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State Network for Groundwater Monitoring in Andhra Pradesh

By

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Abstract : *Measurements of water levels in open wells form the most important part of groundwater investigations. Water level data is analysed for monitoring changes in the storage of groundwater in response to rainfall, pumpage, surface irrigation etc., The data is also essential for forecasting future trends of water levels. Water table contour maps are useful in identifying recharge and discharge areas and to find out the direction of movement of groundwater.*

Records of water level fluctuations are being obtained in about 1650 observatian wells in the Andhra Pradesh. Apart from these the State Ground Water Department has established a network of about 1000 observation wells spread over 12.47 lakh ha. of irrigated area under the four Major Irrigation Projects. Manual measurements at regular intervals ranging from one per week to one per month are made with a tape. Water samples are being collected from all these wells twice in a year and analysed for chemical constituents.

The frequency of the measurement depends on the nature of fluctuations and on the intended use of the data. The various factors that govern the selection of network density are discussed. Statistical techniques for selecting the optimum number of observalion wells are indicated. The criteria adopted for selecting observations wells are outlined. The objectives of collecting the data are summarised in this report.

1. Introduction

Total georaphical area of Andhra Pradesh is 27,440 Sq. km. out of which forest and non-cultivable area amounts to 45,328 Sq. km. (16.5% of total area). About 85% of the total area is occupied by hard rocks of Archean age, consisting of mostly granites and gneisses and the remaining part by sedimentary formations. Ground water potential in the State is estimated to be 43,001 MCM and the present utilisation is about 20% of the above potential.

With a view to estimate ground water potential, draft and for proper management of total water resources, the State Ground Water Department has established 469 observation wells in the year 1973. Subsequently in the year 1983, the wells were increased to 1184 totalling 1653 covering the entire State. These are categorised as general observation wells (Table-I).

Apart from these, the department has established a network of 1120 wells in the year 1979, spread over 12.47 lakh hectare of command area under the four Major Irrigation Projects in the State. This data is analysed for indentifying water logging conditions and to suggest remedial measures including

Table I : List of Observation Wells Monitoring by Groundwater Department, Andhra Pradesh

Sl. No.	District	No. of Observation wells monitored since		Total at present
		1973	1983	
1.	Srikakulam	27	19	46
2.	Vizianagaram	21	19	40
3.	Visakhapatnam	30	23	53
4.	East Godavari	43	10	53
5.	West Godavari	28	19	47
6.	Krishna	29	24	53
7.	Guntur	23	16	39
8.	Prakasam	27	51	78
9.	Nellore	20	59	79
	Coastal Andhra Region :	248	240	488
10.	Kurnool	24	54	78
11.	Ananthapur	28	127	155
12	Cuddapah	28	54	82
13.	Chittoor	15	124	139
	Rayalaseema Region :	95	359	454
14.	Rangareddy	9	65	74
15.	Nizamabad	15	59	74
16.	Mahabubnagar	19	40	59
17.	Medak	11	96	107
18.	Nalgonda	16	84	100
19.	Warangal	14	78	92
20.	Khammam	13	53	66
21.	Karimnagar	14	48	62
22.	Adilabad	15	62	77
	Telangana Region :	126	585	711
	Andhra Pradesh :	469	1184	1653

planning of conjunctive use of surface and ground water for optimum development. Local observers are employed to record weekly water levels in the general observation wells and five times in a year from command area wells. Departmental Staff collect pre and post-monsoon water levels and water samples from all these wells for chemical analysis.

The density of general observation wells network at present works out to one well per 140 Sq. km. In case of command areas, the density adopted is one well per 10 Sq. km. in wet crop areas and one well per 20 Sq. km. in irrigated dry areas. Based on the analysis of data, attempts are being made to reduce the number of wells in certain areas and to increase the wells in over exploited areas. The observation wells are selected keeping in view the degree of ground water development and covering various hydrogeological factors as well as areas having different climatic, topographic and hydrologic fearures. Mostly domestic open wells are selected for observation wells as the draft from these wells will be minimum. Efforts are also being made to utilise some of the exploratory borewells drilled departmentally as observation wells to study the difference in pressure heads and to estimate ground water potential in confined aquifers. Some of the wells are selected along the major river courses to deliniate effluent and influent zones of the streams.

The hydrograph of each individual well is up dated with the inflow of data. Typical hydrographs are enclosed (Fig. 1 to 5). In case of unconfined aquifers, normally variations in water levels occur in top weathered zone, the thickness of which extends on average about 15 m. bgl. Precipitation is the main source for ground water and for a comprehensive appraisal of ground water regime, records of water levels are required for a period of one complete cycle. The data is analysed for estimation of ground water potential, rainfall infiltration factor specific yield of aquifers, water logging conditions in Project command areas and to predict future trends in water levels.

