trotz entwicklungsbedingter und finanzieller Schwierigkeiten wirtschaftlich erreicht hat, noch wesentlich weiter ausgebaut und krisenfester gestaltet werden.

A METHOD OF PLOTTING TWO VARIABLES (SUCH AS MEAN INCIDENCE AND VARIABILITY FROM YEAR TO YEAR) ON THE SAME MAP, USING ISOPLETHS*).

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with 8 Figures

Eine Methode der gleichzeitigen Darstellung von zwei veränderlichen Größen — z. B. des Mittelwertes und der Schwankungen von Jahr zu Jahr mit Hilfe von Isoplethen auf einer einzigen Karte.

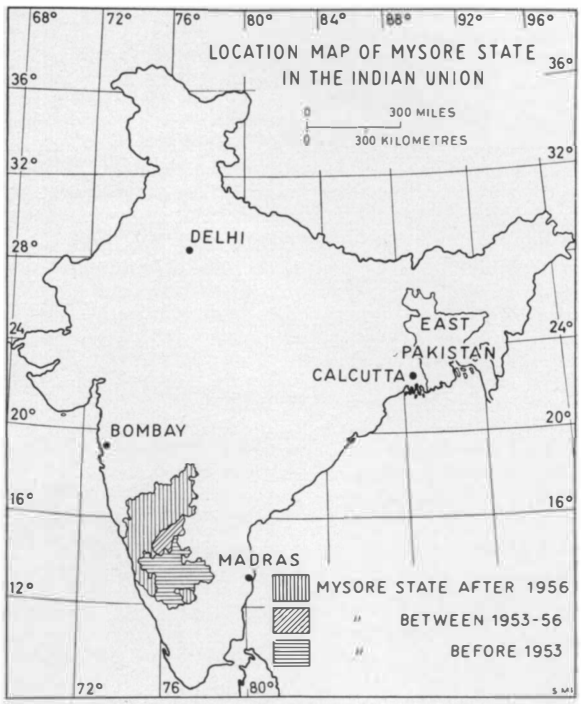
Zusammenfassung: Ein früherer Aufsatz beschrieb eine Methode der kombinierten Darstellung von zwei gegenseitig abhängigen Variablen auf einer Choroplethenkarte; diese Methode wurde inzwischen vom Regional Survey Unit des Indian Statistical Institute für Anwendung auf einer Isoplethenkarte mit zwei Variablen modifiziert.

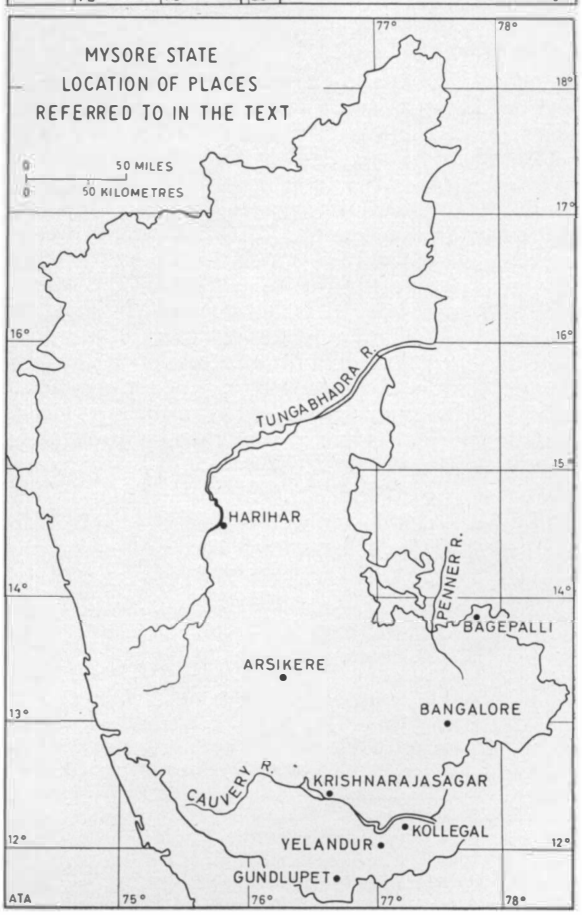
Die Methode wird an drei Beispielen vorgeführt:

