
	0.5	0.2

	0.5	0.2		0.5	0.2
	1.5	0.6		4	1.6
	1	0.4		1	0.4
	0.5	0.2		1	0.4
	1.25	0.5		2	0.8
	8.75	3.5		2	0.8
	1	0.4		1	0.4
	3	1.2		0.25	0.1
	0.25	0.1		0.25	0.1
	6.75	2.7		3	1.2
	11	4.4		2	0.8
	0.75	0.3		0.5	0.2
	0.25	0.1		3.5	1.4
	0.5	0.2		1	0.4
	1.5	0.6		0.5	0.2
	5	2		0.5	0.2
	1	0.4	29	2	0.8
	3	1.2		3	1.2
	3	1.2		1	0.4
	0.5	0.2		0.5	0.2
	6.5	2.6		1	0.4
25	0.75	0.3		0.5	0.2
	2.25	0.9		0.25	0.1
	1	0.4		0.5	0.2
	6	2.4		0.25	0.1
	3.25	1.3		2	0.8
	0.5	0.2		1.75	0.7
	2.75	1.1		0.25	0.1
26	1	0.4	30.	10	4
	5	2		1.5	0.6
	0.5	0.2		0.5	0.2
	2	0.8		1.5	0.6
	1	0.4		4	1.6
	0.5	0.2		3.5	1.4
	1.5	0.6		2	0.8
	0.75	0.3		1.5	0.6
	1.5	0.6		2	0.8
	0.75	0.3		1.5	0.6
	0.75	0.3		2	0.8
	0.75	0.3		2	0.8
	0.75	0.3		1.5	0.6
	4.25	1.7		0.5	0.2
	5.75	2.3		0.5	0.2
	1.75	0.7	JULY		0
	0.5	0.2	2	0.25	0.1
	5.25	2.1		0.25	0.1
	8	3.2		0.5	0.2
	1	0.4		0.25	0.1
27	1.5	0.6	3	0.5	0.2
	0.75	0.3		0.5	0.2
	2.5	1		0.5	0.2
	1.5	0.6		0.5	0.2
	2	0.8		8.5	3.4
	4.5	1.8		2	0.8
	0.25	0.1		0.25	0.1
	0.5	0.2		0.25	0.1
	0.25	0.1		2	0.8

		0.5	0.2		0.5	0.2
		0.5	0.2		0.5	0.2
		1.5	0.6		0.25	0.1
		0.5	0.2		0.25	0.1
		0.75	0.3		0.5	0.2
		1.5	0.6		2	0.8
		0.5	0.2		1	0.4
		0.5	0.2		0.5	0.2
		3	1.2		0.25	0.1
		1	0.4		0.25	0.1
		1.25	0.5		0.5	0.2
		0.5	0.2		0.25	0.1
		0.75	0.3		1.5	0.6
		3.5	1.4		2.5	1
		3	1.2	4	10	4
		1.25	0.5		0.5	0.2
		0.75	0.3		6.75	2.7
		1.5	0.6		0.25	0.1
		2.5	1		1.5	0.6
		1	0.4		0.75	0.3
		1.5	0.6		0.5	0.2
		1	0.4		4.5	1.8
		1	0.4		1	0.4
		0.5	0.2		0.5	0.2
	29	4	1.6		0.25	0.1
		0.5	0.2		0.5	0.2
		1.5	0.6		2.25	0.9
		1	0.4		7	2.8
		1.5	0.6		0.5	0.2
		2	0.8		0.5	0.2
		1	0.4		0.5	0.2
		0.75	0.3	5	10	4
		0.5	0.2		1.75	0.7
		1	0.4		0.25	0.1
		4	1.6		0.25	0.1
		6	2.4		0.25	0.1
		3.75	1.5		2	0.8
		1.5	0.6		1	0.4
		3.5	1.4		2.5	1
		1.5	0.6		0.5	0.2
		0.5	0.2		0.75	0.3
		0.25	0.1		1.75	0.7
		0.75	0.3	6	0.5	0.2
		1.75	0.7		5.5	2.2
		1.75	0.7		2	0.8
		0.75	0.3		1	0.4
		0.25	0.1		0.25	0.1
		0.25	0.1		0.75	0.3
		0.5	0.2		1.5	0.6
		5.5	2.2		0.5	0.2
		5	2		2	0.8
JULY					4	1.6
	4	0.5	0.2		0.75	0.3
		1	0.4		5	2
		5	2		0.25	0.1
		1	0.4		7	2.8
		1.25	0.5	7	8.5	3.4

	3	1.2		4.75	1.9
	4.5	1.8		0.25	0.1
	3.5	1.4		0.75	0.3
	1	0.4		1.25	0.5
	0.5	0.2		0.25	0.1
	0.5	0.2	30	1	0.4
	0.5	0.2		0.25	0.1
5	0.5	0.2		2.25	0.9
	0.25	0.1		0.25	0.1
	0.25	0.1		1.25	0.5
	0.25	0.1		0.25	0.1
	1	0.4		0.25	0.1
	4.5	1.8		0.5	0.2
	0.5	0.2		1.5	0.6
	1.5	0.6		1	0.4
	1.25	0.5	31	8	3.2
	0.25	0.1		3	1.2
	0.25	0.1		1	0.4
	0.25	0.1		0.5	0.2
	0.5	0.2		0.25	0.1
	1	0.4		0.25	0.1
	0.5	0.2		0.25	0.1
	0.25	0.1		2	0.8
	5	2		0.5	0.2
	0.25	0.1		0.25	0.1
	0.25	0.1		0.25	0.1
	0.5	0.2		1.75	0.7
	3.5	1.4		2.25	0.9
	1.5	0.6		4	1.6
	0.25	0.1		1	0.4
	3.5	1.4		0.5	0.2
	0.5	0.2		0.5	0.2
	0.5	0.2		0.5	0.2
6	1.5	0.6		0.5	0.2
	0.25	0.1		0.25	0.1
	1.75	0.7		0.75	0.3
	5	2		1.25	0.5
	9.5	3.8		1	0.4

	1.25	0.5		2	0.8
	2.5	1		5	2
7	1.75	0.7		3.5	1.4
8	2.75	1.1		6	2.4
	2.5	1		1	0.4
	2	0.8		4.5	1.8
	2.5	1		0.5	0.2
10	1.75	0.7		4	1.6
	0.5	0.2		1	0.4
	0.5	0.2		0.25	0.1
	1.25	0.5		0.25	0.1
11	0.75	0.3		1.25	0.5
	0.5	0.2		3	1.2
	2.5	1		0.25	0.1
	1.5	0.6		1.5	0.6
	0.5	0.2		3.5	1.4
	2	0.8		5.5	2.2
	1	0.4		9	3.6
	0.5	0.2		7	2.8
12	0.5	0.2	8	10	4
	0.5	0.2		3	1.2
	1.5	0.6		3.5	1.4
	1.5	0.6		2	0.8
	1.5	0.6		2	0.8
	2.5	1		0.5	0.2
	0.5	0.2		0.5	0.2
	1	0.4		0.25	0.1
	4.5	1.8		3	1.2
	3	1.2		0.25	0.1
	3.5	1.4		0.25	0.1
	3	1.2		0.5	0.2
	3	1.2		4.5	1.8
	3	1.2		10	4
	3	1.2		4	1.6
	4	1.6		3	1.2
	4	1.6		2	0.8
	2	0.8		2	0.8
	5	2		1	0.4
	3	1.2		0.5	0.2
	0.5	0.2		2.5	1
	0.5	0.2		2.5	1
	0.5	0.2		0.5	0.2
	0.5	0.2		0.25	0.1
	0.25	0.1		8	3.2
	1.75	0.7		6.25	2.5
	2	0.8		3.25	1.3
	0.5	0.2		0.25	0.1
	0.5	0.2		0.25	0.1
	4	1.6		1.25	0.5
	5	2		1.25	0.5
	3.5	1.4		1	0.4
	1.5	0.6		1	0.4
	4	1.6		0.75	0.3
	7.5	3		1	0.4
	0.5	0.2		3.25	1.3
	0.5	0.2		0.25	0.1
	0.75	0.3		3	1.2

	0.5	0.2		3	1.2
	0.5	0.2		2.75	1.1
	0.5	0.2		0.25	0.1
	0.5	0.2		1.5	0.6
	1.5	0.6		0.5	0.2
	5	2		0.5	0.2
	11	4.4		0.5	0.2
	4	1.6		4	1.6
	0.1	0.04	9	1.5	0.6
	0.2	0.08		4	1.6
	0.2	0.08		1	0.4
13	0.5	0.2		1	0.4
	2	0.8		1.5	0.6
	1	0.4		5.5	2.2
	0.5	0.2		2	0.8
	0.5	0.2		4	1.6
	2	0.8		1.5	0.6
	0.5	0.2		0.5	0.2
	1	0.4		0.5	0.2
	0.5	0.2		1.5	0.6
	3.5	1.4		2.5	1
	0.75	0.3		3.5	1.4
	8	3.2		4.5	1.8
	4	1.6		0.5	0.2
	1	0.4		1.5	0.6
	0.5	0.2		4.75	1.9
	3	1.2		0.5	0.2
	0.5	0.2		4.5	1.8
	0.25	0.1		11.5	4.6
	1.25	0.5		0.5	0.2
	0.25	0.1		1.5	0.6
	0.5	0.2		4	1.6
	0.25	0.1		0.5	0.2
	0.1	0.04		1	0.4
	0.5	0.2		0.5	0.2
	0.5	0.2		0.25	0.1
	0.75	0.3	13	2	0.8
	6.5	2.6		0.25	0.1
	0.75	0.3		0.25	0.1
	1	0.4		2	0.8
	0.5	0.2	14	1.25	0.5
	2	0.8		1	0.4
	0.5	0.2		3	1.2
	1	0.4		0.25	0.1
	1.5	0.6	16	0.5	0.2
	0.75	0.3		0.5	0.2
	0.6	0.24		0.25	0.1
15	5	2		0.25	0.1
	1.5	0.6		0.5	0.2
	1	0.4		0.5	0.2
	0.5	0.2		0.25	0.1
	1	0.4		0.25	0.1
	3	1.2		1	0.4
	1	0.4		8.75	3.5
	3	1.2		0.25	0.1
	3	1.2		0.25	0.1
	1	0.4		1.75	0.7

	0.5	0.2
	1	0.4
	1	0.4
	1.5	0.6
	1	0.4
	0.75	0.3
	0.5	0.2
16	0.5	0.2
	0.5	0.2
19	1	0.4
	1	0.4
	0.25	0.1
	0.5	0.2
	0.75	0.3
	1	0.4
	5	2
	0.5	0.2
	1	0.4
	3.5	1.4
	1	0.4
	0.25	0.1
	2	0.8
20	0.5	0.2
	1	0.4
	1.5	0.6
	1.5	0.6
	1	0.4
	0.5	0.2
	0.5	0.2
	0.5	0.2
	0.5	0.2
	0.75	0.3
	0.25	0.1
	1.5	0.6
	1.5	0.6
	0.5	0.2
	3	1.2
	1	0.4
	1	0.4
	0.5	0.2
	0.5	0.2
	4	1.6
	0.5	0.2
	0.5	0.2
	2	0.8
	5	2
	2	0.8
	1	0.4
	1	0.4
	0.5	0.2
	0.25	0.1
	0.5	0.2
21	0.5	0.2
	6.5	2.6
22	2	0.8
	0.5	0.2
	0.5	0.2