2. Network Density

For analysis purpose, these wells are considered basin wise and formation-wise. With the help of water table contours, the groundwater basin is demarcated. Various factors govern the selection of network density such as size and slope of the basin, land use, climatic factors, and mainly the purpose for which the data is analysed. For estimation of groundwater potential in basins with homogeneous lithology, temperate climate and with plain relief, the approximate number of observation wells recommended depending on the size of the basin are indicated below (Ref. UNESCO publications on basins).

Size of the basin		No. of Observation wells
Small	50 km^2	5–10
Medium	200–500 km^2	10–15
Large	800–1000 km^2	15–20

This indicates that the density of observation wells for a large basin should be of the order of one well per 50 Sq. km. The Groundwater Estimation Committee (NABARD, 1984) have recommended a density of one well per 100 Sq. km. A dense network of observation stations are required when high degree of accuracy is essential or in over exploited areas. National Bank for Agriculture and Rural Development recommended one well per 20 Sq. km. in order to estimate groundwater potential in over exploited areas. Thus the density of network stations depends on the accuracy of results required and the method of analysis of data. The groundwater potential in the State is estimated by two methods namely by adopting norms prescribed by

FIG. 1

COVERNMENT OF ANDHRA PRADESH
GROUND WATER DEPARTMENT

HYDROGRAPHS AND RAINFALL
IN CHEEMALAPADU VILLAGE
VIJAYAWADA TALUQ, KRISHNA DIST.

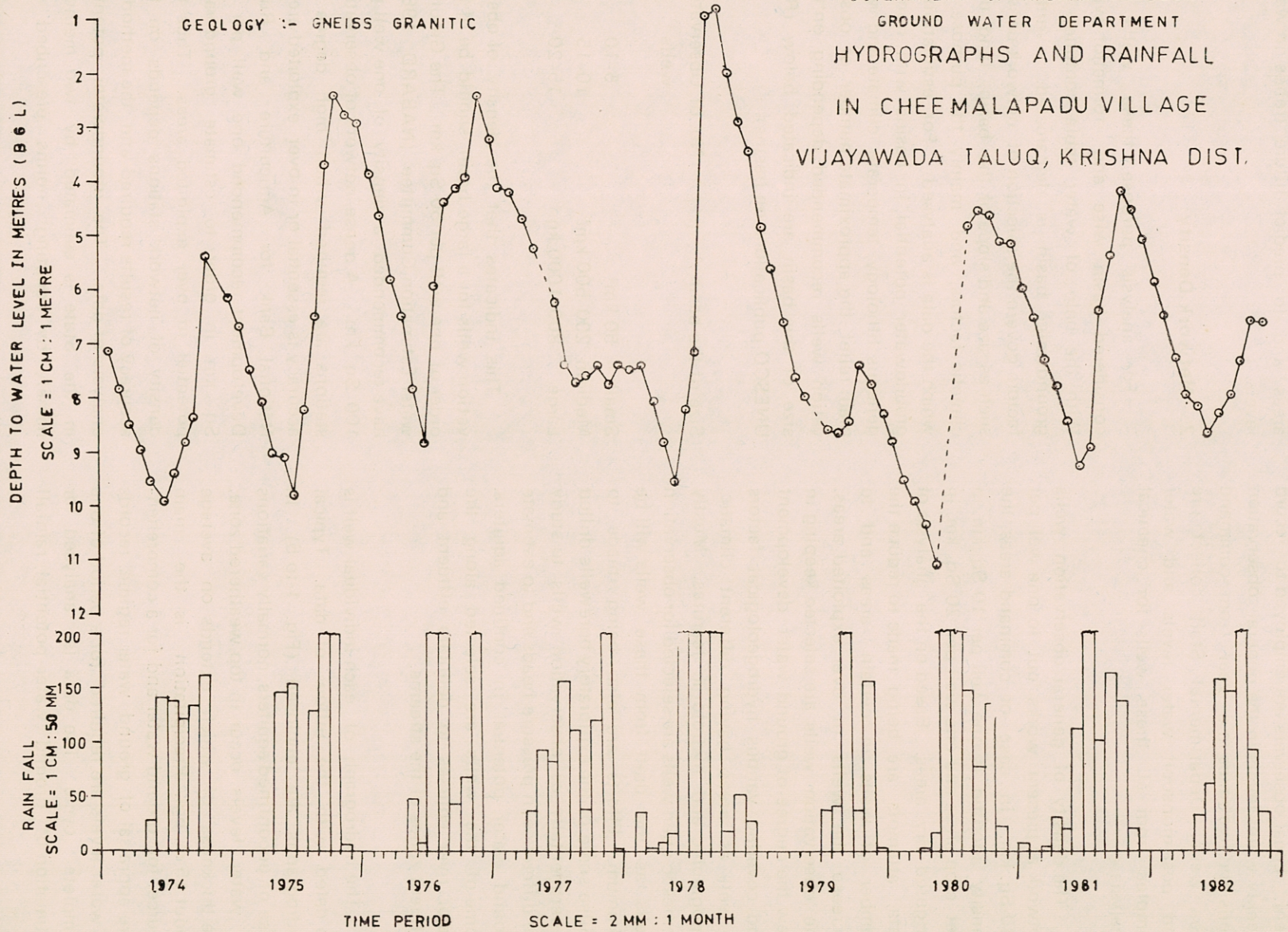


FIG.2

GOVERNMENT OF ANDHRA PRADESH

GROUND WATER DEPARTMENT.