1. Abbildung 1a und 1b vergleichen eine Choroplethen- und eine Isoplethenkarte der durchschnittlichen Cholera Todesfälle und deren Schwankungen von Jahr zu Jahr für die 82 „talukas" (untere Verwaltungseinheiten) des ehemaligen Staates Mysore. Wie auch in allen anderen Beispielen wurde die Wahl der Schraffierungsart nach einer vorangegangenen Prüfung der Frequenz und einer etwaigen auffallenden räumlichen Verteilung getroffen. Die Höhe der Todesfälle wird durch Dichte der Schraffierung und Stärke der Linien, das Ausmaß der Schwankung durch die Richtung der Schraffierung dargestellt. Die Isolinien wurden in der gebräuchlichen Weise von in den geometrischen Mittelpunkt jeder Verwaltungseinheit gesetzten „Höhenzahlen" interpoliert. Die gewählte Maßeinheit der Schwankung hing von der Untersuchung ab; in diesem Fall war es die absolute durchschnittliche Abweichung (ausgedrückt in %) im Verhältnis zur durchschnittlichen Zahl der Todesfälle.

Beide Karten sind aufschlußreich, indem sie den Kontrast zwischen endemischen Gebieten mit einer relativ konstanten Zahl der Todesfälle und den epidemischen Gebieten mit großen Schwankungen in deren Zahl aufzeigen. Die Choroplethenkarte ist „ehrlicher", indem aus ihr deutlich zu entnehmen ist, auf welche Raumeinheiten sich die Zahlen beziehen. Die Isoplethenkarte hat den Vorteil, daß sie räumliche Tendenzen in einer fast dreidimensionalen Weise aufzeigt. Im Anschluß an die Karten wird der Versuch unternommen, die durch sie aufgedeckten Verteilungsmuster zu interpretieren.

2. Abbildung 2a und 2b sind zwei Karten einer Reihe, die das Monatsmittel des Niederschlages und dessen Schwankung über eine Dreißig-Jahr-Periode zeigen. Als Maßeinheit für die Abweichung wurde der Prozentsatz des Quartal-Zwischenraumes, d. h. die Hälfte der Entfernung zwischen dem oberen und unteren Quartal, im Verhältnis





*) Acknowledgement: The work on wich this paper is based was carried out as part of a pilot project in regional survey for planning in Southern India by the Indian Statistical Institute. Permission to use the material has kindly been granted the Director of the Institute, Professor p. c. Mahalanobis, F R S

zum durchschnittlichen Niederschlag an jeder der 145 verwendeten Beobachtungsstationen gewählt. Die Kartenreihe als solche wurde für eine vorläufige Festlegung der Gebiete mit unterschiedlichem Niederschlagscharakter verwendet. Es wird die Hoffnung ausgesprochen, daß sie die Forderung nach der Erstellung von Karten anregen möge, die den Feuchtigkeitsbedarf bestimmter Feldfrüchte im Jahreslauf zeigen, so daß allgemeine Schlüsse gezogen werden können, in welchen Gebieten zum Anbau einer bestimmten Feldfrucht durch Organe der Landwirtschaftsausbildung und -beratung angeraten werden soll.

3. Abbildung 3 ist eine Karte, die den durchschnittlichen Ertrag von „ragi" *(eleusine corocana)* und die Abweichungen vom Durchschnitt zeigt. Sie beruht auf in ausgewählten Dörfern entnommenen Beispielen, wobei die Dörfer nach talukas im ehemaligen Staat Mysore gruppiert sind. Als Maßstab für die Abweichung wurde in diesem Fall die durchschnittliche absolute Abweichung im wertmäßigen Ertrag gewählt. Diese Karte ergab den äußerst interessanten Hinweis, daß im zentralen Gebiet des marktwirtschaftlichen Anbaus die Erträge gleichmäßig, aber ziemlich niedrig sind, während in den Randgebieten eine Tendenz zu hohen jedoch schwankenden Erträgen besteht.

A method of plotting two variables on the same choropleth map has already been described[1]). Recently some work has been done on regional patterns involving two variables at the Regional Survey Unit of the Indian Statistical Institute. Under this stimulus a refinement has been introduced, namely isopleth maps showing two variables.

