INVESTIGATION AND METEOROLOGICAL ANALYSIS OF GEOGRAPHICAL VARIATION IN THE BRAZILIAN CERRADO AREA

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1. purpose of investigation

The purpose of this investigation was to collect rainfall data in the Brazilian Cerrado area in order to analyze the rainfall mechanisms related to the synoptic meteorological conditions.

2. Summary of investigation

Brazil extends from 5°N to 33°47'S in the South American continent. The area of Brazil exceeds 8,500,000 km}. The climate in Brazil can be divided into three main zones, namely the tropical rain forest in the basin of the Amazon river, subtropical climate in the southwestern plateau. "Cerrado" is a Portuguese word which means an enclosed area and in Brazil, the term "Cerrado" is used for an acid savanna area with sparse vegetation consisting of bush and shrubs. The Cerrado area, indicated in Figure 1, is located on a plateau which extends from 3°S to 23°S and 42°W to 60°W. The altitude of this area ranges from 200 to 1200 m. Formosa, elevation about 900 m which is one of the major cities located in this area has a cool climate. According to the meteorological statistics for the period from 1931 to 1960, as shown in Figure 2 and Table 1, the annual mean temperature at Formosa is 21,3°C which is 5 to 6°C lower than that at Belém, located in the mouth of the River Amazon and at Boa Vista in the northern outback. The mean annual rainfall at Formosa is 1559 mm. which is lower than that in the tropical rain forest area

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area. It is obvious that the climate in the Cerrados is completely different from that in the tropical rain forest area. In addition the precipitation in summer (October to March) is about 90% of the total precipitation while that in the dry period is only 4%, according Figure 3.

TABLE 1 - Annual change of precipitation and air temperature in Brazil. (30 years mean: 1031-1960)

	Formosa (15°32'S,47°20',912m)			Belém (1°27'S,48°28'w,16m)			Boa Vista (2°49'N,60°39'w,90m		
Mon.	Precipitation		Air temp.	Precipitation		Air temp.	Precipitation		Air temp
	(mm)	(%)	(°C)	(mm)	(%)	(°C)	(mm)	(%)	(°C)
Jan	252	16.16	22.00	318	20.40	25.60	75	4.81	27.80
Feb	204	13.09	22.10	407	26.11	25.50	75	4.81	27.90
Mar	227	14.56	22.00	436	27.97	25.40	80	5.13	28.20
Apr	93	5.97	21.50	382	24.50	25.70	151	9.69	27.90
May	17	1.09	20.10	265	17.00	26.00	304	19.50	26.70
Jun	3	0.19	19.00	165	10.58	26.00	365	23.41	25.90
Jul	5	0.32	18.90	161	10.33	25.90	346	22.19	25.70
Aug	3	0.19	20.70	116	7.44	26.00	226	14.50	26.20
Sep	30	1.92	22.80	116	7.44	26.00	110	7.06	27.80
Oct	127	8.15	22.90	105	6.74	26.20	74	4.75	28.40
Nov	255	16.36	21.90	94	6.03	26.50	66	4.23	28.50
Dec	343	22.00	21.60	197	12.64	26.30	69	4.43	28.00
Total	1559	100.00	21.29	2762	100.00	25.93	1941	100.00	27.42

The climate in the Cerrado area as represented by that at Formosa, is characterized by a rainy season in summer which markedly affects the main agricultural products. In particular, Veranico (a short dry spell in summer), adversely affects the growth of the products resulting in a considerable decrease of the production.

This investigation is being carried out, under the joint operation of EMBRAPA-CPAC of Brazil and Agricultural Research Cooperation Team of JICA, to collect and analyze the rainfall data as well as other meteorological parameters, the effect on agricultural products, the damage caused by drought in the Cerrado area. In particular the objective is to provide basic information to the Brazilian authorities on meteorological data to improve the agricultural technology in the Cerrado area.