HYDROGRAPHS AND RAINFALL IN JONNADA VILLAGE BHEEMUNIPATNAM TALUQ, VISAKHAPATNAM DIST.

GEOLOGY : KHONDALITES.

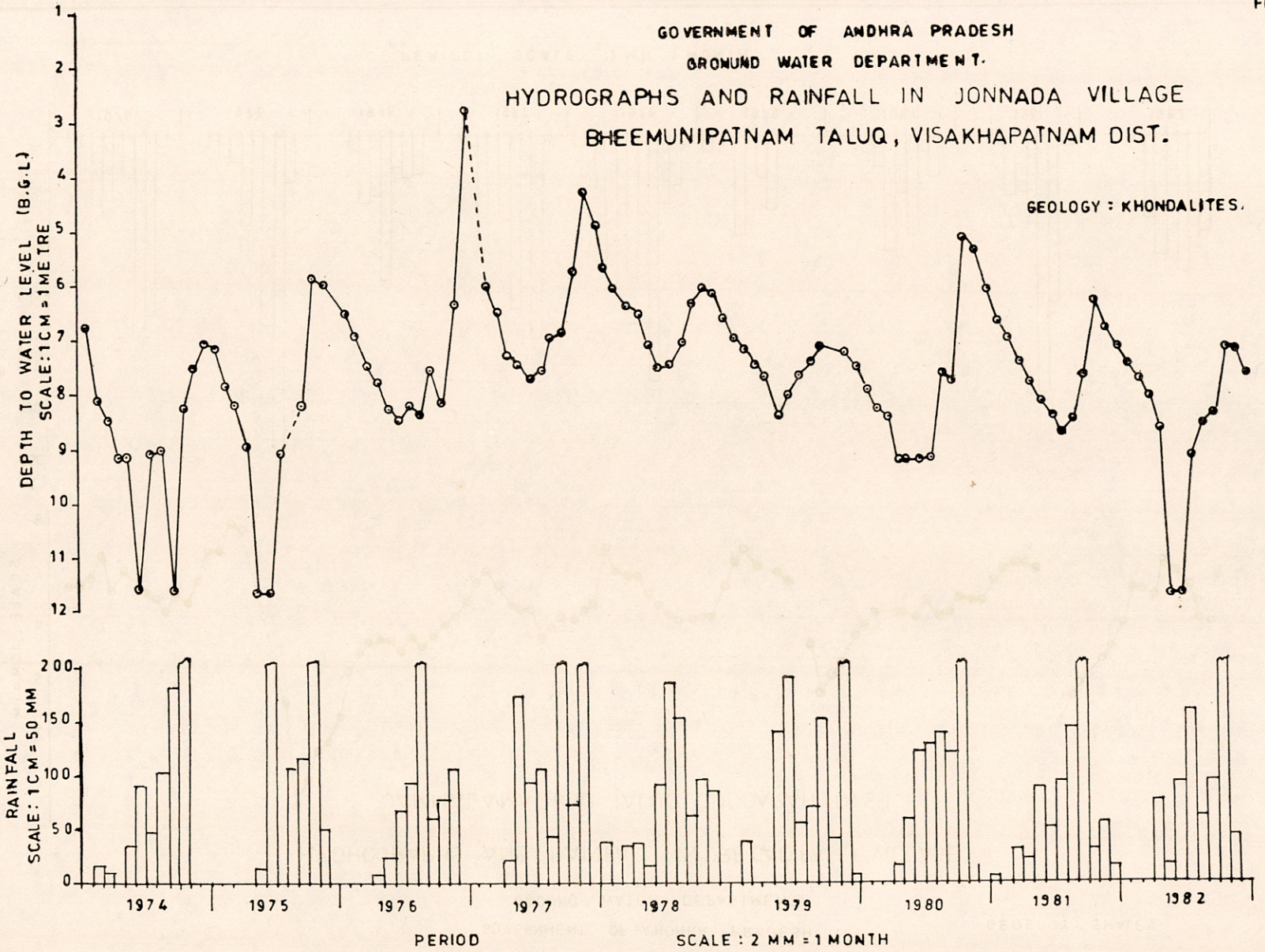


FIG. 3

GOVERNMENT OF ANDHRA PRADESH
GROUND WATER DEPARTMENT

GEOLOGY: SHALES

HYDROGRAPHS AND RAINFALL IN REGADIPALLI VILLAGE

JAMMALAMADUGU TALUQ, CUDDAPAH DIST.