	1.25	0.5
	1.5	0.6
	0.5	0.2
17	1	0.4
	0.25	0.1
	0.75	0.3
	1	0.4
	0.25	0.1
	0.25	0.1
	0.5	0.2
	3.5	1.4
	0.5	0.2
18	0.25	0.1
	1	0.4
	0.25	0.1
	2.25	0.9
	1	0.4
	2	0.8
19	0.5	0.2
	0.25	0.1
	0.75	0.3
	0.25	0.1
	0.25	0.1
	0.5	0.2
	1.5	0.6
	1.5	0.6
	0.5	0.2
21	0.25	0.1
	0.25	0.1
	0.5	0.2
	2	0.8
	0.75	0.3
	0.5	0.2
	0.25	0.1
	0.5	0.2
	0.5	0.2
	1.25	0.5
	0.75	0.3
	0.25	0.1
	0.5	0.2
	0.25	0.1
	0.5	0.2
22	0.25	0.1
	0.25	0.1
	1	0.4
	0.5	0.2
	1.5	0.6
	0.5	0.2
	0.5	0.2
	0.5	0.2
	0.25	0.1
	0.25	0.1
	0.5	0.2
	1	0.4
	1.5	0.6
	0.25	0.1
	0.5	0.2

		4	1.6		0.25	0.1
		0.5	0.2		0.25	0.1
		4	1.6		2	0.8
		1	0.4		0.25	0.1
		0.5	0.2		0.25	0.1
AUG					0.5	0.2
	1	1.5	0.6		2	0.8
		1	0.4		1.5	0.6
		0.5	0.2		2	0.8
		0.25	0.1		1.5	0.6
		0.25	0.1		0.25	0.1
		0.25	0.1		0.75	0.3
		0.25	0.1		3	1.2
		0.25	0.1		0.5	0.2
		1	0.4		0.25	0.1
		0.25	0.1		0.25	0.1
		0.25	0.1		0.25	0.1
		1.5	0.6		0.5	0.2
		1.5	0.6		0.25	0.1
		0.5	0.2	23	1	0.4
		4	1.6		0.25	0.1
		5	2		0.25	0.1
	4	0.25	0.1		0.25	0.1
		0.25	0.1		0.25	0.1
		1.5	0.6		0.25	0.1
		1.5	0.6	24	0.5	0.2
		3.25	1.3		3.25	1.3
		1	0.4		2.25	0.9
		1.75	0.7		0.75	0.3
		1	0.4		1	0.4
		0.5	0.2		1	0.4
		0.5	0.2		0.5	0.2
		0.25	0.1		1	0.4
		0.75	0.3		3.5	1.4
		2.25	0.9		1	0.4
		4	1.6		2	0.8
		1.5	0.6		0.75	0.3
		0.75	0.3		0.75	0.3
		0.5	0.2		2	0.8
		0.25	0.1		0.25	0.1
		7	2.8		0.5	0.2
		4	1.6		0.5	0.2
		2	0.8		0.5	0.2
		0.75	0.3		0.5	0.2
		3.25	1.3		4	1.6
		5	2		4	1.6
		5	2	25	1.5	0.6
		1.5	0.6		8.5	3.4
		3	1.2		0.25	0.1
		0.5	0.2		0.25	0.1
		0.25	0.1		0.25	0.1
		0.25	0.1		0.5	0.2
		0.5	0.2		2.5	1
		2	0.8		1	0.4
		0.5	0.2		1	0.4
		1	0.4	26	2	0.8

	0.5	0.2	29	1	0.4
	0.25	0.1		0.75	0.3
	0.25	0.1		3.25	1.3
	3	1.2		4.75	1.9
	4.5	1.8		0.25	0.1
	3.5	1.4		0.75	0.3
	1	0.4		1.25	0.5
	0.5	0.2		0.25	0.1
	0.5	0.2	30	1	0.4
	0.5	0.2		0.25	0.1
5	0.5	0.2		2.25	0.9
	0.25	0.1		0.25	0.1
	0.25	0.1		1.25	0.5
	0.25	0.1		0.25	0.1
	1	0.4		0.25	0.1
	4.5	1.8		0.5	0.2
	0.5	0.2		1.5	0.6
	1.5	0.6		1	0.4
	1.25	0.5	31	8	3.2
	0.25	0.1		3	1.2
	0.25	0.1		1	0.4
	0.25	0.1		0.5	0.2
	0.5	0.2		0.25	0.1
	1	0.4		0.25	0.1
	0.5	0.2		0.25	0.1
	0.25	0.1		2	0.8
	5	2		0.5	0.2
	0.25	0.1		0.25	0.1
	0.25	0.1		0.25	0.1
	0.5	0.2		1.75	0.7
	3.5	1.4		2.25	0.9
	1.5	0.6		4	1.6
	0.25	0.1		1	0.4
	3.5	1.4		0.5	0.2
	0.5	0.2		0.5	0.2
	0.5	0.2		0.5	0.2
6	1.5	0.6		0.5	0.2
	0.25	0.1		0.25	0.1
	1.75	0.7		0.75	0.3
	5	2		1.25	0.5
	9.5	3.8		1	0.4
	2	0.8		0.25	0.1
	6.5	2.6		0.25	0.1
	1	0.4		1.5	0.6
	4	1.6		4	1.6
	2	0.8		1	0.4
	0.25	0.1		0.25	0.1
	0.75	0.3		0.25	0.1
	0.25	0.1		2.25	0.9
	2	0.8		4	1.6
	1	0.4		2	0.8
	0.5	0.2		0.5	0.2
	2.5	1		0.5	0.2
	3.5	1.4		1	0.4
	0.1	0.04		1	0.4
	0.2	0.08		0.5	0.2
				0.25	0.1

	0.25	0.1			0.75	0.3
	3.5	1.4			0.25	0.1
	1.5	0.6			1.25	0.5
	2	0.8			2.5	1
	0.5	0.2			1	0.4
	0.5	0.2			0.5	0.2
	2.5	1			0.25	0.1
	1	0.4	AUG			0
	0.25	0.1		2	9	3.6
	3	1.2			2	0.8
	1	0.4			1.5	0.6
	0.5	0.2			1.5	0.6
	0.75	0.3			1.5	0.6
	6.5	2.6			1.5	0.6
	0.5	0.2			4.5	1.8
	0.5	0.2			2	0.8
	0.25	0.1			14	5.6
	0.25	0.1			6	2.4
	3	1.2			4	1.6
	3	1.2			0.5	0.2
	10	4			0.5	0.2
	5	2			0.5	0.2
	2.5	1			0.5	0.2
	3	1.2			4	1.6
7	0.25	0.1			0.5	0.2
	5	2			2	0.8
	2	0.8			1.5	0.6
	4.5	1.8			0.5	0.2
	2	0.8			3.5	1.4
	8	3.2			0.5	0.2
	0.75	0.3			1	0.4
	0.1	0.04			1	0.4
	0.1	0.04			1	0.4
	0.2	0.08		4	0.5	0.2
	0.1	0.04			7.5	3
	1.25	0.5			1.5	0.6
	1	0.4			0.5	0.2
	0.3	0.12			0.5	0.2
	0.2	0.08			1	0.4
	0.2	0.08			0.5	0.2
	1	0.4			0.5	0.2
	2	0.8		5	0.5	0.2
	1.5	0.6			0.5	0.2
8	2.5	1		6	5.5	2.2
	1.5	0.6			2	0.8
	0.25	0.1			2	0.8
	0.5	0.2			4	1.6
	1.25	0.5			0.5	0.2
	1.25	0.5			2	0.8
	1.5	0.6			1	0.4
	0.5	0.2			0.5	0.2
	3	1.2			0.5	0.2
	8	3.2			0.5	0.2
	10	4			0.5	0.2
	10	4			0.5	0.2
	2	0.8			1	0.4
	3	1.2				

	3	1.2		0.5	0.2
	1	0.4	7	0.5	0.2
	0.5	0.2		0.5	0.2
	1.75	0.7		0.5	0.2
	3	1.2		0.5	0.2
9	1	0.4		0.5	0.2
	1	0.4		2	0.8
	1	0.4		1	0.4
	1	0.4		0.5	0.2
	2	0.8		0.5	0.2
	0.5	0.2		6.5	2.6
	1	0.4		0.5	0.2
	1.5	0.6		0.5	0.2
	1.5	0.6	8	2	0.8
	0.75	0.3		0.5	0.2
	2	0.8		1	0.4
	0.5	0.2		2	0.8
	0.5	0.2		3	1.2
	1	0.4		0.5	0.2
	7	2.8		0.5	0.2
	0.75	0.3	9	2.5	1
	5	2		1	0.4
	0.5	0.2		1	0.4
	0.5	0.2		4	1.6
11	6.5	2.6	10	2	0.8
	0.5	0.2		8	3.2
	0.5	0.2		0.5	0.2
	0.25	0.1		0.5	0.2
	0.5	0.2		2	0.8
	1	0.4		1.5	0.6
	1.5	0.6		6	2.4
	0.75	0.3		0.5	0.2
	0.75	0.3		0.5	0.2
	1.25	0.5		0.5	0.2
	0.75	0.3	12	0.25	0.1
	1	0.4		3	1.2
	0.5	0.2		2	0.8
	1	0.4		0.25	0.1
15	9	3.6		3.25	1.3
	2.75	1.1		2	0.8
	0.5	0.2		0.75	0.3
	2	0.8		3	1.2
	0.5	0.2		1.75	0.7
	0.5	0.2		0.75	0.3
	1.5	0.6		2	0.8
	0.5	0.2		1.75	0.7
	0.25	0.1		1.5	0.6
	0.25	0.1		0.5	0.2
	0.5	0.2		0.5	0.2
	1	0.4	11	1.5	0.6
	1	0.4		1	0.4
	0.5	0.2		0.25	0.1
	0.25	0.1		0.5	0.2
	0.25	0.1		0.25	0.1
13	8	3.2		4	1.6
	3	1.2		3.25	1.3
	0.25	0.1		1.25	0.5

	1.5	0.6
	1	0.4
	4	1.6
	2.25	0.9
	0.25	0.1
	0.25	0.1
	0.25	0.1
	1	0.4
	1	0.4
	0.25	0.1
	1.5	0.6
	0.25	0.1
	2	0.8
	2	0.8
	1.5	0.6
	1.5	0.6
	1	0.4
	3.5	1.4
	0.5	0.2
	1	0.4
	0.5	0.2
24	1	0.4
	1	0.4
	1.5	0.6
25	2	0.8
26	5.75	2.3
	0.25	0.1
	3.25	1.3
	1	0.4
	9	3.6
	0.5	0.2
	1.5	0.6
	0.5	0.2
27	1.5	0.6
	1.25	0.5
	2	0.8
24	1	0.4
	1	0.4
	6	2.4
	3	1.2
	0.25	0.1
	0.5	0.2
	3	1.2
	1	0.4
	1.25	0.5
	0.5	0.2
SEPT		
5	0.5	0.2
	2.5	1
	0.5	0.2
	6.75	2.7
	2	0.8
	1	0.4
	0.25	0.1
6	2.75	1.1
10	2.5	1

	23	2.5	1
		5	2
		1	0.4
		1	0.4
		2	0.8
		0.5	0.2
		0.5	0.2
		0.5	0.2
		2.25	0.9
		0.25	0.1
	28	7.25	2.9
		3	1.2
		4	1.6
		1	0.4
		0.5	0.2
		1.5	0.6
		0.25	0.1
	29	0.5	0.2
		0.75	0.3
	30	0.5	0.2
		0.5	0.2
		1.25	0.5
SEPT			0
	10	0.5	0.2
		1	0.4
		0.75	0.3
		0.25	0.1
	8	2	0.8
		0.75	0.3
	12	1	0.4
		0.5	0.2
	11	9.5	3.8
		9	3.6
		3	1.2
		1.5	0.6
		0.5	0.2
		0.25	0.1
		0.25	0.1
		0.25	0.1
		1	0.4
		0.5	0.2
		1.5	0.6
		0.5	0.2
		0.5	0.2
		0.5	0.2
		0.5	0.2
		1	0.4
		0.25	0.1