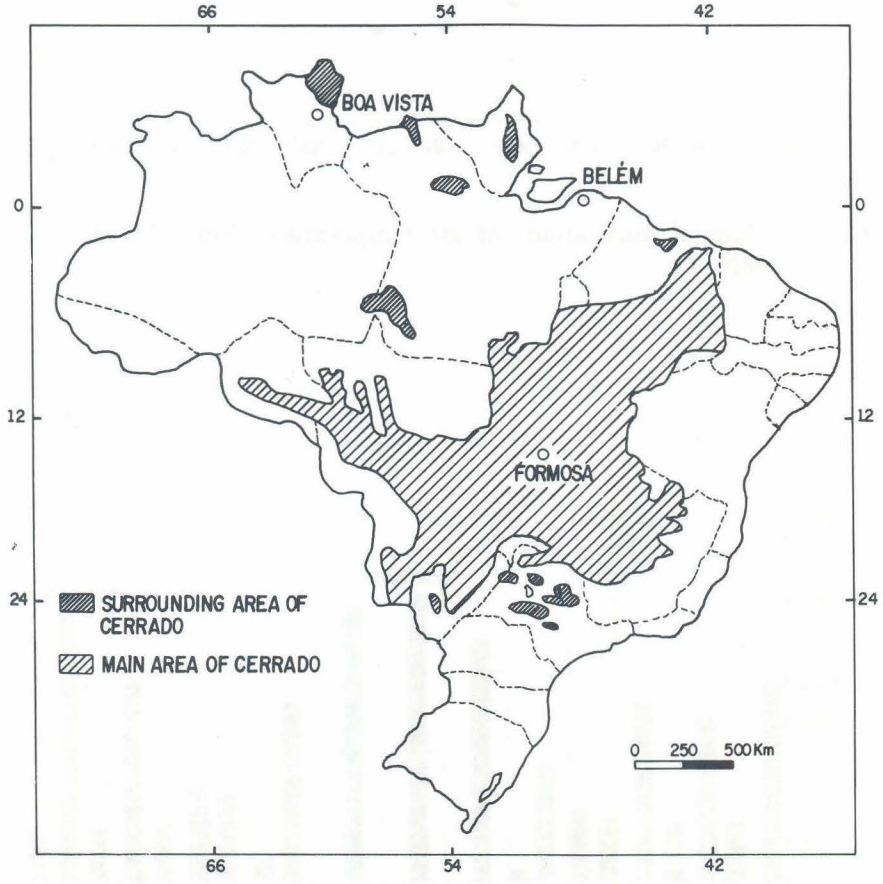

FIG. 1 - Location of Cerrado area in Brazil.

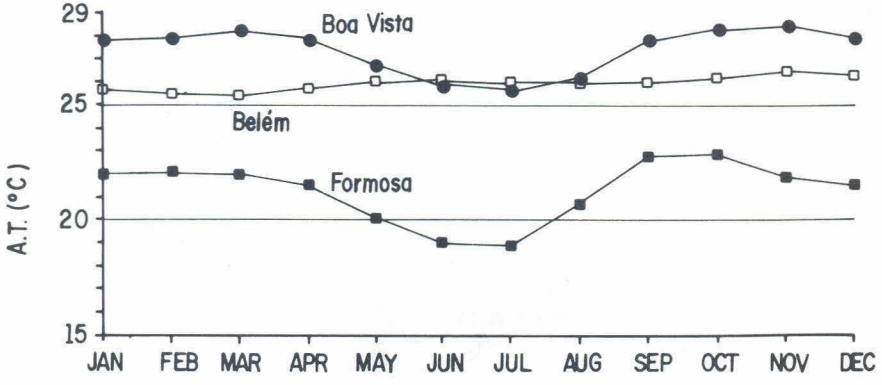

FIG. 2 - Annual fluctuations of air temperature (Mon. Mean: 1931-1960).

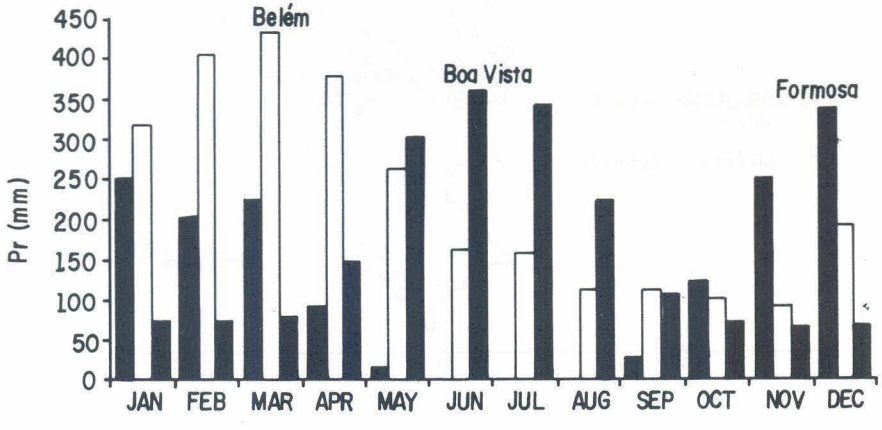

FIG. 3 - Annual fluctuations of air precipitation (Mon. Mean: 1931-1960).