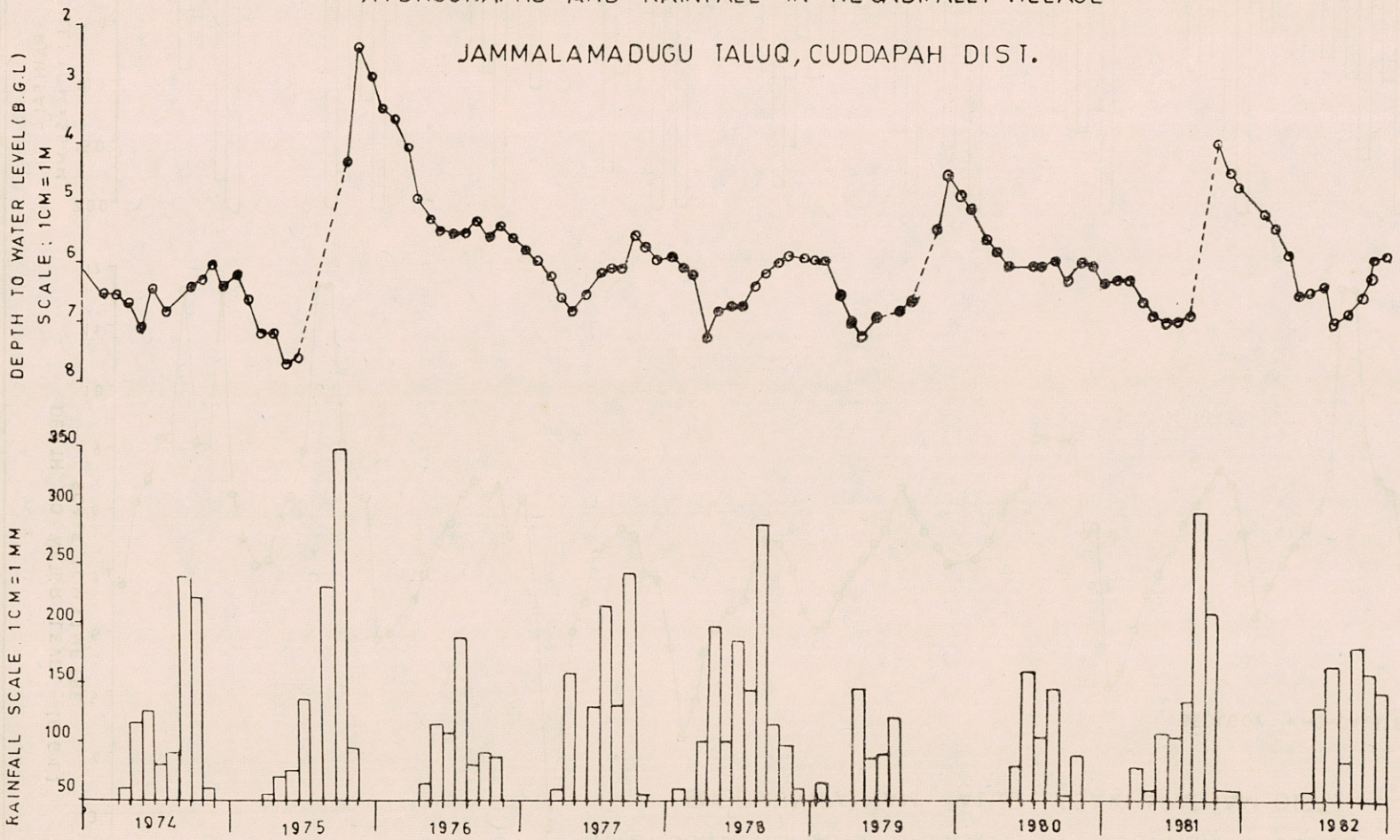


FIG. 4

GOVERNMENT OF ANDHRA PRADESH
GROUND WATER DEPARTMENT

GEOLOGY : SANDSTONES

HYDROGRAPHS AND RAINFALL IN YERNAGUDEM VILLAGE

KOVVUR TALUQ, WEST GODAVARI DIST.