14	2	0.8
	1	0.4
	0.25	0.1
15	0.5	0.2
	1.25	0.5
	3	1.2
	6	2.4
18	2	0.8
	0.5	0.2
	0.25	0.1
	0.25	0.1
	0.25	0.1
	0.5	0.2
	5	.2
	0.75	0.3
	1	0.4
19	10	4
	10	4
	1.5	0.6
	2	0.8
	2.5	1
	3.5	1.4
	5.5	2.2
	9.5	3.8
	0.25	0.1
	0.75	0.3
20	0.75	0.3
	0.25	0.1
	3	1.2
	3	1.2
	4.5	1.8
	1	0.4
	0.75	0.3
	1	0.4
	1	0.4
	1	0.4
	0.5	0.2
	1	0.4
	1	0.4
	0.5	0.2
	0.5	0.2
	0.5	0.2
	0.25	0.1
21	1.25	0.5
	2.75	1.1
	3	1.2
	1	0.4
	0.75	0.3
	0.5	0.2
	0.1	0.04
	0.25	0.1
	0.25	0.1
	0.25	0.1
	0.25	0.1
	0.25	0.1
	0.25	0.1

		0.5	0.2
		0.5	0.2
		0.25	0.1
		0.25	0.1
		0.25	0.1
		0.5	0.2
		0.5	0.2
		0.25	0.1
		0.5	0.2
		0.5	0.2
		1.5	0.6
		1.5	0.6
		1	0.4
		9	3.6
		10	4
		10	4
		10	4
		3	1.2
		1.5	0.6
		0.25	0.1
		0.5	0.2
	23	1	0.4
	24	5	2
		0.25	0.1
		1	0.4
		2	0.8
		0.5	0.2
		2	0.8
		14	5.6
		7.5	3
		0.75	0.3
		0.5	0.2
		0.75	0.3
		0.25	0.1
	25	1.75	0.7
		0.25	0.1
		1	0.4
		0.5	0.2
		0.25	0.1
		3.5	1.4
		0.25	0.1
		0.75	0.3
	26	0.25	0.1
		2.5	1
		1.25	0.5
		1.5	0.6
OCT			
	4	1	0.4
		3	1.2
		0.75	0.3

APPENDIX - II

Daily Rainfall and its maximum intensity for Manjeri, Kottaparambu, and Vettilappara for the Year 1994

Date	Manjeri		Kottamparambu		Ottapalam		Vettilapara	
	Tot cm	Int cm/h	Tot cm	Int cm/h	Tot cm	Int cm/h	Tot cm	Int cm/h
January								
5	0.00	0.00	0.04	0.40	0.00	0.00	0.00	0.00
6	0.00	0.00	0.04	0.40	0.00	0.00	0.00	0.00
18	0.00	0.00	0.02	0.20	0.00	0.00	0.00	0.00
19	0.00	0.00	0.06	0.60	0.00	0.00	0.00	0.00
February								
13	2.70	4.00	0.00	0.00	0.00	0.00	0.00	0.00
19	2.00	2.40	0.00	0.00	0.00	0.00	0.00	0.00
March								
10	0.10	0.20	0.00	0.00	0.00	0.00	0.00	0.00
11	0.05	0.10	1.08	2.00	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00	0.00	0.00	0.60	2.51
April								
3	0.00	0.00	0.00	0.00	0.00	0.00	2.00	3.60
4	0.00	0.00	0.00	0.00	0.00	0.00	3.00	6.00
5	0.00	0.00	0.50	0.40	0.00	0.00	1.00	3.43
6	0.00	0.00	0.50	0.80	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.43
9	0.00	0.00	0.00	0.00	0.00	0.00	2.00	3.75
10	0.00	0.00	0.00	0.00	0.00	0.00	0.55	0.60
16	0.00	0.00	0.00	0.00	0.00	0.00	0.25	3.20
17	0.00	0.00	0.00	0.00	0.00	0.00	1.04	3.20
18	0.00	0.00	3.42	4.00	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00	0.00	0.00	1.01	2.00
20	0.00	0.00	0.02	0.20	0.00	0.00	0.00	0.00
21	0.00	0.00	0.02	0.20	0.00	0.00	0.00	0.00
22	0.00	0.00	0.00	0.00	0.00	0.00	0.33	1.60
23	4.00	4.00	0.00	0.00	0.10	0.40	0.38	1.00
24	0.00	0.00	0.00	0.00	2.20	4.00	0.00	0.00
25	0.00	0.00	0.42	1.60	0.00	0.00	0.00	0.00
26	0.55	2.20	0.00	0.00	0.00	0.00	0.20	9.60
27	1.40	2.20	0.00	0.00	0.00	0.00	2.90	14.44
28	0.00	0.00	1.00	1.30	0.00	0.00	3.70	6.00

May									
	1	0.00	0.00	0.04	0.20	0.00	0.00	3.60	5.85
	2	0.05	0.60	0.00	0.00	0.00	0.00	0.20	0.80
	3	3.30	8.00	0.00	0.00	0.00	0.00	0.15	0.30
	4	0.00	0.00	0.00	0.00	1.25	3.20	0.40	1.00
	5	5.15	8.00	0.80	1.20	0.00	0.00	5.80	10.00
	6	0.20	0.60	2.46	2.00	0.40	0.80	2.80	3.40
	7	0.00	0.00	6.62	4.00	0.85	2.00	6.80	4.00
	8	0.00	0.00	0.06	0.20	0.00	0.00	1.30	4.00
	9	0.00	0.00	0.80	0.80	0.00	0.00	6.00	0.40
	10	0.00	0.00	2.46	2.80	0.65	0.27	2.60	2.40
	11	0.00	0.00	2.14	2.00	0.00	0.00	2.10	8.00
	12	0.00	0.00	2.40	0.80	0.00	0.00	2.55	1.20
	13	0.00	0.00	0.30	0.20	0.40	0.80	0.85	0.80
	14	0.00	0.00	0.02	0.80	2.75	4.00	0.00	0.00
	15	0.00	0.00	0.50	1.20	0.70	1.40	1.20	6.40
	16	0.60	2.70	1.00	0.20	0.00	0.00	0.40	1.20
	17	0.50	1.20	0.10	0.02	0.00	0.00	1.10	3.20
	18	0.00	0.00	0.00	0.00	2.25	0.40	0.00	0.00
	19	0.00	0.00	0.00	0.00	0.30	1.20	0.00	0.00
	20	0.15	1.20	0.00	0.00	0.00	0.00	0.00	0.00
	22	0.00	0.00	0.00	0.00	0.00	0.00	1.30	4.00
	25	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.80
	26	0.00	0.00	0.08	1.20	0.00	0.00	0.00	0.00
	27	0.18	0.90	0.00	0.00	0.00	0.00	0.00	0.00
	28	0.70	1.60	0.00	0.00	0.00	0.00	0.00	0.00
	29	1.00	0.85	0.06	0.20	0.00	0.00	2.65	8.00
	30	0.00	0.00	0.03	0.40	0.00	0.00	0.50	4.80
June									
	2	0.00	0.00	2.70	2.67	0.00	0.00	0.45	1.50
	3	0.00	0.00	2.62	2.80	0.00	0.00	0.70	2.00
	4	0.00	0.00	0.00	0.00	0.00	0.00	1.40	2.60
	5	2.25	0.20	0.00	0.00	1.80	1.33	0.08	0.25
	6	0.20	0.60	0.00	0.00	0.00	0.00	3.60	6.00
	7	0.25	0.80	0.00	0.00	5.20	8.00	0.20	0.80
	8	0.55	1.20	0.01	1.60	0.25	0.40	1.80	4.80
	9	0.00	0.00	3.80	1.20	0.00	0.00	4.70	4.00
	10	0.80	3.20	3.80	1.60	0.00	0.00	2.70	4.00
	11	0.05	0.20	3.80	3.60	0.10	1.60	5.25	2.40
	12	1.55	2.80	15.20	4.80	6.15	4.00	8.30	4.00
	13	8.75	8.00	10.00	4.00	1.40	2.40	2.25	2.00
	14	6.70	2.25	5.48	1.60	2.10	2.40	6.40	4.00
	15	0.80	0.80	1.70	2.60	2.60	4.00	1.70	1.20
	16	4.20	4.00	7.90	4.00	6.75	3.20	0.45	1.80
	17	1.05	1.20	4.04	0.80	6.20	2.40	0.30	1.20
	18	3.90	4.00	0.50	0.80	4.00	4.00	0.00	0.00
	19	3.75	2.85	0.54	1.00	1.75	4.00	0.00	0.00
	20	1.50	2.00	1.30	4.00	6.50	3.20	1.80	1.80
	21	0.65	4.20	1.60	2.80	4.40	1.60	2.30	4.00

22	2.15	4.80	0.02	0.20	7.00	4.00	0.55	0.80
23	5.20	4.00	2.25	2.60	0.60	1.60	0.12	2.20
24	7.85	2.60	0.00	0.00	0.55	0.80	0.00	0.00
25	1.35	4.80	0.80	4.00	0.20	0.60	1.80	3.00
26	3.80	2.80	2.05	2.20	1.75	1.60	2.70	3.14
27	0.00	0.00	2.64	8.00	0.00	0.00	3.40	4.00
28	0.00	0.00	8.36	3.00	6.10	4.00	4.90	2.00
29	1.45	1.60	2.54	4.00	3.25	1.60	7.60	4.00
30	3.55	1.80	0.00	0.00	5.00	1.60	5.00	4.00
July								
1	0.00	0.00	4.90	2.80	2.25	2.60	0.20	0.80
2	0.20	0.80	3.42	0.15	5.50	4.00	0.90	2.40
3	0.00	0.00	0.16	1.20	0.00	0.00	0.10	2.20
4	0.35	1.80	0.80	2.40	1.25	4.00	1.30	2.00
5	0.10	0.60	0.68	1.36	0.00	0.00	2.80	4.00
6	1.30	2.40	4.08	1.50	1.60	2.00	9.80	8.00
7	0.22	0.20	3.26	0.60	0.00	0.00	2.55	2.40
8	0.15	1.20	0.44	0.88	0.10	0.20	0.00	0.00
9	0.05	0.20	1.74	2.40	0.00	0.00	1.20	1.00
10	0.30	1.50	1.08	1.20	0.10	0.20	0.00	0.00
11	0.00	0.00	6.62	1.20	0.10	0.20	4.30	2.00
12	0.00	0.00	2.78	3.20	0.00	0.00	0.00	0.00
13	0.75	0.80	2.80	1.50	1.15	1.60	0.70	1.80
14	4.45	4.00	3.04	2.40	0.00	0.00	1.50	1.60
15	2.50	3.00	2.02	1.60	3.15	4.00	0.30	0.60
16	0.50	1.60	1.14	2.40	8.85	8.00	5.80	2.00
17	0.00	0.00	5.64	1.20	2.00	2.80	1.05	2.00
18	0.65	3.00	1.38	1.40	5.50	3.20	1.65	2.40
19	4.85	7.20	1.44	2.80	6.45	4.00	0.80	1.60
20	1.75	5.40	0.90	3.00	1.80	0.40	0.20	0.60
21	0.45	1.50	1.82	1.73	0.20	0.60	0.00	0.00
22	2.30	2.40	2.26	0.70	0.70	2.00	0.60	2.00
23	2.15	4.80	1.36	0.40	1.55	2.00	0.90	0.20
24	1.40	1.40	1.22	1.20	2.45	2.00	1.05	1.00
25	1.15	3.20	2.70	0.60	3.00	2.40	0.20	0.10
26	*0.20*	*2.10*	*0.30*	*0.20*	*7.05*	*4.00*	*1.00*	*2.00*
27	0.00	0.00	2.00	2.40	9.55	4.00	0.75	1.20
28	0.00	0.00	1.78	2.50	5.60	2.40	4.25	2.40
29	0.00	0.00	2.94	1.00	0.30	0.40	6.05	2.00
30	0.05	0.20	3.70	0.20	0.10	0.20	9.30	8.00
31	*1*	*4*	3.70	0.20	0.00	0.00	0.00	0.00
August								
1	0.00	0.00	0.18	0.70	0.00	0.00	0.00	0.00
2	12.50	1.90	0.46	0.80	3.65	4.00	0.00	0.00
3	24.00	2.10	0.50	1.40	0.65	1.20	0.00	0.00
4	15.00	0.80	1.24	3.60	1.35	1.60	9.60	4.00
5	21.50	3.60	2.26	0.20	0.00	0.00	1.00	4.00
6	78.50	2.00	0.18	0.70	0.00	0.00	0.30	1.60
7	31.00	2.57	0.72	0.70	0.00	0.00	0.00	0.00