3. Main themes

3.1 Collection of reference materials

Prior to the investigation to be carried out in Brazil, reference materials relating to meteorological and climatological conditions in the tropical zone, in particular in Brazil, were collected for the preparation of basic information data. The global meteorological data, in particular those from Brazil, were collected on a real time basis through the Global Telecommunication System in order to analyse monthly fluctuations of rainfall and monthly mean temperatures at meteorological observation stations.

3.2 Collection of meteorological data

The meteorological data of observation stations in Brazil were collected as a follows:

Precipitation data at 103 stations in the Cerrado area, and those at stations near the area concerned, if necessary;

Meteorological data e.g. Air temperature, Evaporation, Solar Radiation, etc.;

Weather charts for surface, 850, 700, 500 hPa, in particular charts for the days of occurrence of Veranico, and those for the rainy and dry seasons including droughts;

Historical record of droughts;

Statistics of annual agricultural production in this area.

Prior to the collection of the data, however, consultations were held with the staff members concerned in order to work out the plan for this investigation.

3.3 Statistical analysis of meteorological data

Meteorological data collected were analyzed statistically. The figures and tables were prepared to study meteorological the conditions relating to Veranico. These figures and tables are as follows:

(a) Statistics of precipitation amount for every year, every month and every ten-day at every observation station; (Refer to Table 2).

TABLE 2. Daily precipitation in Brasília (1986).

	Meses											
Dias	Jan	Fev	Mar	Abr	Mai	Jun	Jul	Ago	Set	Out	Nov	Dez
01	0	0	0	0	0	0	0	13	1	0	12	16
02	0	0	7	0	0	0	0	0	0	0	0	3
03	0	0	13	0	0	0	0	0	0	0	0	1
04	5	2	7	0	0	0	0	0	0	0	0	0
05	0	7	21	0	2	0	0	0	0	0	0	8
06	0	19	0	0	0	0	0	0	0	0	0	0
07	8	9	1	0	0	0	*	0	0	0	2	7
08	2	2	21	0	0	0	0	0	0	0	0	0
09	2	0	2	0	0	0	0	2	0	0	0	0
10	9	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	30	0	*	0	0	0	28	0	0
12	0	0	0	0	0	0	0	0	0	4	7	0
13	32	1	8	0	0	0	0	0	0	1	19	1
14	1	23	8	4	0	0	0	0	0	0	0	5
15	7	32	0	0	2	0	0	0	1	22	0	0
16	31	0	0	4	0	*	0	0	0	0	0	1
17	0	18	0	0	0	0	0	0	0	0	12	11
18	5	0	4	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0
20	0	1	0	0	0	0	0	0	0	7	0	0
21	0	2	0	0	0	0	0	0	0	10	0	0
22	0	0	0	27	0	0	0	20	0	1	0	0
23	0	0	0	3	0	0	16	1	0	0	0	12
24	0	0	0	0	0	0	15	4	0	0	1	4
25	0	0	0	0	0	0	0	0	0	0	0	7
26	0	4	0	1	0	0	0	0	0	3	0	33
27	2	2	0	0	0	0	0	8	0	0	0	5
28	11	0	0	0	0	0	0	0	0	2	0	8
29	41	*	0	0	0	0	0	0	9	0	21	0
30	1	*	0	0	0	0	0	0	0	0	1	16
31	0	*	0	*	0	*	0	0	*	0	*	6
Mon. Total	157	122	92	69	4	0	31	48	16	78	75	144

***: Not available

(b) Frequency of occurrence of consecutive days without rain for every year, every month and every ten-day period at every observation station during the summer season (from November to March); (Refer to Table 3 & Figure 4).