Method: The data studiedconcerned the new Mysore State or Karnataka, as it is since the reorganisation of the States in the Republic of India on 1st November 1956[2]). The data were mainly for the administrative units known as talukas in South India, of approximately 1000 square kilometres in area. There are 169 talukas in the new State. Certain data, however, including those used for figures 1a, 1b and 3, could be obtained only for the 82 talukas of the former State of Mysore less Bellary District which joined the State in 1953. The figure for say average mortality from cholera was plotted for each taluka on a map of Mysore State, a dot placed by eye at the geometric centre of each taluka being conventionally regarded as a 'spot-height'. Isopleths were then interpolated by the usual conventions[3]). The choice of isopleths was reached as follows: —

The data on cholera mortality are arranged in order of magnitude and examined for any significant groupings in the ordered values. Keeping in view that of three roughly equal classes (in number of talukas) are to be formed, we have tried to determine the boundary value of two adjacent classes without breaking any significant grouping in ordered values. The measure of variability is the percentage of the mean absolute deviation in relation to the mean mortality rate. Percentage variability much higher than 100 suggests high epidemicity, and that much less than 100, endemicity of the disease. Thus values around 100 per cent (90 to 110 per cent) are regarded as a class. The remaining values on either side may be further classified if there is any significant grouping. Thus in the cholera data three classes of mean mortality and four classes of variability are obtained (See fig 1a for isopleth values). On superimposing the two sets of isopleths, a twelve-fold classification is obtained involving two variables. For the sake of comparability the same boundary values of classes are used in the corresponding choropleth map. (See fig 1b).

As in the choropleth maps already referred to, shadings were applied, the closer and thicker shading for the heavier mean mortality while vertical direction of shading was used for very high (or high) variability, horizontal shading for low variability and oblique shading (or shadings) for intermediate grade (or grades). Similarly again, it is possible to distinguish for example between areas of high but fluctuating mortality (epidemic areas) and areas of constantly high mortality (areas of severely endemic conditions).

Assessment of figure 1a, an isopleth map of cholera mortality and figure 1b, a choropleth map of cholera mortality, both for Old Mysore State for the period (1932—1954[4]).

The two maps naturally bear a strong resemblance since the data are identical except for the final stage. The choropleth is the franker in declaring that it is plotted according to administrative units. While the isopleth conceals this from the casual reader, the depiction of spatial trends is superior. It is easier to visualise the fluctuations in yearly incidence when they are presented in broad patterns.

Thus in figure 1a, there is mortality suggestive of low endemicity in the east-central area around Bangalore City (low mortality with low variability). In contrast there is relatively severe epidemicity in the extreme north and south (high mortality with high or very high variability). The tendency to epidemics in the north around Harihar may be partly related to the existence of Tungabhadra river and alluvial plains and partly to the big and long-lasting annual fairs, like Sangameswara Jatra and Basavannadevaru Jatra, held in and near Harihar town in the month of March and extending up to the first or second week of April. By then there is appreciable amount of pre-monsoon rainfall — making the climate humid — a favourable condition for the spread of cholera. Epidemicity is also present in Gundlupet and Yelandur talukas in the south; this may be related

[1]) A.T.A. LEARMONTH, 1952: Regional differences in natality and in mortality in the sub-continent of Indo-Pakistan 1921-40, Proceedings of the 8th General Assembly and 17th International Congress, International Geographical Union, Washington, 1952, 195-205.

A.T.A. LEARMONTH:, 1954: A method of plotting on the same map health data on both intensity and variability of incidence, illustrated by three-maps of cholera in Indo-Pakistan. Liverpool Annals of Tropical Medicine and Parasitology, 48, 345-8.

[2]) The new State comprises the whole of the former State of Mysore, the whole of Coorg, and parts of Hyderabad, Madras and Bombay.

[3]) MACKAY, J. R., - 1951: - Some problems and techniques in isopleth mapping, Economic Geography 27, 1-9.

[4]) Unfortunately there are gaps in the available data for eight of the years, but the principle is not effected.