8	83.00	5.40	0.64	1.60	0.00	0.00	0.31	0.08
9	73.00	2.60	2.76	0.87	0.00	0.00	0.00	0.00
10	10.00	1.60	0.74	1.15	0.00	0.00	0.40	0.80
11	7.50	1.20	2.00	0.20	0.00	0.00	0.85	0.24
12	26.00	1.80	0.00	0.00	0.00	0.00	0.00	0.00
13	7.00	2.80	0.16	1.80	0.00	0.00	0.00	0.00
14	12.00	2.20	2.80	0.20	0.00	0.00	0.10	0.86
15	0.00	0.00	0.05	0.20	0.00	0.00	0.00	0.00
16	0.00	0.00	0.03	1.70	0.00	0.00	0.25	1.60
17	0.00	0.00	0.00	0.00	0.00	0.00	10.60	8.00
18	0.00	0.00	2.14	2.00	0.00	0.00	0.30	0.40
19	0.00	0.00	0.02	3.80	0.00	0.00	5.60	8.00
20	0.00	0.00	6.76	2.40	0.00	0.00	1.70	5.60
21	0.00	0.00	0.00	0.00	0.00	0.00	1.00	4.80
22	0.00	0.00	0.04	0.20	0.00	0.00	0.00	0.00
23	0.00	0.00	0.00	0.00	0.00	0.00	7.80	8.00
24	0.00	0.00	7.14	3.60	0.00	0.00	0.35	2.40
25	0.00	0.00	0.00	0.00	0.00	0.00	7.50	4.00
26	0.00	0.00	1.16	0.47	0.50	2.00	2.60	8.00
27	0.00	0.00	2.38	1.00	4.85	4.00	0.45	1.60
28	0.00	0.00	0.12	0.24	0.40	1.00	5.00	4.00
29	0.00	0.00	2.96	3.60	0.95	2.20	5.60	8.00
30	0.00	0.00	3.52	1.80	1.20	0.80	4.70	16.00
31	0	0	7.18	3.60	0.00	0.00	5.65	8.60
September								
1	0.00	0.00	7.22	2.40	0.55	1.60	0.00	0.00
2	0.00	0.00	3.58	1.20	1.70	3.20	0.35	3.20
3	0.00	0.00	1.56	1.80	1.10	2.40	1.60	0.40
4	0.00	0.00	2.58	1.60	0.20	0.20	2.55	5.60
5	3.00	1.50	0.72	1.15	0.00	0.00	3.50	4.00
6	0.00	0.00	2.18	2.00	0.55	1.20	3.40	4.80
7	0.00	0.00	1.20	1.20	0.20	0.40	0.15	0.80
8	0.00	0.00	0.04	0.20	1.60	4.00	0.35	0.40
9	0.00	0.00	0.56	1.20	0.45	1.60	7.75	4.00
10	0.00	0.00	1.78	2.40	0.55	1.60	6.20	4.00
11	0.00	0.00	1.54	1.80	0.40	1.60	1.80	2.00
12	0.00	0.00	1.26	1.15	0.20	0.60	1.80	4.00
13	0.00	0.00	1.44	0.60	0.00	0.00	0.60	1.60
15	3.50	0.60	1.12	2.00	0.00	0.00	4.00	4.00
16	19.50	2.40	0.00	0.00	0.00	0.00	0.45	0.80
17	8.50	1.60	0.00	0.00	0.00	0.00	2.20	4.00
18	2.50	2.16	0.00	0.00	0.00	0.00	2.80	16.00
19	77.00	2.40	0.00	0.00	0.00	0.00	0.90	1.60
20	86.50	4.00	0.00	0.00	0.00	0.00	0.40	1.20
21	36.50	1.60	0.00	0.00	0.00	0.00	0.00	0.00
23	0.35	1.00	0.00	0.00	1.55	3.20	0.00	0.00
24	6.40	2.40	0.00	0.00	0.00	0.00	0.00	0.00
25	0.50	0.40	0.00	0.00	0.60	1.60	0.00	0.00
26	0.00	0.00	0.00	0.00	1.65	3.20	0.00	0.00
27	2.10	3.20	0.00	0.00	1.55	2.40	0.00	0.00
28	0.20	0.40	0.00	0.00	4.85	4.00	0.00	0.00
29	6.60	3.60	0.00	0.00	0.00	0.00	0.00	0.00
30	10.40	12.00	0.00	0.00	0.00	0.00	0.00	0.00

October								
1	0.70	2.00	0.00	0.00	1.05	2.00	0.00	0.00
2	0.00	0.00	0.00	0.00	1.25	2.40	0.00	0.00
3	2.00	4.00	0.00	0.00	1.95	1.60	0.00	0.00
4	1.55	4.00	0.00	0.00	0.65	1.60	0.00	0.00
5	0.20	0.60	0.00	0.00	0.30	0.20	0.00	0.00
6	1.45	1.80	0.40	0.80	0.40	0.80	0.00	0.00
7	0.00	0.00	0.44	3.40	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.55	1.60	0.00	0.00
9	1.50	4.00	0.00	0.00	2.00	2.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.20	0.10	0.00	0.00
11	0.00	0.00	0.02	0.20	3.00	4.00	0.00	0.00
12	5.25	12.00	0.26	0.20	2.55	4.00	0.00	0.00
13	0.65	0.80	0.06	0.60	0.85	2.40	0.00	0.00
14	0.10	0.30	0.00	0.00	0.00	0.00	0.00	0.00
18	0.20	0.20	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	0.00	0.24	1.20	0.00	0.00	0.00	0.00
21	0.00	0.00	0.35	0.20	0.00	0.00	0.00	0.00
23	0.00	0.00	1.54	1.60	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00.	2.55	4.00	0.00	0.00
26	2.70	4.00	0.00	0.00	0.00	0.00	0.00	0.00
27	1.15	6.00	0.18	2.80	0.00	0.00	0.00	0.00
28	0.90	1.20	0.72	1.40	0.00	0.00	0.00	0.00
29	0.25	0.60	0.45	0.70	0.00	0.00	0.00	0.00
30	0.40	0.40	0.43	1.40	0.00	0.00	0.00	0.00
31	1	1	0.02	0.20	0.00	0.00	0.00	0.00
November								
1	7.75	8.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.44	2.10	0.00	0.00	0.00	0.00
3	0.00	0.00	1.68	4.35	0.00	0.00	0.00	0.00
4	2.35	3.80	5.94	2.10	0.00	0.00	2.60	3.20
5	1.70	1.60	1.66	0.20	0.00	0.00	2.00	6.40
6	4.30	3.60	0.12	0.27	0.00	0.00	1.40	9.60
7	1.40	3.60	0.44	0.53	0.00	0.00	2.00	3.20
8	0.85	2.40	0.88	0.60	0.00	0.00	0.00	0.00
9	2.95	1.60	0.10	0.60	0.00	0.00	0.00	0.00
11	0.60	1.60	0.00	0.00	0.00	0.00	0.00	0.00
21	0.00	0.00	0.00	0.00	1.10	0.10	0.00	0.00
25	0.00	0.00	0.00	0.00	0.40	1.60	0.00	0.00
December								
11	2.60	4.00	0.00	0.00	0.00	0.00	0.60	4.80

1995

January								
3	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.60
April								
4	0.00	0.00	0.00	0.00	0.20	0.80	0.30	4.80
6	0.00	0.00	1.84	4.00	0.15	0.80	0.40	4.80
7	0.00	0.00	0.10	0.92	1.80	1.80	0.75	2.20
9	0.00	0.00	0.05	0.20	0.00	0.00	0.00	0.00
10	0.00	0.00	7.42	1.80	0.00	0.00	1.35	0.80
11	0.00	0.00	1.55	1.80	0.00	0.00	0.00	0.00
12	0.00	0.00	1.32	0.80	0.35	2.40	1.10	1.60
13	0.00	0.00	0.10	0.04	0.85	11.20	1.00	1.60
14	0.00	0.00	0.07	0.20	0.00	0.00	0.55	0.80
17	0.00	0.00	0.94	1.20	0.00	0.00	1.05	1.60
18	0.00	0.00	0.34	4.00	0.00	0.00	0.65	1.60
19	0.00	0.00	0.06	0.20	0.00	0.00	1.45	4.80
23	0.00	0.00	0.00	0.00	0.95	4.80	1.40	4.00
26	0.00	0.00	0.00	0.00	1.60	6.40	8.50	1.20
28	0.00	0.00	0.00	0.00	0.00	0.00	0.40	2.40
29	0.45	1.80	0.02	0.08	0.00	0.00	0.10	0.80
30	0.60	2.00	0.06	0.24	0.00	0.00	0.00	0.00
May								
4	0.00	0.00	0.00	0.00	0.15	0.80	0.10	0.10
7	0.00	0.00	3.24	4.00	0.00	0.00	0.00	0.00
8	0.15	0.90	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.65	3.20	0.00	0.00
12	1.30	4.00	0.00	0.00	0.00	0.00	0.75	0.80
13	0.00	0.00	0.32	1.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.12	0.60	0.65	9.60	0.25	3.20
15	0.00	0.00	0.00	0.00	3.40	4.00	0.00	0.00
16	1.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.02	1.80	0.00	0.00	0.05	0.80
18	2.40	6.00	0.96	1.80	0.00	0.00	0.15	1.60
20	0.80	3.20	0.00	0.00	0.00	0.00	0.00	0.00
21	2.10	4.00	0.60	1.60	0.00	0.00	2.20	2.00
22	8.15	8.00	0.00	0.00	0.00	0.00	0.00	0.00
23	0.00	0.00	0.56	1.28	0.85	2.40	1.00	0.80
25	0.00	0.00	0.02	0.60	0.00	0.00	0.75	1.20
26	0.00	0.00	0.34	1.36	0.00	0.00	0.10	0.60
27	0.00	0.00	0.02	6.00	0.00	0.00	1.00	3.20
28	0.00	0.00	3.40	2.80	0.45	4.80	0.00	0.00
29	0.00	0.00	1.04	0.30	0.00	0.00	0.00	0.00
30	0.00	0.00	0.04	1.60	0.05	0.20	0.00	0.00
31	0	1.20	0.22	0.88	0.00	0.00	0.00	0.00