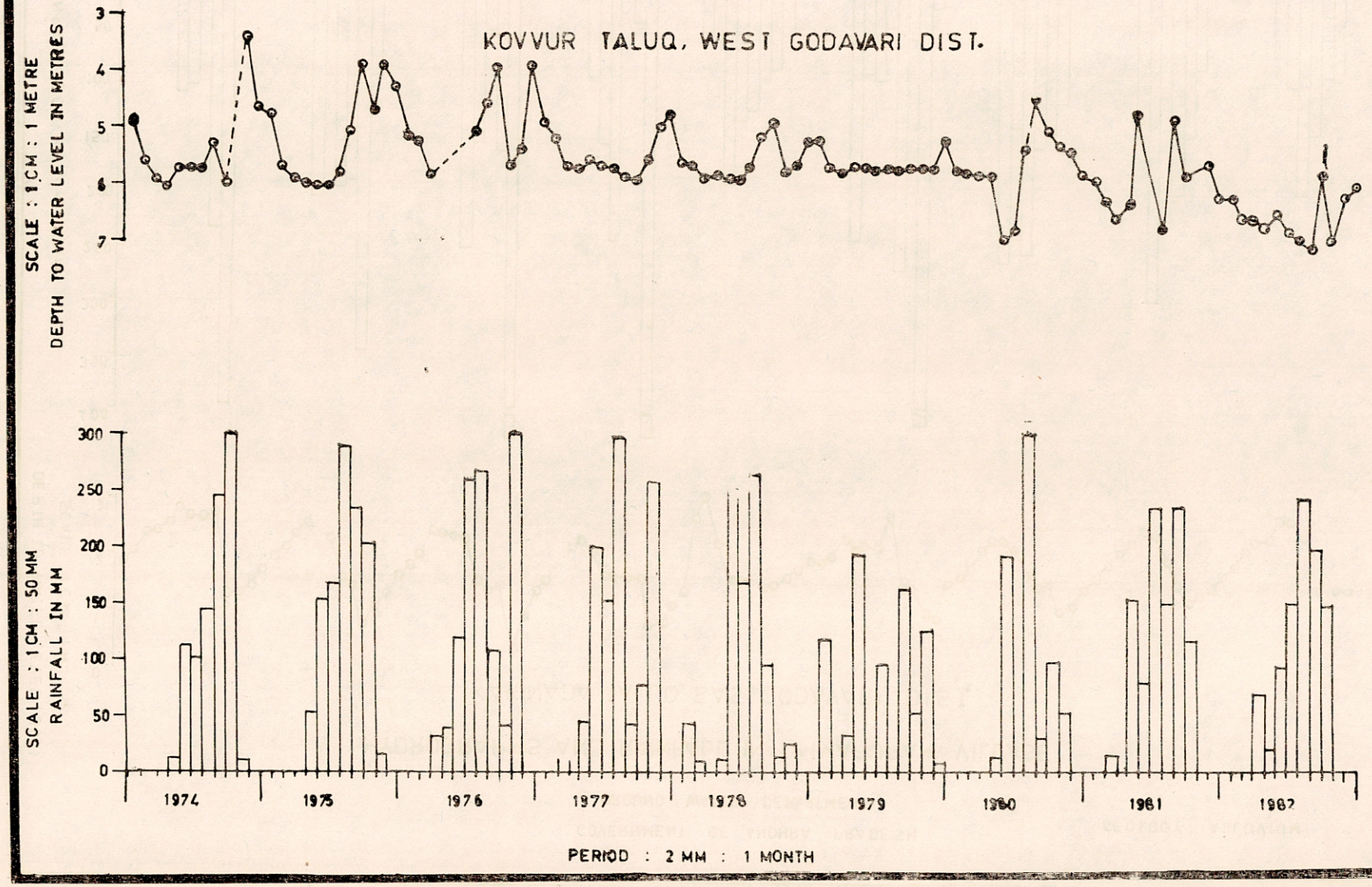


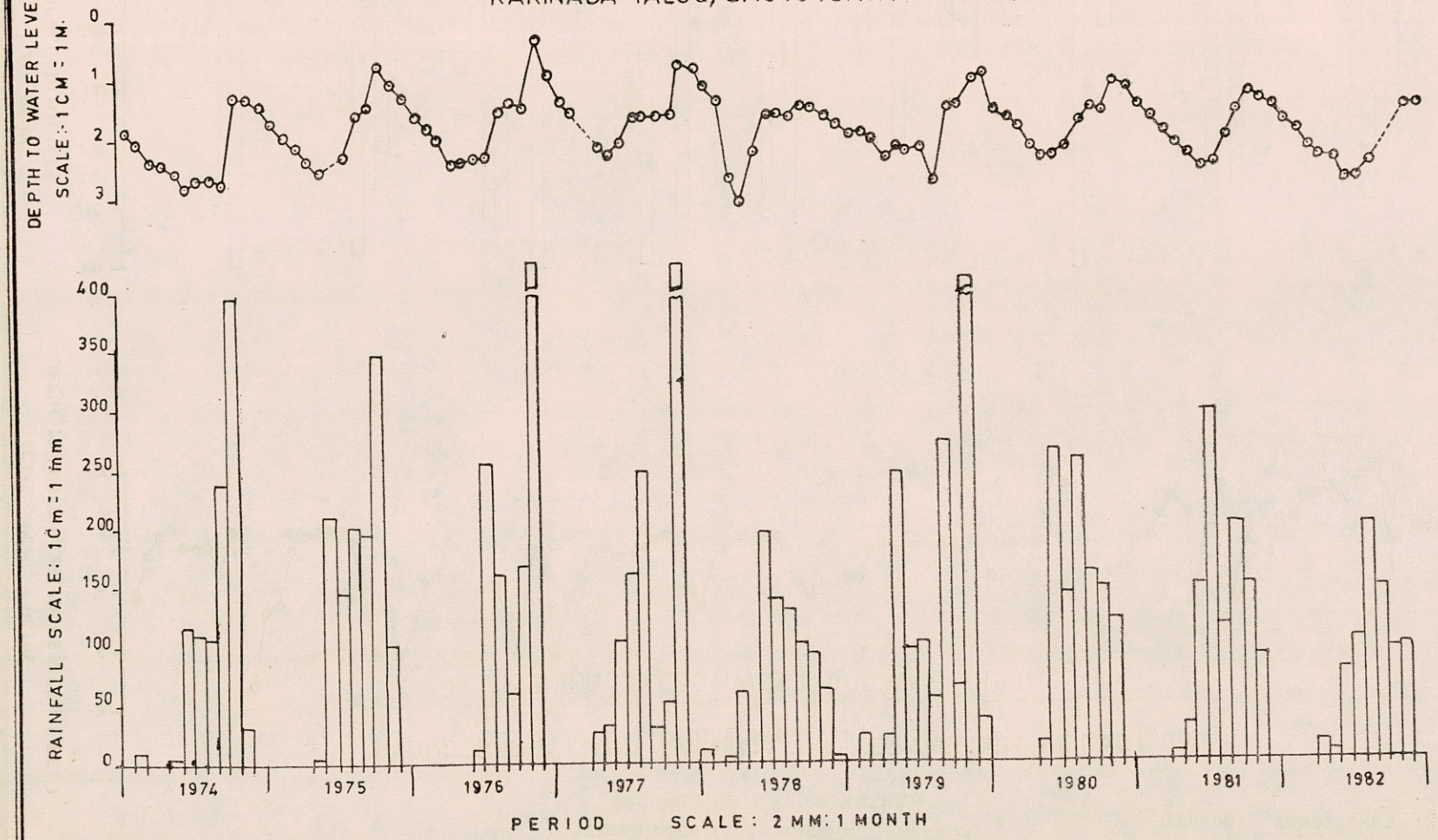
FIG. 5

GOVERNMENT OF ANDHRA PRADESH
GROUND WATER DEPARTMENT

GEOLOGY : ALLUVIUM

HYDROGRAPHS AND RAINFALL IN TIMMAPURAM VILLAGE

KAKINADA TALUQ, EASTGODAVARI DIST.



NABARD and by water level fluctuation/ specific yield approach. As such the present density of one well per 140 sq. km. in the State in non-command areas is considered reasonable. However, it may have to be raised to normal standards in a phased manner.

Statistical techniques are employed for processing and comparing water level data of different wells, for selecting the optimum number of observation wells. By correlating the water level fluctuation of several wells located within the same hydrological regime, it is possible to reduce the number of observation wells by monitoring a single well, if its water level fluctuations are well correlated with others around it. In Irrigation Project Command areas the recharge to aquifers is mainly from applied water which is more or less constant every year. The groundwater extraction in these areas is significant. Under these conditions, the fluctuation in groundwater levels are constant. This fact was observed in some of the observation wells in Sreeramsagar Project Command Area (Table-2) and further monitoring was discontinued in these wells, except in few representative wells. Attempts are also being made to prepare mathematical models for some of the basins where integrated water development is planned. In such cases the observation wells can be further reduced if satisfactory results are obtained from the models.

3. Frequency of Measurements

Frequency and periodicity of observations are governed by the purpose for which the water level data is required. If the purpose is to study the tidal effects, bank storage effects etc., continuous recording of data with automatic water level recorders is required. For regional or basin studies the frequency of observation depends on the type of formations and rainfall pattern. Normally monthly readings are sufficient to study the multiple effects in the basins. NABARD have recommended a frequency of six times in a year for the purpose of estimation of groundwater potential in a basin.

Irrigation scheduling in the projects is made for monthly intervals, as such groundwater potential that can be tapped in a month is required. In some cases there will be time lag between rainfall and corresponding rise in water levels. In irrigation projects the effects of canal flows and applied irrigation are to be studied. To achieve these objectives, groundwater levels are being measured five times in a year in the observation wells in the Command Areas of Irrigation Projects. Since local observers are employed to record data, weekly levels are insisted in general observation wells to minimise missing data and errors in the readings.

4. Criteria for Selecting a Well as an Observation Well

The following conditions should be satisfied before fixing a well as "Observation well".