TABLE 3. Frequency of continuous days without precipitation. (Accumulated average)

DAY	OCT	NOV	DEC	JAN	FEB	MAR
1	21.50	20.10	14.50	17.20	14.50	20.30
2	8.70	10.30	4.10	7.10	6.40	8.50
3	4.70	5.50	2.30	2.80	3.20	6.20
4	3.20	3.70	1.80	1.90	2.10	3.30
5	2.10	2.10	1.40	0.90	0.70	2.10
6	1.60	0.90	0.60	0.30	0.20	2.10
7	1.30	0.50	0.20			1.90
8	1.00	0.20			1.70	
9	0.80				1.50	
10	0.70				1.30	
11	0.50				1.10	
12	0.20				0.90	
13	0.10				0.40	
14	0.05				0.20	
15					0.10	

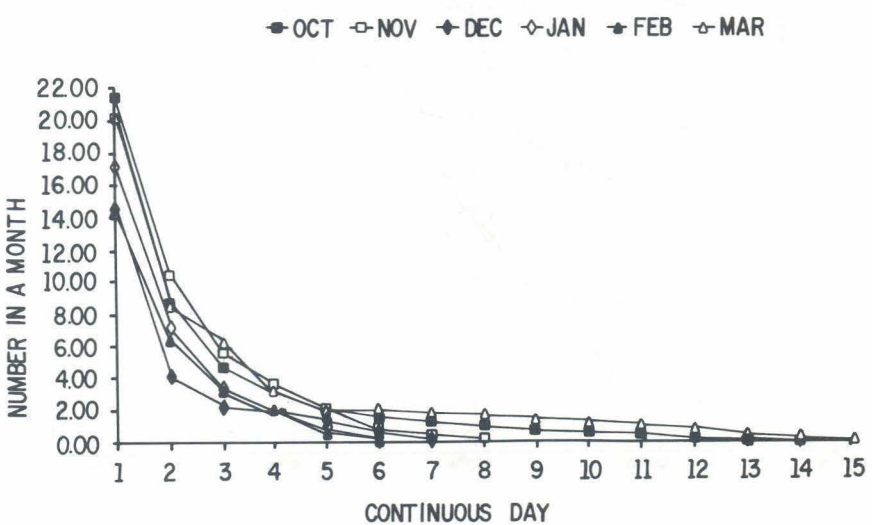

FIG. 4 - Ocurrence of continous days without precipitation.

(c) Geographical distribution of mean precipitation amount in Brazil for every year, every ten-day period; (Refer to Figure. 5).