June								
1	1.15	2.40	5.24	4.00	1.00	16.00	2.65	1.40
2	9.65	8.00	12.40	8.00	4.55	6.00	12.00	4.00
3	0.60	3.00	9.42	9.00	5.25	8.00	3.00	1.20
4	1.60	6.00	6.04	9.00	7.50	8.00	6.00	2.80
5	0.00	0.00	6.18	2.40	0.20	0.80	6.85	0.80
6	0.00	0.00	4.76	4.00	4.25	8.00	9.95	1.60
7	0.30	2.40	5.22	0.80	4.25	2.00	3.35	1.20
8	2.65	4.00	1.52	2.00	2.45	1.40	2.95	1.00
9	0.70	4.71	2.64	4.80	8.10	8.00	5.45	2.20
10	2.90	4.80	1.60	3.45	4.30	8.00	1.60	0.40
11	1.55	6.00	4.62	3.00	1.20	3.20	0.75	0.80
12	4.50	6.00	4.62	2.00	2.00	2.00	5.55	1.20
13	0.45	2.40	4.62	9.00	9.00	8.00	1.60	0.40
14	3.85	2.80	4.62	2.20	0.70	1.20	7.40	3.20
15	2.90	2.80	1.15	3.20	2.00	12.80	1.60	1.60
16	2.70	7.20	2.53	1.60	3.20	4.00	7.25	0.53
17	6.00	8.40	1.03	0.21	2.25	4.00	0.75	0.40
18	0.00	0.00	0.20	1.40	1.80	1.20	0.23	6.40
19	1.70	4.00	0.86	2.80	0.40	3.20	1.15	3.20
20	0.00	0.00	1.00	0.10	1.90	2.00	0.10	0.80
21	0.00	0.00	0.02	0.40	1.25	2.00	3.25	1.20
22	14.20	8.00	0.12	2.80	2.60	8.00	0.45	0.60
23	0.15	0.60	1.94	2.20	0.20	0.40	3.35	0.80
24	1.15	1.80	1.14	0.15	2.20	2.20	2.85	1.00
25	2.60	4.00	4.60	3.40	1.40	2.20	4.20	0.80
26	7.00	3.20	0.86	1.60	3.30	2.80	5.05	1.60
27	2.40	4.00	3.38	3.20	2.00	2.40	2.45	0.80
28	0.25	2.40	2.50	5.60	1.40	3.20	1.05	1.20
29	1.40	1.60	2.78	3.20	0.00	0.00	0.25	2.40
30	3.95	3.60	5.90	4.00	0.00	0.00	0.00	0.00
July								
1	2.10	4.00	2.10	1.47	4.65	2.20	7.30	0.80
2	1.15	3.60	1.74	5.80	0.15	0.40	0.10	0.80
3	1.40	2.40	2.72	1.97	2.70	4.00	0.35	1.20
4	3.60	2.40	2.20	3.00	2.10	8.00	1.55	6.40
5	3.20	6.00	1.06	0.40	0.10	0.80	1.95	3.20
6	1.10	3.00	0.16	3.20	8.35	6.00	1.00	4.40
7	2.60	3.60	3.74	1.60	6.05	4.00	3.20	4.00
8	3.20	4.00	1.38	0.40	5.45	12.00	4.20	6.40
9	0.00	0.00	0.14	2.80	0.00	0.00	2.00	0.80
10	0.00	0.00	1.76	2.45	2.10	3.20	3.10	2.40
11	0.00	0.00	2.34	2.00	0.75	3.20	0.18	0.60
12	0.00	0.00	8.56	4.40	1.70	6.40	0.80	0.80
13	0.00	0.00	5.70	5.10	0.05	0.80	0.35	2.40
14	0.00	0.00	15.84	2.40	0.70	6.40	0.30	0.60
15	0.00	0.00	8.46	2.00	0.60	7.20	0.95	0.80
16	0.00	0.00	2.62	4.40	0.15	0.32	2.50	3.20

17	2.40	2.40	5.90	3.60	2.75	8.00	1.80	1.60
18	1.75	2.80	3.86	8.40	0.50	1.60	0.15	0.20
19	0.70	2.80	4.20	6.00	0.90	0.40	0.10	0.80
20	0.00	0.00	3.75	6.00	0.20	0.20	1.05	8.00
21	0.00	0.00	7.34	1.60	1.10	4.00	2.50	1.60
22	0.00	0.00	2.34	2.10	4.00	2.00	0.20	1.60
23	0.00	0.00	4.94	2.00	1.00	0.80	2.50	3.20
24	3.95	3.00	2.28	2.60	0.60	3.60	8.85	1.00
25	0.00	0.00	1.60	3.00	1.60	7.20	6.80	16.00
26	0.00	0.00	2.52	2.40	5.40	2.40	1.25	3.20
27	0.00	0.00	3.80	5.18	7.80	3.20	8.00	3.40
28	0.00	0.00	10.64	3.60	0.90	5.60	3.45	3.20
29	2.85	3.00	7.83	2.80	4.35	10.40	4.75	3.20
30	0.00	0.00	8.60	2.60	3.40	16.00	0.00	0.00
31	0.00	0.00	4.18	3.40	8.40	4.00	0.00	0.00
August								
1	0.00	0.00	4.34	3.40	5.20	1.07	7.80	4.00
2	0.00	0.00	4.16	4.00	0.05	0.80	0.25	0.20
3	2.70	2.40	7.51	4.00	0.20	0.40	0.15	0.20
4	0.00	0.00	1.56	1.30	0.10	0.40	0.65	0.40
5	0.00	0.00	1.68	1.00	0.10	0.13	0.15	0.20
6	2.30	4.00	0.24	0.30	0.00	0.00	1.95	3.20
7	0.00	0.00	0.18	0.80	2.50	4.00	0.85	4.00
8	0.35	3.60	0.02	0.08	0.85	1.60	0.45	0.40
9	0.00	0.00	0.00	0.00	1.10	6.00	2.60	1.60
10	1.00	4.00	0.56	2.20	0.00	0.00	4.45	4.00
11	1.75	3.43	0.36	1.20	0.15	0.80	10.40	0.93
12	1.65	6.60	0.92	0.80	1.35	1.20	2.20	3.60
13	2.55	4.00	0.08	1.20	2.70	1.20	2.05	0.40
14	0.70	7.20	0.32	0.40	4.25	5.60	3.95	0.60
15	1.20	2.60	0.00	0.00	1.35	3.20	7.95	2.40
16	1.15	1.20	0.00	0.00	1.00	1.20	1.75	0.80
17	4.30	1.60	3.72	4.00	4.30	2.00	0.15	1.60
18	4.10	9.60	2.14	1.20	9.40	12.00	1.40	1.60
19	2.25	3.00	3.70	1.00	0.75	0.60	2.00	3.20
20	1.80	4.80	0.20	0.40	0.20	0.80	1.40	3.20
21	2.25	2.20	0.16	1.20	0.00	0.00	0.35	1.60
22	1.15	2.60	1.56	1.40	1.00	1.80	0.55	0.27
23	7.50	4.00	0.04	0.16	0.70	2.00	1.55	1.60
24	4.30	6.00	0.50	0.20	0.15	0.60	0.35	0.60
25	6.50	6.00	0.20	1.00	0.75	0.60	1.30	3.20
26	2.60	3.20	0.50	0.20	3.40	5.20	0.15	1.20
27	0.55	1.60	0.08	1.20	0.00	0.00	0.00	0.00
28	1.80	1.60	3.22	4.00	0.00	0.00	0.00	0.00
29	0.50	5.40	3.22	2.00	0.00	0.00	0.00	0.00
30	0.00	0.00	3.22	1.00	0.00	0.00	0.00	0.00
31	0.00	0.00	4.06	1.00	0.15	0.60	0.00	0.00

September								
1	0.00	0.00	4.52	3.40	0.00	0.00	0.00	0.00
2	0.00	0.00	2.14	2.40	0.00	0.00	0.00	0.00
3	1.40	1.03	1.62	2.20	0.00	0.00	0.00	0.00
4	2.60	1.80	3.62	2.60	0.00	0.00	0.00	0.00
5	0.00	0.00	2.48	2.40	0.00	0.00	0.00	0.00
6	0.00	0.00	1.65	1.40	0.00	0.00	0.00	0.00
7	0.00	0.00	1.28	1.20	0.00	0.00	0.00	0.00
8	0.00	0.00	0.03	0.12	0.00	0.00	0.00	0.00
9	0.00	0.00	0.10	0.40	0.00	0.00	0.00	0.00
14	0.00	0.00	0.28	0.40	0.00	0.00	2.70	3.20
17	1.00	1.80	0.08	0.20	0.00	0.00	2.00	3.20
18	2.80	4.00	0.00	0.00	0.00	0.00	0.35	1.60
19	0.90	2.00	0.00	0.00	0.00	0.00	1.00	0.53
20	0.55	1.60	1.44	3.60	0.00	0.00	0.20	0.40
21	0.30	1.20	0.00	0.00	0.00	0.00	0.50	1.20
22	1.00	3.00	0.00	0.00	0.00	0.00	0.50	0.20
23	12.00	4.80	0.00	0.00	0.10	0.40	0.00	0.00
24	0.85	2.40	0.14	0.40	0.60	1.80	0.00	0.00
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27	0.00	0.00	0.30	0.33	3.50	2.20	0.00	0.00
28	0.00	0.00	0.12	0.40	0.50	0.40	0.00	0.00
29	1.75	4.00	0.20	0.40	0.00	0.00	0.00	0.00
30	4.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00
October								
1	0.10	1.30	0.34	2.80	2.10	4.00	0.00	0.00
2	0.00	0.00	0.38	1.60	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.80
4	0.00	0.00	7.32	2.20	0.00	0.00	0.85	1.60
5	0.55	0.30	0.10	1.80	0.00	0.00	0.40	0.40
6	0.00	0.00	0.28	2.80	1.15	1.60	0.75	1.60
7	3.50	12.00	2.92	0.80	4.85	1.60	1.00	1.60
8	8.45	8.00	0.40	0.80	0.00	0.00	4.75	2.60
9	0.00	0.00	0.00	0.00	0.15	0.20	1.25	9.60
10	0.00	0.00	0.16	0.64	0.85	6.40	3.20	1.60
11	1.45	1.10	0.24	0.40	0.00	0.00	1.15	3.20
12	0.00	0.00	8.36	4.00	0.00	0.00	0.00	0.00
13	0.00	0.00	0.70	0.80	0.00	0.00	0.00	0.00
14	0.80	2.40	0.00	0.00	0.00	0.00	0.00	0.00
15	1.45	6.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.74	0.80	1.80	2.40	0.00	0.00
17	0.10	1.20	1.52	3.60	4.50	4.80	0.00	0.00
18	0.00	0.00	0.02	0.12	0.00	0.00	0.00	0.00
19	3.30	4.00	0.20	0.40	0.00	0.00	0.00	0.00
20	2.70	3.90	0.54	2.16	0.00	0.00	0.00	0.00
21	0.15	0.40	0.00	0.00	0.00	0.00	0.00	0.00
22	0.00	0.00	0.18	0.72	0.00	0.00	0.00	0.00
23	0.00	0.00	0.82	4.00	0.00	0.00	0.00	0.00

24	0.00	0.00	0.02	0.40	0.00	0.00	0.00	0.00
25	0.55	2.20	0.69	3.20	0.00	0.00	0.00	0.00
26	0.08	4.45	0.34	0.40	0.00	0.00	0.00	0.00
27	0.00	0.00	3.70	0.20	0.00	0.00	0.00	0.00
28	0.00	0.00	0.04	1.60	0.00	0.00	0.00	0.00
29	4.95	4.00	0.00	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	12.72	0.60	0.00	0.00	0.00	0.00
31	0.00	0.00	0.60	1.00	0.00	0.00	0.00	0.00
November								
1	0.00	0.00	1.28	0.40	0.25	1.00	1.65	3.20
2	0.00	0.00	0.20	1.60	0.50	0.20	1.95	6.40
3	0.08	0.45	0.74	0.80	0.00	0.00	0.15	0.80
4	0.40	1.30	0.02	0.20	0.00	0.00	0.85	0.60
5	0.00	0.00	0.18	1.60	0.30	0.80	3.00	4.00
6	4.25	4.00	1.02	0.80	0.60	1.60	7.95	2.00
7	1.15	0.40	0.60	1.60	0.00	0.00	0.15	0.20
8	4.15	8.00	0.00	0.00	0.00	0.00	2.55	6.40
9	0.80	3.60	0.00	0.00	0.15	4.00	0.00	0.00
12	0.00	0.00	0.56	1.47	0.65	1.00	0.00	0.00
14	0.00	0.00	0.32	0.80	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	1.90	2.13	0.00	0.00
16	0.10	1.20	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00	0.90	3.20	0.00	0.00
19	5.50	2.14	0.00	0.00	0.70	0.80	0.00	0.00
20	1.05	1.60	0.00	0.00	1.35	4.00	0.00	0.00
21	0.00	0.00	0.00	0.00	0.20	0.40	0.00	0.00
22	0.00	0.00	0.00	0.00	3.00	6.00	0.00	0.00
23	0.00	0.00	2.20	2.00	0.00	0.00	0.00	0.00
24	0.65	0.60	0.00	0.00	1.10	1.60	0.00	0.00
25	0.00	0.00	0.00	0.00	4.40	1.60	0.00	0.00
26	0.00	0.00	0.00	0.00	0.15	1.20	0.00	0.00
27	0.00	0.00	0.00	0.00	1	2	0	0
28	0.00	0.00	0.00	0.00	0.15	0.27	0.00	0.00
29	0.00	0.00	0.00	0.00	1.00	0.60	0.00	0.00
30	0.00	0.00	0.00	0.00	5.75	8.00	0.00	0.00
December								
4	0.45	0.60	0.00	0.00	0.00	0.00	0.00	0.00
6	1.05	0.27	0.00	0.00	0.00	0.00	0.00	0.00
8	1.05	0.80	0.00	0.00	0.00	0.00	0.00	0.00
9	1.40	1.60	0.00	0.00	0.00	0.00	0.00	0.00
12	0.40	2.40	0.00	0.00	0.00	0.00	0.00	0.00
14	2.25	4.50	0.00	0.00	0.00	0.00	0.00	0.00
21	0.00	0.00	0.86	1.40	0.00	0.00	0.00	0.00
23	0.60	1.60	0.00	0.00	0.00	0.00	0.00	0.00