(i) It should be in good condition and not silted up or collapsed.

(ii) It should preferably be of small diameter.

(iii) It should have a proper parapet or other fixed point for measurument of water levels.

(iv) The aquifer tapped in the well should be identifiable.

(v) It should not be in constant use and static levels should be available for monitoring.

(vi) It should have an adequate water column to ensure that it does not dry up in summer or in drought years.

(vii) It should be approachable at all times.

Table 2 : Depth to Water Level in Metres Recorded in Observation Wells in Sreeramsagar Project Command Area

Sl. No.	VILLAGE	Observation well No.	1972		1973		1974		1975		1976		1977	
			Apr.	Oct.	Apr.	Oct.	Apr.	Oct.	Apr.	Oct.	Apr.	Oct.	Apr.	Oct.
1	2	3	4		5		6		7		8		9	
1.	Mendora	7	6.55	4.10	7.45	1.15	8.10	1.60	7.70	1.50	6.80	3.30	7.80	—
2.	Savel	13	9.35	1.22	9.20	0.80	8.05	1.40	8.90	1.70	7.60	1.60	7.45	4.05
3.	Battapuram	15	8.65	5.92	8.25	2.50	7.50	5.60	6.90	3.20	6.60	4.80	7.90	8.00
4.	Varshakonda	26	2.97	2.18	4.66	0.78	3.25	0.75	2.00	1.00	2.50	1.60	2.40	2.00
5.	Chowlamanddi	54	7.30	7.09	7.36	0.35	8.05	0.00	4.85	0.00	4.15	0.00	5.75	4.31
6.	Vempet	62	2.93	1.25	2.69	1.20	3.35	1.30	4.35	1.30	3.70	1.20	3.15	—
7.	Mutthampet	64	4.35	1.48	4.08	1.10	4.40	0.00	4.40	1.10	4.50	0.90	4.50	1.66
8.	Raghavapet	66	2.30	1.41	2.58	1.25	3.10	1.70	3.15	1.30	2.80	1.50	3.10	1.60
9.	Gundampally	76	3.40	0.60	2.65	0.60	3.10	—	3.50	—	3.70	0.20	4.55	0.70
10.	Kortla	83	4.95	2.95	4.65	0.71	5.95	0.60	4.80	0.75	2.50	0.50	4.55	0.90
11.	Srikonda	87	2.25	2.08	3.95	0.90	3.76	2.90	3.50	1.50	2.00	2.20	3.00	3.30
12.	Kalleda	140	—	—	—	2.80	8.15	6.30	5.01	1.20	7.00	0.60	2.20	1.10
13.	Chandoli	156	—	—	—	2.00	4.12	2.30	3.05	1.00	3.30	—	2.90	—
14.	Kompally	163	—	—	—	0.32	2.79	0.24	0.44	0.29	0.19	0.28	0.58	0.33
15.	Chelgal	212	—	—	—	—	—	—	—	—	—	—	—	—
16.	Raikal	218	—	—	—	—	—	—	—	—	—	—	—	—
17.	Gollapally	242	—	—	—	—	—	—	—	—	—	—	—	—

Contd.....2

1978		1979		1980		1981		1982		1983		1984		1985	
Apr.	Oct.	Apr.	Oct.	Apr.	Oct.	Apr.	Oct.	Apr.	Oct.	Apr.	Oct.	Apr.	Oct.	Apr.	Oct.
10		11		12		13		14		15		16		17	
2.30	1.40	5.05	1.80	4.55	1.60	4.92	1.50	5.05	1.40	5.40	1.48	2.98	1.76	2.95	1.60
1.60	1.51	7.40	1.70	6.15	1.70	4.10	1.65	7.10	2.10	3.10	1.56	1.95	1.78	2.05	1.60
5.00	4.03	6.85	5.21	6.90	4.68	7.05	3.10	7.30	4.55	6.80	3.47	6.35	4.65	6.05	4.40
1.75	1.84	2.20	2.05	2.00	1.72	2.10	1.82	2.20	1.70	2.20	1.70	2.00	1.95	2.05	1.62
5.70	1.89	5.25	1.60	4.25	1.20	4.10	1.30	4.25	0.80	4.90	0.44	3.00	0.90	3.10	1.35
4.20	0.77	3.10	0.82	1.35	0.60	1.35	0.70	2.15	0.65	2.04	1.62	1.70	1.30	1.90	1.12
4.95	0.72	3.60	0.95	4.00	1.00	2.83	1.00	5.40	0.70	3.07	0.94	1.05	0.95	1.60	0.08
2.80	1.54	2.25	1.56	1.75	2.40	1.55	1.58	1.90	1.50	1.85	1.58	1.74	1.45	1.70	1.40
5.40	—	—	0.87	2.05	0.75	1.70	0.80	2.55	0.80	2.00	1.47	2.00	0.95	2.20	1.34
5.00	1.55	1.72	0.00	1.55	0.60	1.00	0.37	1.65	0.00	1.38	0.68	0.45	0.40	1.10	1.60
1.70	2.49	4.20	1.45	2.90	4.50	3.20	0.90	3.73	1.20	3.25	0.85	3.80	3.60	4.20	4.50
4.37	0.80	2.33	1.30	1.85	1.50	2.25	0.60	1.95	0.62	1.80	0.37	0.90	1.90	—	—
0.40	2.60	5.11	3.30	4.54	3.70	4.30	2.70	4.10	2.75	4.10	2.25	3.82	3.36	3.77	3.08
0.13	0.65	0.83	0.55	0.93	0.57	0.78	0.50	0.75	0.42	0.75	1.10	0.56	0.65	0.60	3.08
—	2.64	2.97	2.70	2.87	2.57	2.82	2.20	2.83	2.43	2.86	2.46	2.85	2.73	2.97	2.58
—	1.59	3.50	2.43	2.86	2.08	2.82	1.27	3.63	1.40	3.80	1.78	3.40	2.94	4.15	3.01
—	3.35	6.11	3.65	5.89	3.75	4.25	3.95	4.65	4.05	4.75	3.89	4.10	4.55	4.11	4.55