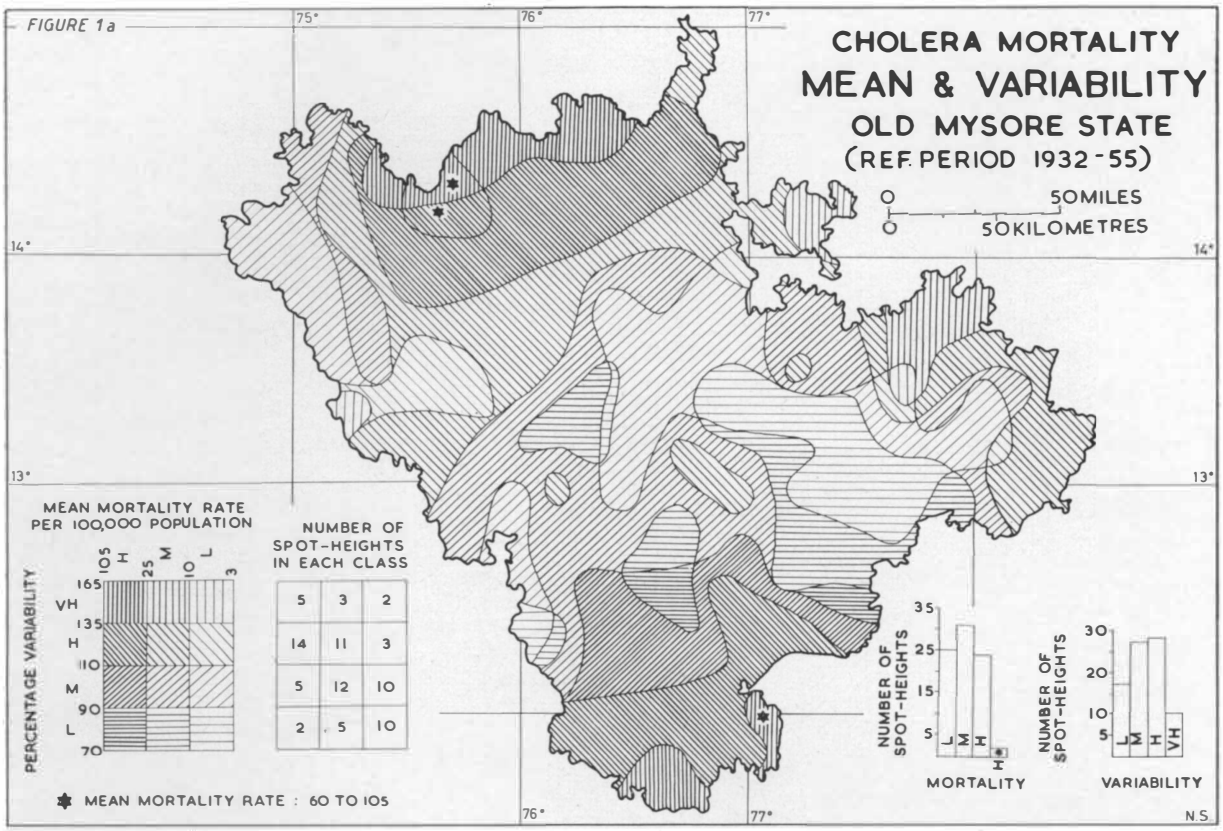


FIGURE 1a
CHOLERA MORTALITY
MEAN & VARIABILITY
OLD MYSORE STATE
(REF. PERIOD 1932-55)
50 MILES
50 KILOMETRES
75°
76°
77°
14°
13°
MEAN MORTALITY RATE PER 100,000 POPULATION
PERCENTAGE VARIABILITY
105 H 25 M 10 L 3
165 VH 135 H 110 M 90 L 70
NUMBER OF SPOT-HEIGHTS IN EACH CLASS
5 3 2
14 11 3
5 12 10
2 5 10
MEAN MORTALITY RATE : 60 TO 105
NUMBER OF SPOT-HEIGHTS
L M H H
MORTALITY
NUMBER OF SPOT-HEIGHTS
L M H VH
VARIABILITY
N.S.