Daily Rainfall and its maximum intensity for Thiruvananthapuram, Cochin, Alappuzha for two consecutive years

	Thiruvananthapuram (1995)		Cochin (1996)		Alappuzha (1996)	
Date	Tot cm	Int cm/h	Tot cm	Int cm/h	Tot cm	Int cm/h
April						
4	0.07	0.06	0.00	0.00	0.15	0.13
5	0.03	0.03	0.26	0.25	2.79	1.76
6	3.04	2.47	0.39	0.32	0.00	0.00
7	0.08	0.06	1.88	1.88	0.18	0.11
8	1.90	1.88	0.00	0.00	0.00	0.00
9	1.38	1.38	2.79	2.20	7.20	6.60
10	0.44	0.44	0.00	0.00	0.00	0.00
12	0.00	0.00	0.10	0.10	0.00	0.00
13	0.00	0.00	0.00	0.00	0.38	0.27
14	0.00	0.00	0.00	0.00	1.00	1.00
15	0.00	0.00	0.00	0.00	0.65	0.58
17	0.00	0.00	1.88	1.50	1.25	1.04
18	1.67	1.07	0.00	0.00	0.00	0.00
20	0.04	0.03	1.10	1.10	0.11	0.06
21	0.00	0.00	0.00	0.00	0.11	0.09
23	0.00	0.00	0.61	0.61	0.00	0.00
24	5.27	3.00	0.00	0.00	0.52	0.50
25	0.00	0.00	0.11	0.11	0.53	0.53
26	0.30	0.30	0.13	0.10	1.94	0.96
28	0.00	0.00	0.43	0.43	0.04	0.04
29	0.02	0.02	0.00	0.00	0.00	0.00
30	1.75	1.47	0.00	0.00	0.05	0.05
May						
1	0.00	0.00	0.00	0.00	0.01	0.01
2	0.00	0.00	0.00	0.00	2.30	2.30
4	4.57	3.00	0.00	0.00	0.00	0.00
5	0.30	0.19	0.00	0.00	0.00	0.00
6	8.54	6.35	0.00	0.00	0.31	0.22
7	3.47	1.70	0.00	0.00	0.00	0.00
8	5.85	2.00	0.00	0.00	0.00	0.00
9	2.50	0.90	0.00	0.00	0.00	0.00
10	1.84	0.59	0.00	0.00	0.18	0.12
11	1.56	0.57	0.00	0.00	0.00	0.00
12	0.43	0.25	0.00	0.00	0.00	0.00
13	0.52	0.45	0.14	0.14	2.10	1.85
14	0.70	0.70	0.00	0.00	0.00	0.00
15	0.01	0.01	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	0.00	0.04	0.04
19	0.10	0.07	0.00	0.00	0.00	0.00
21	2.32	1.65	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00	0.85	0.36
25	0.00	0.00	0.64	0.64	0.00	0.00
26	0.00	0.00	0.00	0.00	0.11	0.11
27	0.00	0.00	0.06	0.03	2.15	2.15
28	0.00	0.00	0.00	0.00	0.22	0.09
29	0.05	0.04	1.06	0.70	0.27	0.15
30	0.00	0.00	0.46	0.33	1.10	1.10
31	1.25	0.90	0.69	0.40	0.75	0.70

June						
1	0.00	0.00	0.00	0.00	2.00	1.51
2	0.00	0.00	0.77	0.47	1.50	1.50
3	0.00	0.00	0.00	0.00	0.00	0.00
7	*0.40*	*0.22*	*0.14*	*0.07*	*0.12*	*0.12*
8	0.39	0.20	1.55	0.77	3.40	0.81
9	2.60	0.78	0.45	0.28	1.50	1.46
10	5.34	2.99	1.91	0.54	1.95	0.77
11	1.87	0.45	0.27	0.12	1.25	1.06
12	1.07	0.50	0.92	0.41	2.10	1.32
13	2.34	0.58	4.80	1.55	3.55	0.98
14	*0.92*	*0.38*	*5.38*	*1.34*	*5.46*	*1.64*
15	2.01	1.23	4.35	1.15	0.00	0.00
16	0.80	0.70	6.75	0.83	0.00	0.00
17	0.10	0.06	1.79	0.82	3.40	1.14
18	0.00	0.00	4.95	2.03	4.99	1.24
19	0.00	0.00	4.62	1.52	3.41	0.97
20	0.00	0.00	4.90	2.29	1.27	0.53
21	1.15	0.35	5.77	2.75	0.00	0.00
22	0.27	0.24	3.59	1.44	1.19	0.32
23	0.00	0.00	0.02	0.02	2.14	2.05
27	0.03	0.02	0.00	0.00	0.00	0.00
28	0.84	0.69	0.00	0.00	0.00	0.00
29	1.12	0.72	0.07	0.07	0.66	0.49
30	1.06	0.25	0.00	0.00	0.00	0.00
July						
1	0.18	0.13	0.00	0.00	0.00	0.00
5	0.02	0.02	0.34	0.22	0.09	0.05
6	0.41	0.40	2.36	1.70	3.00	1.00
7	0.13	0.08	1.62	1.25	0.26	0.18
8	1.33	1.15	5.70	1.80	2.90	1.13
9	1.23	0.52	3.24	1.05	1.37	0.46
10	1.10	0.51	4.78	1.30	3.94	0.96
11	0.41	0.29	1.76	0.55	1.78	1.06
12	0.08	0.17	3.07	0.75	4.70	2.53
13	0.00	0.00	1.15	1.05	0.66	0.25
14	0.00	0.00	0.96	0.21	1.02	0.53
15	0.00	0.00	1.52	0.87	1.97	0.70
16	2.80	1.40	3.94	1.32	0.21	0.10
17	0.00	0.00	1.28	0.60	0.12	0.10
18	0.00	0.00	2.65	1.11	2.67	1.15
19	0.32	0.26	6.48	1.88	3.85	0.67
20	0.02	0.01	2.18	0.59	1.77	0.50
21	0.00	0.00	7.21	1.35	0.32	0.17
22	0.00	0.00	4.85	1.13	2.99	0.96
23	0.00	0.00	0.49	0.30	4.03	2.54
24	0.07	0.07	2.83	0.62	3.02	1.65
25	3.68	1.20	3.59	0.76	3.25	0.68
26	0.00	0.00	1.85	0.71	1.90	0.72
27	0.45	0.33	0.37	0.2	1.43	0.43
28	0	0	0.42	0.32	1.15	0.59
29	0.23	0.08	1.25	0.53	2.37	0.6
30	2.02	0.67	0.64	0.25	0.52	0.47
31	0.05	0.03	0.68	0.51	0.38	0.28

August							
	1	0.00	0.00	1.88	0.80	1.46	0.67
	2	0.06	0.04	1.27	1.24	0.09	0.03
	3	0.00	0.00	0.03	0.03	0.18	0.18
	4	0.00	0.00	0.78	0.44	0.00	0.00
	5	0.12	0.05	1.82	1.20	0.06	0.06
	6	0.02	0.01	5.95	2.20	0.88	0.28
	7	0.35	0.17	0.21	0.14	1.16	0.96
	8	0.00	0.00	0.38	0.20	0.03	0.03
	9	0.03	0.03	0.85	0.35	0.14	0.05
	10	0.00	0.00	0.72	0.54	4.82	3.91
	11	0.00	0.00	1.55	0.58	2.53	1.05
	12	0.00	0.00	0.42	0.30	0.56	0.28
	13	0.00	0.00	1.38	0.43	0.54	0.37
	14	0.00	0.00	0.12	0.11	2.20	0.91
	15	0.23	0.15	6.83	2.35	1.82	0.38
	16	0.08	0.08	1.27	1.12	1.10	0.40
	17	0.00	0.00	0.18	0.07	2.71	1.38
	18	1.09	0.54	0.00	0.00	0.00	0.00
	19	0.02	0.02	0.00	0.00	0.20	0.15
	20	0.00	0.00	0.00	0.00	0.00	0.00
	21	0.33	0.25	0.03	0.03	0.07	0.07
	22	0.01	0.01	0.45	0.21	0.46	0.30
	23	0.00	0.00	3.52	1.58	4.46	1.62
	24	0.08	0.07	0.47	0.25	0.33	0.31
	25	0.20	0.20	2.33	0.96	0.32	0.09
	26	0.10	0.05	1.95	1.07	0.40	0.22
	27	0.88	0.47	0.83	0.55	0.45	0.4
	28	1.82	1.02	0.00	0.00	0.00	0.00
	29	1.14	0.62	0.66	0.42	0.59	0.25
	30	0.43	0.23	0.27	0.13	0.00	0.00
	31	0.57	0.22	0.00	0.00	0.00	0.00
September	r						
	1	0.52	0.26	0.09	0.09	0.10	0.06
	2	0.08	0.05	0.04	0.04	0.00	0.00
	3	0.27	0.12	0.17	0.11	2.63	1.73
	4	0.76	0.33	0.36	0.15	1.66	0.95
	5	0.14	0.08	0.48	0.46	0.19	0.09
	6	0.03	0.03	0.13	0.13	4.59	3.01
	7	0.00	0.00	0.32	0.17	2.79	0.87
	8	0.00	0.00	3.48	1.90	5.86	3.65
	9	0.00	0.00	1.54	1.47	1.51	1.47
	10	0.00	0.00	0.18	0.18	0.06	0.03
	11	0.00	0.00	1.51	0.72	6.89	1.87
	12	0.00	0.00	3.43	1.64	0.93	0.30
	13	0.00	0.00	1.19	0.26	3.39	3.14
	14	0.18	0.17	1.13	0.34	2.38	0.90
	15	0.06	0.02	1.45	0.60	1.01	0.77
	16	1.60	0.61	2.21	1.13	0.74	0.41
	17	2.66	1.30	3.38	0.13	0.99	0.33
	18	0.01	0.01	0.78	0.35	1.48	1.06
	19	0.00	0.00	1.81	0.48	0.59	0.40