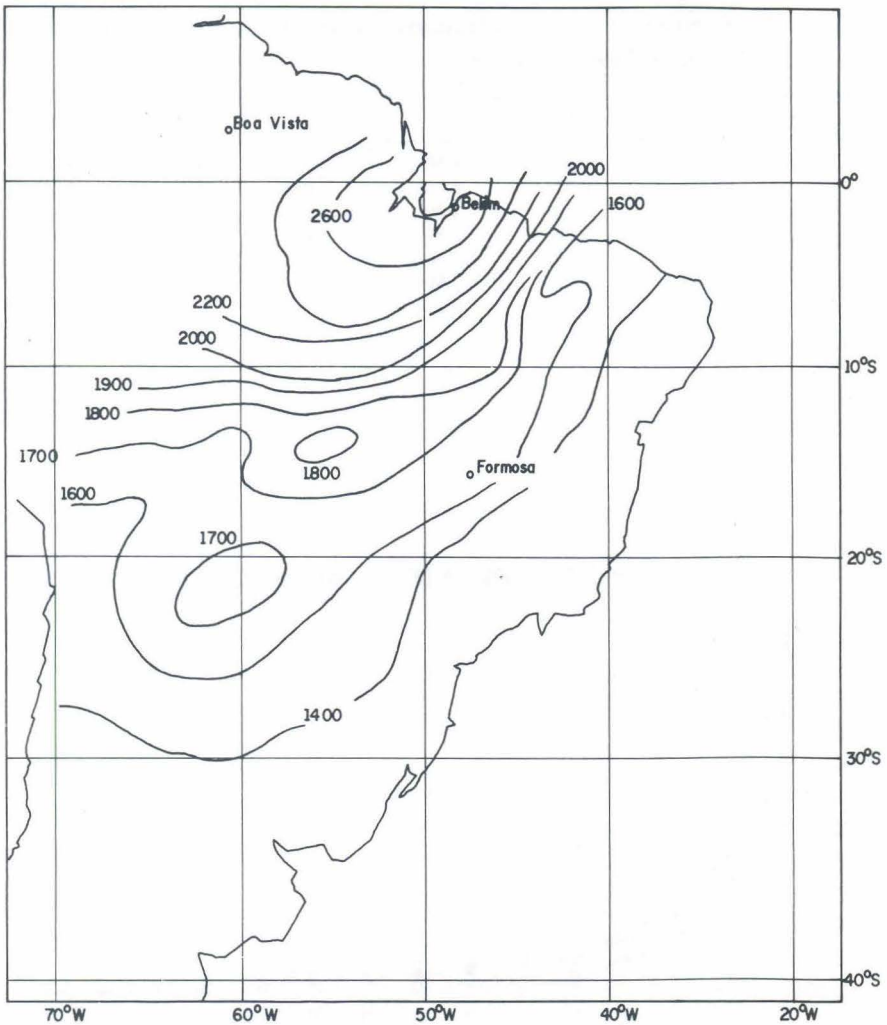

FIG. 5 - Distribtion map of annual precipitation (Bogus data).

(d) Geographical distribution of average periods of consecutive days without rain in Brazil for every year, every ten-day period; (Refer to Figure 6).

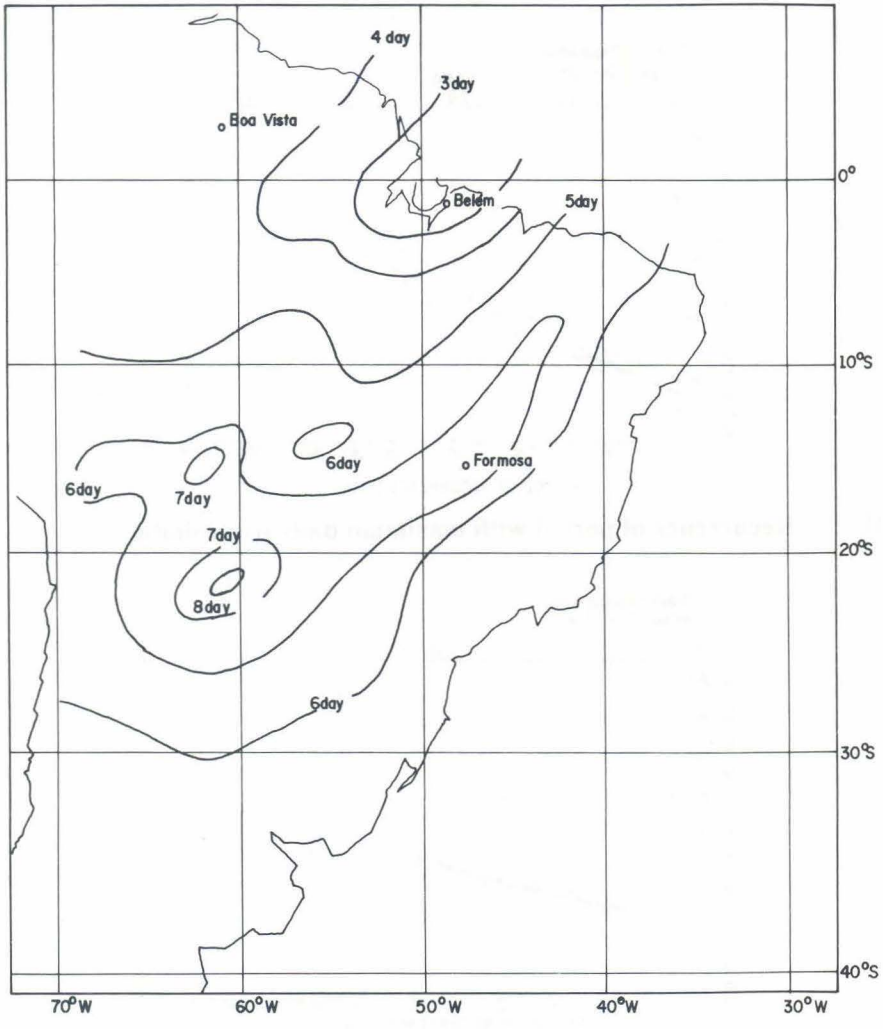

FIG. 6 - Distribtion map of mean continous days without precipitation (Frebruary) (Bogus data).