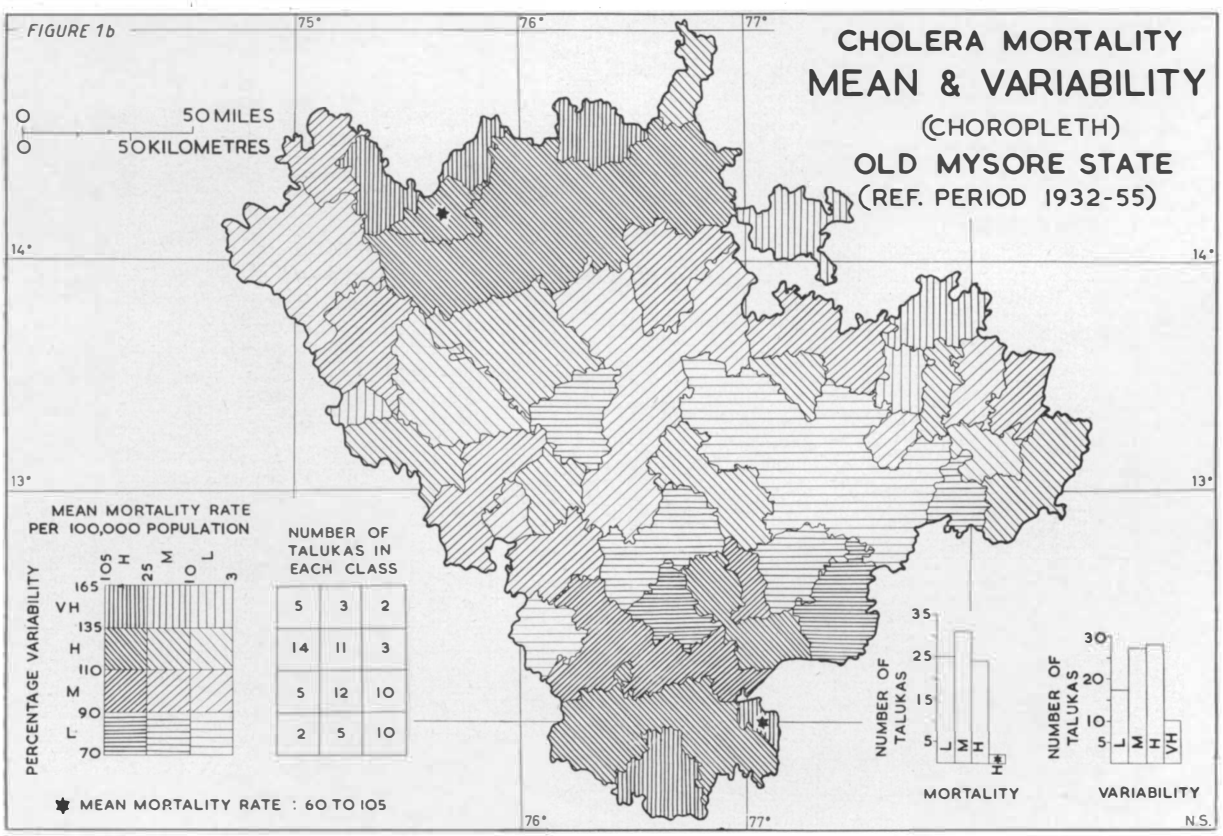
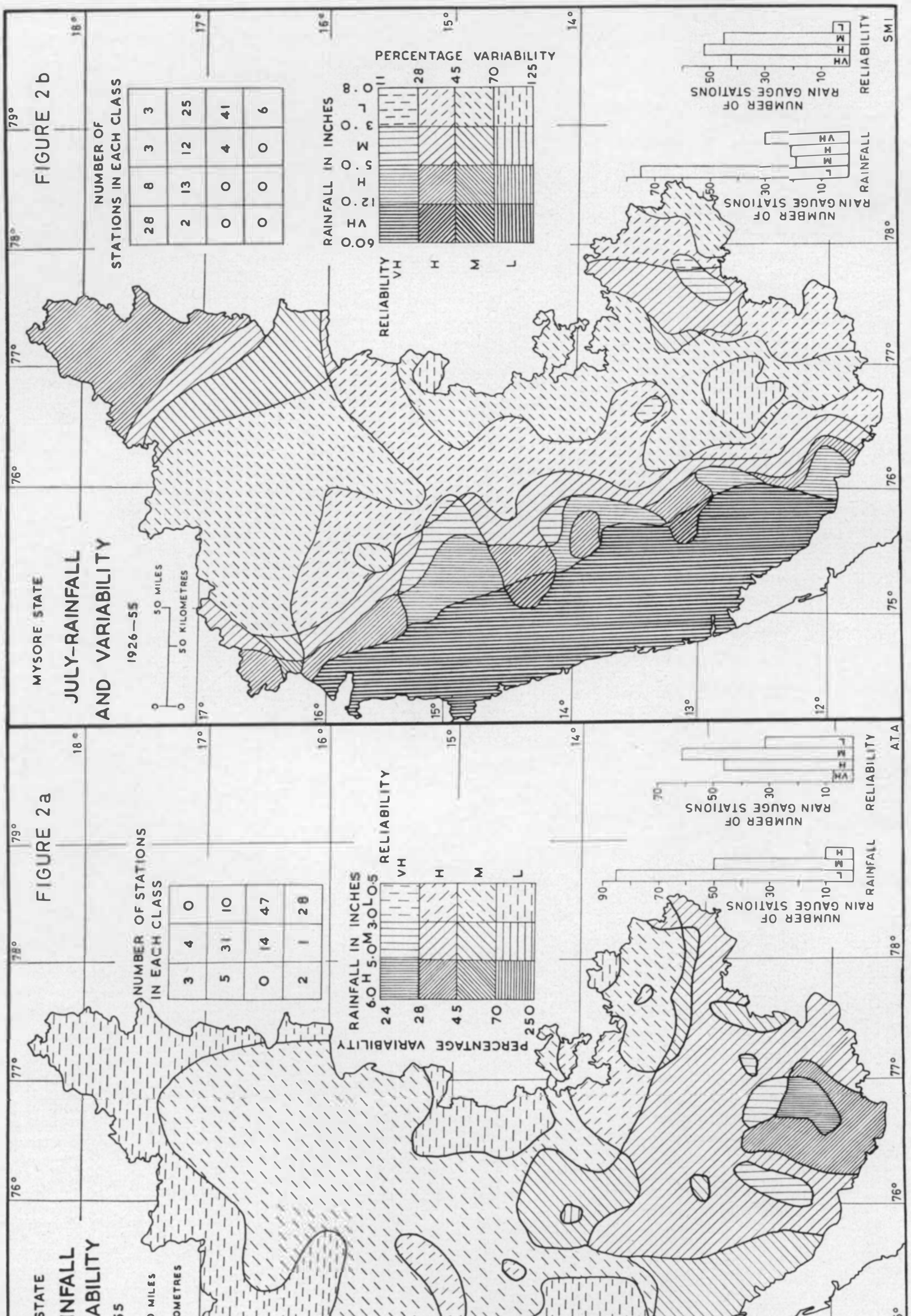