20	0.20	0.12	0.21	0.11	1.03	0.30
21	2.40	0.73	0.00	0.00	0.50	0.37
22	0.03	0.02	0.00	0.00	1.24	0.95
26	0.00	0.00	0.52	0.48	0.57	0.27
27	0.00	0.00	5.78	1.25	5.84	1.20
28	0.02	0.02	8.62	2.07	4.76	1.72
29	0.00	0.00	0.12	0.05	0.00	0.00
30	0.00	0.00	0.13	0.10	0.10	0.09
October						
1	0.00	0.00	0.68	0.44	0.42	0.18
2	0.00	0.00	1.38	0.93	0.00	0.00
3	1.22	1.13	0.00	0.00	0.00	0.00
4	0.91	0.65	1.61	0.70	0.15	0.10
5	0.06	0.02	0.00	0.00	0.00	0.00
6	0.07	0.07	0.00	0.00	0.00	0.00
7	2.63	1.43	0.08	0.08	0.00	0.00
8	3.75	1.25	2.65	1.85	0.02	0.01
9	0.26	0.26	0.73	0.22	0.90	0.30
10	0.86	0.53	0.44	0.22	0.00	0.00
11	1.44	0.87	0.01	0.01	0.05	0.03
12	0.27	0.27	0.85	0.85	0.70	0.26
13	0.35	0.33	7.92	4.35	0.39	0.17
14	0.00	0.00	1.35	0.90	1.58	1.11
15	0.00	0.00	1.37	0.72	0.15	0.10
16	0.00	0.00	0.37	0.24	7.43	3.96
17	0.00	0.00	0.40	0.13	1.32	0.44
18	0.00	0.00	0.67	0.52	1.76	0.82
19	0.00	0.00	0.00	0.00	2.17	1.00
20	0.16	0.13	0.00	0.00	0.00	0.00
21	0.08	0.08	4.63	3.00	0.00	0.00
22	0.39	0.32	0.00	0.00	5.11	1.30
23	2.17	2.02	0.00	0.00	0.00	0.00
25	0.45	0.45	0.00	0.00	0.00	0.00
26	0.20	0.15	0.00	0.00	0.00	0.00
27	1.67	1.32	0.00	0.00	0.00	0.00
28	0.45	0.43	0.00	0.00	0.00	0.00
29	0.29	0.14	0.00	0.00	0.00	0.00
30	0.13	0.08	0.00	0.00	0.00	0.00
November						
1	0.04	0.03	0.00	0.00	0.00	0.00
2	0.37	0.30	0.03	0.03	0.00	0.00
3	2.55	1.17	1.10	0.64	0.00	0.00
4	0.49	0.13	0.00	0.00	1.44	0.60
5	1.96	0.91	0.00	0.00	0.00	0.00
7	0.47	0.40	0.00	0.00	0.00	0.00
8	0.10	0.10	0.00	0.00	0.29	0.27
9	0.06	0.04	0.00	0.00	0.00	0.00
11	0.00	0.00	0.02	0.02	5.26	3.04
12	3.18	1.07	0.97	0.78	1.28	0.82
13	0.43	0.30	0.00	0.00	0.00	0.00
14	8.06	7.05	0.00	0.00	0.00	0.00
15	3.95	2.45	0.00	0.00	1.07	1.02
17	0.01	0.01	0.00	0.00	0.00	0.00

	18	0.00	0.00	0.25	0.25	0.00	0.00
	19	0.00	0.00	0.10	0.01	0.03	0.03
	20	0.00	0.00	0.00	0.00	0.03	0.03
	21	0.08	0.08	0.00	0.00	3.59	2.48
	22	0.00	0.00	0.74	0.50	0.50	0.38
	23	0.12	0.12	0.04	0.04	0.86	0.37
	24	0.00	0.00	0.00	0.00	0.22	0.10
	25	0.00	0.00	0.10	0.04	0.21	0.15
	28	0.07	0.04	3.6	3.57	4.77	4.27
	29	0.07	0.04	0.00	0.00	0.00	0.00
	30	0.00	0.00	0.00	0.00	1.04	1.02
December							
	1	0.00	0.00	0.00	0.00	0.11	0.11
	7	0.00	0.00	0.00	0.00	0.35	0.15
	8	0.00	0.00	0.20	0.08	1.94	1.58
	9	0.00	0.00	0.00	0.00	0.06	0.06
	12	0.00	0.00	3.27	1.82	0.00	0.00
	13	0.00	0.00	1.94	1.30	1.46	1.17
	14	0.00	0.00	0.05	0.03	0.00	0.00
	15	0.00	0.00	0.27	0.16	0.80	0.77
	16	0.00	0.00	1.12	0.88	0.50	0.33
	18	0.00	0.00	0.00	0.00	0.70	0.69
	19	0.00	0.00	0.00	0.00	0.06	0.05

		(1994)		(1995)		(1995)	
April							
	4	2.23	2.20	0.46	0.40	0.55	0.18
	5	0.00	0.00	0.79	0.75	0.72	0.63
	6	0.53	0.40	0.49	0.49	0.02	0.01
	7	2.48	1.70	0.00	0.00	1.76	1.70
	8	0.00	0.00	0.00	0.00	0.41	0.28
	9	1.03	0.80	0.00	0.00	2.92	2.83
	10	0.00	0.00	0.25	0.25	0.00	0.00
	11	0.00	0.00	0.29	0.29	0.14	0.09
	12	0.42	0.36	0.05	0.04	0.05	0.05
	13	3.75	1.79	0.00	0.00	0.10	0.09
	16	0.01	0.01	0.00	0.00	0.00	0.00
	17	0.45	0.45	0.00	0.00	0.00	0.00
	18	0.00	0.00	2.23	1.26	0.03	0.03
	19	0.17	0.11	0.02	0.02	0.02	0.02
	20	0.00	0.00	0.71	0.69	0.00	0.00
	23	0.00	0.00	0.00	0.00	0.09	0.09
	24	0.01	0.01	0.46	0.46	1.21	1.18
	28	0.00	0.00	1.50	0.95	1.50	0.12
	29	0.18	0.13	0.00	0.00	0.00	0.00
	30	0.00	0.00	0.00	0.00	0.62	0.60
May							
	2	0.00	0.00	0.00	0.00	0.01	0.01
	4	0.00	0.00	0.51	0.38	0.24	0.15
	5	0.00	0.00	2.41	1.40	0.31	0.13

6	0.08	0.08	2.23	1.25	2.43	1.58
7	0.00	0.00	1.85	1.42	1.64	0.78
8	0.00	0.00	6.55	1.94	2.25	0.77
9	0.00	0.00	8.70	2.50	4.11	1.02
10	0.00	0.00	15.22	3.90	0.93	0.38
11	0.00	0.00	1.96	0.96	0.42	0.35
12	0.00	0.00	0.57	0.29	0.00	0.00
13	0.00	0.00	0.10	0.09	0.00	0.00
14	0.00	0.00	0.26	0.17	0.00	0.00
15	0.00	0.00	1.27	0.53	1.00	0.93
16	0.00	0.00	0.10	0.10	0.02	0.02
20	0.00	0.00	0.60	0.60	0.25	0.12
21	0.00	0.00	4.76	1.79	9.89	5.74
22	0.72	0.32	0.00	0.00	0.00	0.00
23	1.24	0.23	0.00	0.00	0.00	0.00
24	1.96	0.90	0.00	0.00	3.16	2.00
25	0.06	0.06	0.21	0.08	0.00	0.00
26	0.69	0.61	0.00	0.00	0.00	0.00
27	1.51	1.37	0.00	0.00	1.68	0.65
28	9.05	1.63	0.81	0.50	0.00	0.00
29	0.51	0.39	0.00	0.00	0.25	0.11
30	4.02	1.51	0.00	0.00	0.10	0.08
31	1.48	0.50	0.00	0.00	0.00	0.00
June						
1	1.61	0.47	0.00	0.00	0.00	0.00
2	2.49	1.06	0.00	0.00	0.09	0.09
3	0.12	0.10	0.00	0.00	0.00	0.00
4	1.80	0.65	0.00	0.00	0.00	0.00
5	0.52	0.21	0.00	0.00	0.03	0.03
6	4.94	2.13	0.00	0.00	0.00	0.00
7	0.28	0.08	0.00	0.00	1.75	0.90
8	1.83	1.14	0.00	0.00	0.26	0.10
9	2.06	0.44	2.23	1.05	0.67	0.30
10	0.61	0.12	6.25	1.50	5.48	1.91
11	2.33	0.97	1.37	0.58	0.99	0.35
12	0.02	0.02	4.49	0.90	3.85	1.54
13	0.00	0.00	9.54	2.28	5.88	1.35
14	0.03	0.02	6.12	1.34	5.05	1.05
15	1.44	0.37	2.37	1.03	1.38	0.85
16	0.40	0.28	1.56	0.35	9.31	2.20
17	1.17	0.95	0.23	0.18	0.97	0.72
18	0.00	0.00	0.00	0.00	0.25	0.11
19	0.00	0.00	0.05	0.05	0.00	0.00
20	0.00	0.00	0.30	0.30	5.12	2.58
21	0.00	0.00	3.37	1.60	1.24	0.65
22	0.00	0.00	0.22	0.13	0.62	0.37
23	0.00	0.00	0.24	0.14	0.94	0.70
24	0.01	0.01	0.00	0.00	0.00	0.00
25	0.17	0.17	0.25	0.20	0.00	0.00
26	0.02	0.01	3.64	2.33	0.90	0.81
27	0.00	0.00	1.88	1.20	0.31	0.18
28	0.12	0.05	5.35	1.15	0.20	0.11
29	0.51	0.26	3.07	0.93	1.60	0.76
30	0.03	0.03	9.43	2.30	12.76	2.00

July

1	0.00	0.00	0.85	0.29	0.18	0.08
2	0.22	0.07	0.00	0.00	0.00	0.00
3	0.40	0.27	0.00	0.00	0.00	0.00
4	0.13	0.10	0.00	0.00	0.81	0.67
5	0.00	0.00	2.95	0.73	1.09	0.26
6	0.05	0.05	7.90	2.86	4.22	1.78
7	0.00	0.00	1.10	0.56	0.69	0.25
8	0.00	0.00	1.59	0.56	1.76	0.73
9	0.00	0.00	2.97	1.03	3.99	1.17
10	0.00	0.00	5.07	1.35	4.99	0.49
11	0.00	0.00	1.67	0.64	1.32	1.01
12	0.64	0.38	2.53	1.23	1.86	0.57
13	0.11	0.08	0.35	0.31	0.16	0.15
14	3.23	1.00	0.26	0.14	0.48	0.26
15	0.78	0.38	0.00	0.00	0.01	0.01
16	4.37	1.55	2.44	0.57	3.76	1.00
17	0.31	0.17	0.06	0.02	0.13	0.07
18	0.00	0.00	1.16	0.70	0.06	0.03
19	4.45	1.72	0.33	0.33	1.52	1.15
20	0.03	0.03	0.20	0.19	1.46	1.00
21	1.04	0.90	0.02	0.02	0.05	0.02
22	0.28	0.27	0.00	0.00	0.00	0.00
23	0.00	0.00	6.62	4.15	0.10	0.08
24	0.11	0.11	0.52	0.32	0.52	0.42
25	0.22	0.22	1.18	0.46	0.97	0.32
26	0.28	0.11	0.00	0.00	0.00	0.00
27	1.68	1.06	0.8	0.31	1.02	0.32
28	1.57	.1	0.98	0.83	0.97	0.33
29	4.29	1.08	0.83	0.38	1.18	0.58
30	0.99	0.6	1.87	0.88	5.53	1.8
31	2.9	0.72	1.36	0.68	2.13	1.4

August

1	3.65	0.55	0.03	0.03	0.14	0.12
2	6.55	1.46	0.21	0.13	0.05	0.01
3	0.99	0.19	0.32	0.22	0.02	0.01
4	0.09	0.04	0.00	0.00	0.03	0.01
5	0.00	0.00	1.18	0.40	0.11	0.06
6	0.00	0.00	0.22	0.20	4.53	2.53
7	0.00	0.00	1.36	0.54	0.93	0.38
8	0.00	0.00	1.00	0.50	0.03	0.01
9	0.23	0.14	1.75	0.95	0.00	0.00
10	0.00	0.00	0.33	0.15	0.00	0.00
12	0.00	0.00	4.13	1.62	0.25	0.23
14	0.00	0.00	0.00	0.00	1.78	0.77
15	0.00	0.00	0.00	0.00	0.17	0.10
16	0.00	0.00	0.96	0.80	0.54	0.40
17	0.30	0.28	0.08	0.04	0.26	0.14
18	0.46	0.33	4.34	2.30	2.02	0.76
19	0.04	0.02	7.29	3.27	3.22	1.25
20	0.18	0.18	0.11	0.11	0.03	0.01
21	0.00	0.00	0.55	0.47	4.74	2.12
22	0.00	0.00	0.05	0.03	0.16	0.06
23	0.00	0.00	1.59	0.93	2.64	1.01