(e) Expected recurrence values for maximum daily precipitation amounts during a period of 5 years, 10 years and 30 years at every observation station; (Refer to Figure 7).

(f) Expected recurrence values of periods without rain during 5 years, 10 years, and 30 years; (Refer to Figure 8).

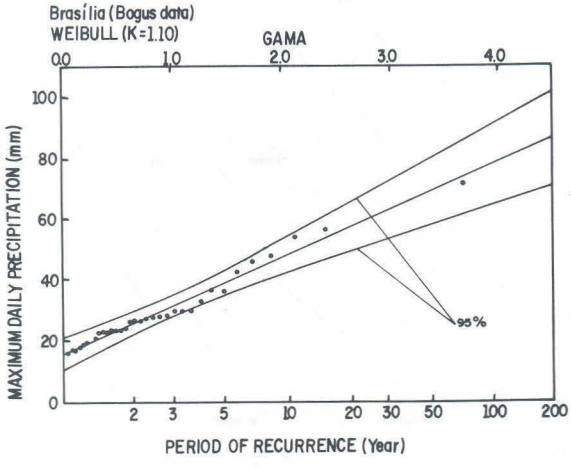

FIG. 7 - Recurrence of period with maximum daily precipitation.

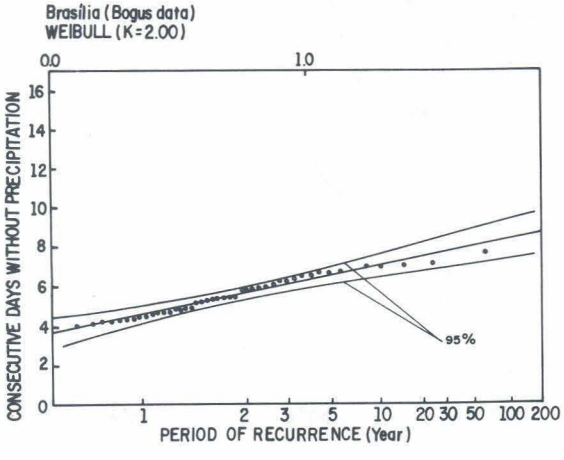

FIG. 8 - Recurrence of period whit continous days whitout precipitation. (January).

3.4 Analysis of meteorological data

(a) Correlation between the period without rain and synoptic weather conditions will be studied;

(b) Analysis of the development of methods for prediction of occurrence of Veranico, based on the (a) above.

4. Procedure for investigation

A procedure for investigation will be developed, taking into account the information available in Brazil. A tentative plan is shown in Figure 9.

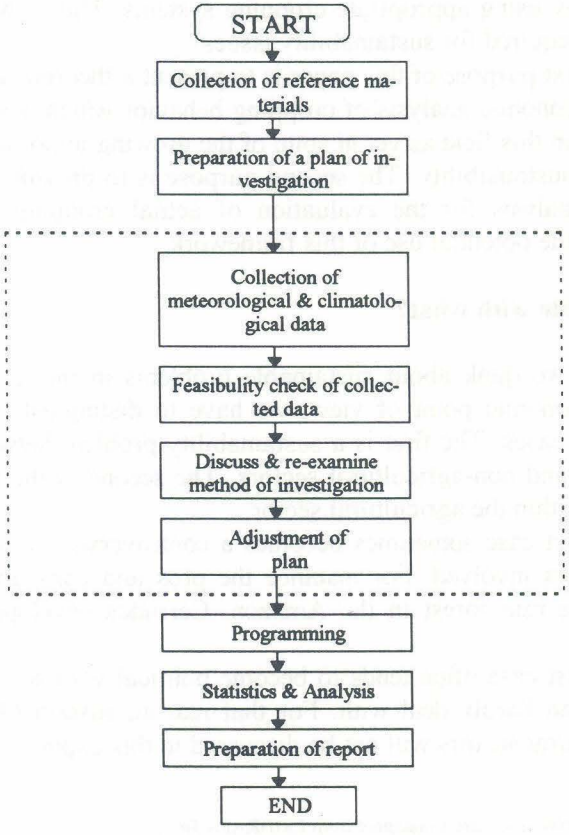

FIG. 9 - Plan of investigation.