FIGURE 1b
CHOLERA MORTALITY
MEAN & VARIABILITY
(CHOROPLETH)
OLD MYSORE STATE
(REF. PERIOD 1932-55)
50 MILES
50 KILOMETRES
75°
76°
77°
14°
13°
MEAN MORTALITY RATE PER 100,000 POPULATION
PERCENTAGE VARIABILITY
105 H 25 M 10 L 3
165 VH 135 H 110 M 90 L 70
NUMBER OF TALUKAS IN EACH CLASS
5 3 2
14 11 3
5 12 10
2 5 10
MEAN MORTALITY RATE : 60 TO 105
NUMBER OF TALUKAS
L M H H
MORTALITY
NUMBER OF TALUKAS
L M H VH
VARIABILITY
N.S.


MYSORE STATE
MAY-RAINFALL AND VARIABILITY
1926-55
FIGURE 2a
NUMBER OF STATIONS IN EACH CLASS
RAINFALL IN INCHES
PERCENTAGE VARIABILITY
RELIABILITY
NUMBER OF RAIN GAUGE STATIONS
RAINFALL
RELIABILITY
MYSORE STATE
JULY-RAINFALL AND VARIABILITY
1926-55
FIGURE 2b
NUMBER OF STATIONS IN EACH CLASS
PERCENTAGE VARIABILITY
RAINFALL IN INCHES
RELIABILITY
NUMBER OF RAIN GAUGE STATIONS
RAINFALL
RELIABILITY

to of the Mahadeswara Jatra (fair) near the town of Kollegal. Very high variability or more epidemicity is also observed in the extreme north-east, though the mortality is medium there. This may partly be related to the existence of the Penner river there and partly to the big fair, Gadidam Venkataramanaswamy Jatra along with others, held sometimes at the beginning of the monsoon in Bagepalli taluka. The area just to the north-east of Krishnaraja Sagar (a big irrigation reservoir on the Cauvery near Mysore) shows high to medium mortality but of endemic nature which is evidently related to the canal irrigation. The medium cholera mortality which is of endemic nature around Arsikere town may be related to scarcity of water, especially in Arsikere town where population growth was very high in this period. It is also believed locally that cholera is related to the picking season for mangoes *(mangifera indica)*; flies including the house-fly *musca domestica* are numerous with the first rains, and they may carry the pathogen from infected stools to the juicy fruit which are commonly exposed cut into dice in rural houses and markets. Similarly with jack-fruit *(artocarpus integrifolia)* which is too large to be sold as a whole, and is exposed broken in manageable pieces. The mortality rate falls off rapidly to the west in the northern part of the Malnad (hilly tract) which may partly be related to a dispersed settlement pattern along cleared ribbons of valley-bottom rice-land among the forested hills; each household tends to have its own well, and risk of pollution is small[5]).

The isopleth can of course be modified if there is enough local knowledge available for the whole area studied, to allow working rules to be set forth e. g. if the incidence of cholera within talukas is well enough known to apportion the mortality say on a basis of 75 per cent to areas within a certain distance of a water-course, and 25 per cent to all the remaining area. This has not been attempted in any of our maps of Mysore.