24	0.00	0.00	0.02	0.02	0.05	0.04
25	0.76	0.17	1.62	0.54	2.46	0.85
26	0.00	0.00	3.61	0.54	2.88	0.66
27	0.26	0.14	0.00	0.00	4.44	1.01
28	0.47	0.46	6.62	1.85	2.21	0.65
29	0.12	0.12	0.00	0.00	2.00	0.94
30	0.34	0.24	3.85	0.76	0.32	0.22
31	1.74	0.46	2.44	0.88	3.32	1.29
September						
1	1.51	1.00	2.05	0.97	1.44	0.64
2	1.16	0.33	0.28	0.28	0.02	0.02
3	0.28	0.19	0.05	0.05	1.04	0.79
4	0.48	0.38	0.31	0.18	0.45	0.18
5	0.34	0.25	1.45	0.42	0.62	0.56
6	2.41	0.52	3.37	0.81	0.15	0.09
7	0.00	0.00	0.00	0.00	0.04	0.02
8	0.08	0.08	0.00	0.00	0.05	0.04
13	0.00	0.00	0.24	0.21	0.47	0.26
14	0.00	0.00	0.53	0.30	0.09	0.07
15	0.15	0.15	0.78	0.38	1.05	0.47
16	0.01	0.01	2.61	0.54	8.88	3.05
17	0.80	0.52	5.84	2.60	5.17	2.95
18	0.02	0.02	2.39	1.15	1.68	0.53
19	0.02	0.02	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.85	0.32
21	0.00	0.00	7.34	3.60	0.70	0.20
22	0.00	0.00	1.49	0.90	1.17	0.60
23	0.32	0.32	0.00	0.00	0.00	0.00
24	0.00	0.00	0.05	0.02	0.07	0.05
25	0.00	0.00	0.00	0.00	0.06	0.05
26	0.00	0.00	0.02	0.02	0.10	0.04
28	0.10	0.10	1.13	1.00	0.02	0.01
29	0.53	0.31	0.00	0.00	0.00	0.00
30	0.84	0.30	0.05	0.05	0.00	0.00
October						
1	0.00	0.00	0.00	0.00	2.32	2.13
2	0.02	0.20	0.00	0.00	0.02	0.02
3	1.97	1.36	0.82	0.40	0.05	0.03
4	3.26	0.80	0.00	0.00	0.02	0.01
5	8.85	3.05	1.30	1.30	0.99	0.65
6	2.42	0.63	0.90	0.87	0.22	0.16
7	0.00	0.00	2.25	1.30	1.04	1.02
8	0.00	0.00	1.78	0.57	3.30	1.13
9	0.00	0.00	1.37	1.00	2.22	1.79
10	0.02	0.02	0.34	0.30	0.55	0.41
11	2.16	1.40	2.45	0.93	2.87	1.27
12	0.00	0.00	0.09	0.09	0.00	0.00
14	0.02	0.01	0.00	0.00	0.00	0.00
15	9.07	5.50	2.92	2.00	0.00	0.00
16	0.64	0.20	0.07	0.07	0.00	0.00
17	0.05	0.03	0.00	0.00	0.00	0.00
18	0.02	0.02	0.00	0.00	0.04	0.02
19	0.00	0.00	1.65	1.20	0.92	0.87
20	0.00	0.00	0.53	0.53	0.09	0.08

	21	1.01	1.00	0.02	0.02	2.55	2.49
	22	0.42	0.38	0.79	0.35	1.24	0.58
	23	0.00	0.00	0.00	0.00	0.41	0.38
	24	0.00	0.00	0.00	0.00	0.04	0.04
	25	0.10	0.10	0.00	0.00	0.25	0.24
	26	3.01	1.74	3.42	2.42	0.00	0.00
	28	0.41	0.20	6.04	3.30	0.69	0.43
	29	0.76	0.43	0.00	0.00	1.07	0.78
	30	0.02	0.02	0.52	0.25	1.68	1.50
	31	5.66	0.95	0.94	0.57	0.31	0.29
November							
	1	1.59	0.30	7.65	5.00	1.52	0.81
	2	0.00	0.00	5.83	4.48	0.24	0.12
	3	0.02	0.02	2.44	1.44	0.64	0.28
	4	0.27	0.10	0.43	0.24	0.00	0.00
	5	0.60	0.22	1.11	0.55	0.61	0.23
	6	0.09	0.07	0.04	0.04	0.05	0.03
	7	0.00	0.00	0.00	0.00	0.03	0.03
	8	0.03	0.02	0.00	0.00	0.70	0.51
	9	0.00	0.00	0.15	0.02	0.03	0.01
	10	0.00	0.00	0.00	0.00	0.01	0.01
	11	0.54	0.52	0.00	0.00	0.00	0.00
	12	1.17	0.32	0.00	0.00	0.00	0.00
	13	0.00	0.00	0.14	0.14	0.00	0.00
	14	0.00	0.00	0.29	0.29	1.40	1.40
	15	0.00	0.00	0.00	0.00	1.06	0.56
	17	0.00	0.00	0.10	0.09	3.46	2.85
	20	0.20	0.20	0.00	0.00	0.00	0.00
	22	0.00	0.00	0.00	0.00	0.08	0.08
	23	0.00	0.00	0.14	0.14	0.04	0.02
	26	0.03	0.03	0.00	0.00	0.00	0.00
	27	1.00	0.58	0.00	0.00	0.00	0.00
	28	0.02	0.02	0.00	0.00	0.00	0.00
	29	0.00	0.00	0.00	0.00	0.04	0.04
	30	2.12	1.86	0.00	0.00	0.00	0.00
December							
	1	0.68	0.58	0.00	0.00	0.00	0.00

Appendix III

Correlation between EI_{30} and EI_{1440} values for Kadiyangadu for the year 1986

	Date	Xi	Yi	Xi^2	Yi^2	Xi Yi
Jan						
	14	3.3706	0.0873	11.3609	0.0076	0.2943
	15	14.6946	0.1976	215.9304	0.0390	2.9030
Mar						
	15	0.6484	0.0390	0.4204	0.0015	0.0253
	16	0.3225	0.0263	0.1040	0.0007	0.0085
	20	33.5094	0.3114	1122.8785	0.0970	10.4358
	29	0.1204	0.0143	0.0145	0.0002	0.0017
Jun						
	3	0.0061	0.0025	0.0000	0.0000	0.0000
	5	7.3988	0.2118	54.7499	0.0449	1.5671
	6	0.3175	0.0357	0.1008	0.0013	0.0113
	10	0.1613	0.0168	0.0260	0.0003	0.0027
	11	1.8942	0.1047	3.5881	0.0110	0.1983
	12	3.0400	0.0941	9.2413	0.0089	0.2860
	13	2.9282	0.0777	8.5746	0.0060	0.2274
	14	76.8800	0.9819	5910.5298	0.9642	75.4900
	15	5.5769	0.1655	31.1023	0.0274	0.9228
	16	29.7500	0.4114	885.0613	0.1692	12.2382
	17	12.8561	0.1861	165.2796	0.0346	2.3928
	18	31.5088	0.5876	992.8038	0.3453	18.5154
	19	39.3231	0.6386	1546.3038	0.4079	25.1132
	20	4.4802	0.1208	20.0722	0.0146	0.5410
	21	35.8644	0.5850	1286.2523	0.3422	20.9795
	22	34.3051	0.8134	1176.8392	0.6616	27.9024
	23	43.6555	0.7267	1905.7983	0.5281	31.7242
	24	80.7839	0.9154	6526.0353	0.8380	73.9501
	25	8.5545	0.2086	79.1791	0.0435	1.7845
	26	26.3697	0.4786	695.3606	0.2291	12.6208
	27	11.4161	0.4369	130.3262	0.1909	4.9878
	29	22.9866	0.5315	528.3847	0.2825	12.2176
Jul						
	4	3.1126	0.1136	9.6880	0.0129	0.3536
	7	0.1204	0.0143	0.0145	0.0002	0.0017
	8	1.8390	0.0869	8.3818	0.0076	0.1599
	10	0.2525	0.0328	0.0637	0.0011	0.0083
	11	1.0409	0.0723	1.0834	0.0052	0.0752
	12	72.2596	1.2041	5221.4527	1.4497	87.0043
	13	24.4050	0.5701	595.6016	0.3250	13.9127
	15	6.3389	0.2593	40.1813	0.0672	1.6438
	16	0.0296	0.1095	0.0009	0.0120	0.0032
	19	4.2916	0.0099	18.4181	0.0001	0.0424
	20	4.0936	0.3581	16.7577	0.1282	1.4660
	21	2.1854	0.0824	4.7759	0.0068	0.1801
	22	2.4320	0.1238	5.9146	0.0153	0.3010

Date	Xi	Yi	X_i^2	Y_i^2	Xi Yi
Sep					
5	5.1819	0.1399	26.8517	0.0196	0.7249
6	0.3237	0.0245	0.1047	0.0006	0.0079
10	0.2629	0.0219	0.0691	0.0005	0.0058
14	0.3651	0.0273	0.1333	0.0007	0.0100
15	4.3565	0.0381	18.9795	0.0015	0.1662
18	2.4444	0.1037	5.9752	0.0108	0.2536
19	44.9586	0.4920	2021.2712	0.2421	22.1210
20	6.0067	0.1990	36.0801	0.0396	1.1955
21	58.5650	0.7037	3429.9014	0.4952	41.2117
23	0.0350	0.0073	0.0012	0.0001	0.0003
24	31.0563	0.4067	964.4944	0.1654	12.6300
25	1.3500	0.0768	1.8224	0.0059	0.1036
26	0.8035	0.0482	0.6456	0.0023	0.0387
Aug					
1	6.6005	0.1457	43.5669	0.0212	0.9618
4	33.7160	0.8284	1136.7660	0.6863	27.9319
5	6.0581	0.2840	36.7000	0.0806	1.7206
6	49.5300	1.0291	2453.5131	1.0591	50.9766
7	11.6133	0.3239	134.8685	0.1049	3.7611
8	50.6347	0.6487	2563.8749	0.4208	32.8474
9	9.5675	0.3022	91.5368	0.0913	2.8913
11	4.3444	0.1725	18.8739	0.0298	0.7496
13	5.4042	0.1595	29.2055	0.0255	0.8622
14	1.2913	0.1153	1.6675	0.0133	0.1489
15	10.6485	0.2300	113.3906	0.0529	2.4496
16	0.7962	0.0723	0.6339	0.0052	0.0576
24	2.9611	0.1526	8.7681	0.0233	0.4518
Oct					
4	0.7598	0.0521	0.5773	0.0027	0.0396
Total	1004.7592	18.8497	42368.9249	10.9300	646.8131

Correlation coefficient.

$$r = \frac{\Sigma x_i y_i - \Sigma x_i \, . \, \Sigma y_i / n}{\sqrt{(\Sigma x_i^2 - (\Sigma x_i)^2/n)(\Sigma y_i^2 - (\Sigma y_i)^2/n)}}$$

$$= 0.935$$

ANALYSIS OF EROSIVITY INDICES WITH SPECIAL REFERENCE TO KERALA

BY

GEETHA. V.
PRABHADEVI. P. S.
SUDHEER NARAYANAN

ABSTRACT OF THE PROJECT REPORT

Submitted in partial fulfilment of the requirement for the degree

BACHELOR OF TECHNOLOGY
in
AGRICULTURAL ENGINEERING

Faculty of Agricultural Engineering & Technology
KERALA AGRICULTURAL UNIVERSITY

Department of Land & Water Resources Conservation Engineering
KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY
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1997

ABSTRACT

USLE is a unique tool for estimating soil loss. Factor 'R' in the USLE is an erosion index which is one hundredth of the product of the kinetic energy of rain storm and its 30 minute intensity. Computation of erosion index invariably requires the data of self recording rain gauges, because of the non availability of these data and cumbersome work involved in the analysis of this data, some alternatives are necessary. In this work, daily rainfall chart of automatic rain gauge were collected for Kozhikkode district for two consecutive years. Data were analyzed for computing EI_{30} and EI_{1440} using the procedure suggested by Reghunath and Erasmus (1971). The correlation coefficient of 0.9297 shows a significant positive correlation between these values and so EI_{1440} values were calculated for the 7 locations of Kerala from daily rainfall data and maximum intensity. These data were then analyzed for computing EI_{1440} and PI_{1440} and model was developed between EI_{1440} and PI_{1440} values. By using this model, EI_{1440} values were found for varying amount of rainfall ranging from 1 to 20 cm as a ready reckner for stations under study. The model developed is useful for quick computation of erosion index from daily rainfall data for the 7 districts under study.