A rainfall map showing both median monthly incidence and variability from year to year for the 30 Years 1926—1955.

Figures 2a and 2b are two of a series of maps drawn in the course of a rainfall study aimed at identifying the rainfall regions of Mysore State particularly with reference to amount, seasonal incidence and variability. The methods employed so far have been very similar to those described in respect of cholera. The measure of variability chosen here was the percentage of the quartile interval (half the difference between the upper and the lower quartile) in relation to the median rainfall for a particular rainfall station. The intervals selected in drawing isopleths for both variables were chosen in relation to a series of monthly maps in order to secure comparability. The reference points are of course the 145 rainfall stations for which records were available for the period, and the question of a choropleth map does not arise. The maps have proved satisfactory for preliminary and over-all studies. It is hoped that they may stimulate a demand for ad hoc maps, related to the moisture requirements of a particular crop through the seasons, so that a broad view may be obtained of the area in which the growing of that crop might be encouraged by the agricultural extension (educational and advisory) workers. For instance the May peak of rainfall is not utilised for unirrigated crops over most of south-eastern Mysore; by far the greater part of the crops are grown relying on the September or October peak. Yet a village near Bangalore was found to be using the May peak, for three-month unirrigated crop of potatoes and of pulse in alternate years, the slight

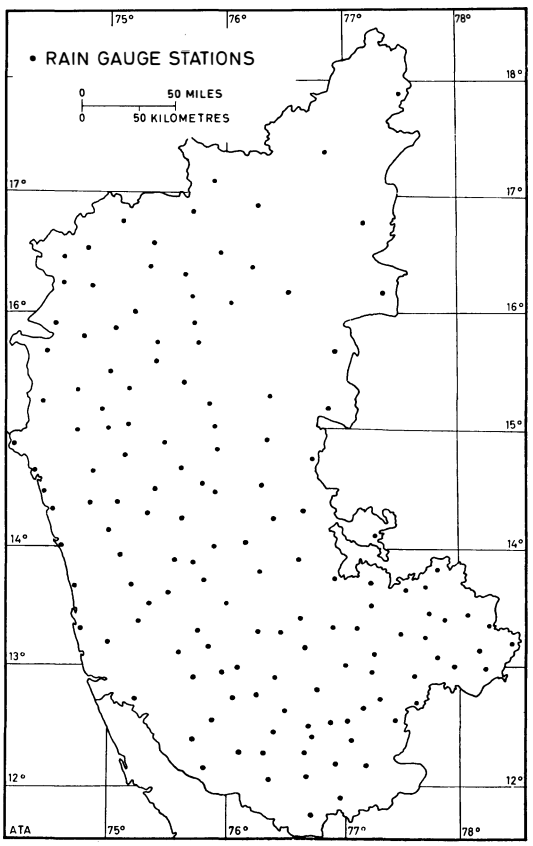


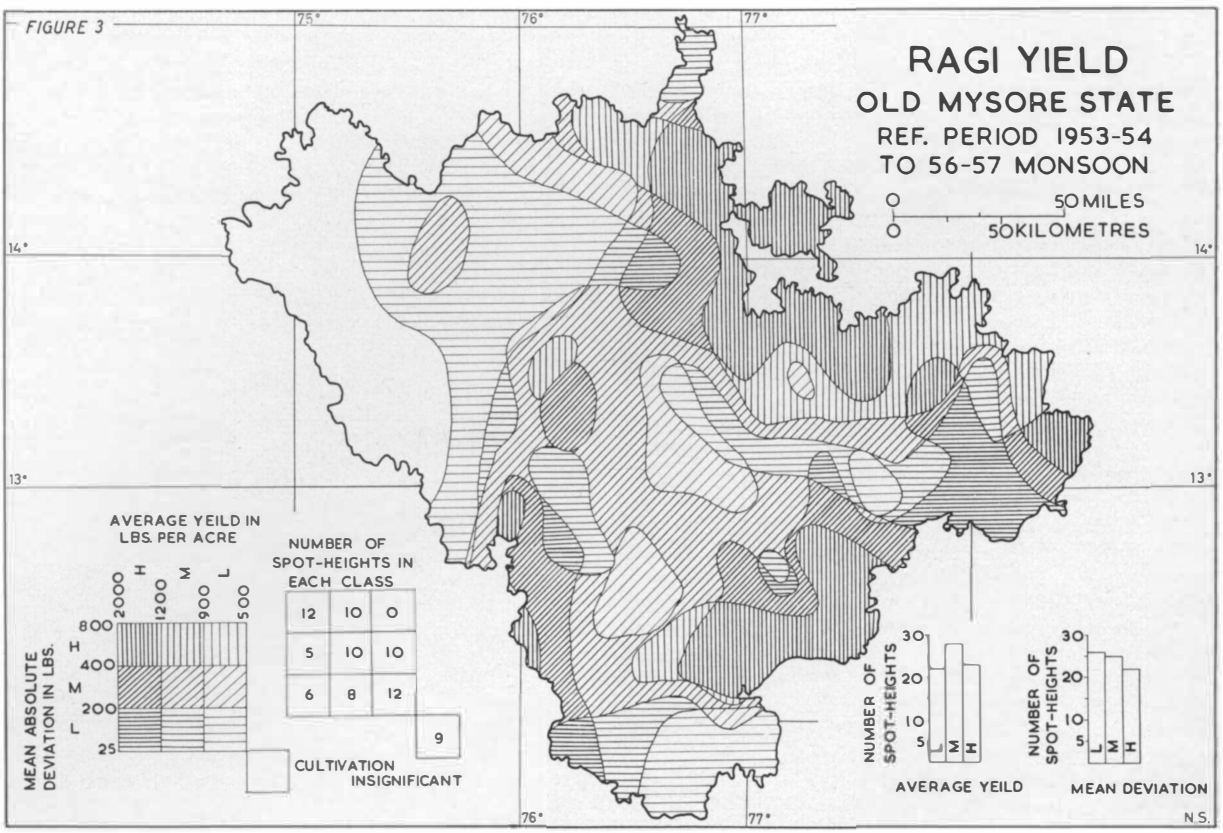
FIGURE 2c MYSORE STATE LOCATION OF RAIN GAUGE STATIONS

delay in planting the staple food-crop ragi *(eleusine corocana)* being off-set by transplanting it instead of sowing it broadcast. The preparation of special rainfall maps might assist the agricultural authorities in planning a campaign to extend this practice.

A map of average yield of ragi (eleusine corocana) along with its variability from year to year 1953—54 to 1956—57 (4 years).

Figure 3 was drawn by very similar methods to that for cholera. These yield figures are based on crop-cutting experiments by the Government of Mysore,

[5]) A fuller analysis of the factors involved in the distribution and variability of cholera in Mysore will be given in the Report of the Regional Survey Unit to be published by the Indian Statistical Institute.



kindly made available to us by the State Statistician. The sample was designed to yield District figures only. Districts are administrative units consisting of about ten talukas, and much too large for geographical analysis of yield data. A single taluka, however, only contains a handful of samples each year. This map should therefore be treated with caution, particularly where the characteristics of a taluka appear to be isolated or anomalous as compared with its neighbours. There is a further need for caution in that a longer run of years will be needed in order to get a reasonably accurate measurement of variability. A particular restriction is that the data refer only to ragi lands, generally unirrigated, and that either a choropleth or an isopleth map generalises as if the ragi were spread evenly over every taluka; this is certainly not true in talukas with a high proportion of canal irrigation, such as those of the middle Cauvery basin.

Nevertheless groupings of talukas do emerge susceptible of rational interpretation, and the isopleth map is particularly helpful in drawing attention to the broad trends. This map more than any other presentation of the data so far employed, brings out a most interesting observation i. e. the central areas of the ragi-growing region, which have a considerable amount of cash-cropping, also have low yields of this staple food-crop. The cash crops are usually on irrigated fields and do not therefore greatly compete with ragi for the best unirrigated land; it seems rather that the cash-crops receive nearly all the available manures, and that the ragi-crop is relatively neglected. More detailed mapping by proportional symbols on the actual village sites, and possibly specially designed sample surveys, may throw further light on this problem.

UNTERIRDISCHE JAHRESZEITENWINDE IN FINNISCHEN ÄSERN

C. TROLL

mit 1 Abbildung

Seasonal underground winds in Finnish Eskers

Summary: In „Fennia", Vol. 81, No. 5, 1957, *V.* Okko describes the phenomenon of a seasonally different underground circulation of air in some eskers in Finland. The slopes of those eskers are covered by a sheet of windblown sand, which isolates the air contained within the eskers and thereby stores the warm air of the summer.

On the ridges, on the other hand, there are frequent patches of soil with a gravelly and boulder-like structure, where the air can escape from within; in consequence of that micro-climatic differences are to be observed. The relatively warm air streaming out during the winter is sufficient to keep the snow off those gravelly patches per-