5. Analysis of Data

Water table fluctuation is governed by the specific yield of the formation. All factors remaining the same, water table fluctuation. is inversely proportional to specific yield. The magnitude of the water table fluctuation also depends on climatic factors, drainage, topography and geological conditions. The fluctuations will be higher in elevated areas in a basin indicating recharge areas and will be minimum in low laying areas or discharge zones. Water levels reflect the cumulative effect of natural recharge discharge conditions and withdrawal by pumpage.

Prolonged over-development of ground water in heavily pumped areas resulted in a downward trend of the water table due to the draft exceeding the recharge. The hydrographs also show the periods of recharge and discharge of ground water. If the storage coefficient is known, the rate at which the change in storage occures can be worked out from the water level data. The main intention of monitoring ground water levels is to estimate average annual recharge in a basin, but due to lack of values of specific yield for different formations, the ground water potential calculated on the basis of water table fluctuation is at present compared with those values obtained by using adhoc norms. Some of the results obtained from analysis of water levels data are described in the following paragraphs.

From the analysis of well hydrographs it is possible to estimate the rainfall infiltration factor. For this purpose, well hydrographs which were not affected by canal irrigation, streams etc., were considered. By applying Degalliers equation, the hydrologic parameters obtained are indicated below. In this method it is assumed that recession coefficient represent specific yield. Based on limited analysis done by Ground Water Department, the following infiltration factors for different formations are arrived at, though it is not reasonable to generalise this based on limited data.

Formation	Recession coefficient	Average infiltration factor
1. Granites & Gneisses	0.029	31%
2. Khondalites	0.025	20%
3. Alluvium	0.029	29%
4. Sandstones	0.03	22%
5. Laterites	0.018	22%

Apart from the infiltration rates the fluctutations in the water levels are also controlled by the porosity and specific yield of the formation. The rise in water levels is low when the specific yield is high and vice-versa. The decline of water levels in the absence of recharge depends on Transmisibility, storage confficient and the hydraulic gradient. Natural recession curves showing logarithem of height of water table versus time, which are straight lines are useful in predicting future ground water levels since every aquifer has a characteristic recession curve.

The base flow in a stream represents effluent discharge of ground water. A ground water recession curve shows the variation of base flow with time during period of little or no rainfall. By relating the stage of stream flow during rain less period with corresponding stage of ground water level, it is possible to estimate base flow for various levels of ground water reservoir in a basin when evapotranspiration losses are minimum from the zone of saturation. From the analysis of continuous hydrographs obtained with automatic water

level recorders, it is possible to estimate evapotranspiration rates.

Groundwater contour maps are useful in location of basin divide, the direction and intensity of flow of groundwater recharge and discharge areas can also be demarcated from water table contour maps. In Irrigation Projects, with the help of water table contour maps water logged areas are identified. The areas having depth to water table between 0 to 3 m. bgl are called water logged areas. Projectwise extent of water logged areas identified from water level data are shown below in Andhra Pradesh.

	Project	No. of Observation wells established	Ayacut affected by waterlogging (Ha.)
1.	Sriramsagar Project	345	30,000
2.	Nagarjunasagar Left Canal	209	27,000
3.	Nagarjunasagar Right Canal	225	30,000
4.	Tungabhadra Project Command Area	215	40,000
	Total	994	1,27,00

In the above areas large scale ground water extraction with restrictions on Canal supplies is recommended.

In non-command areas, the average depth to water level during pre-moosoon period ranges between 4.30 m. to 10.6 m. bgl in the State. Shallow water level is observed in coastal districts and in most of other districts, the average water level lies around 7.0 mts. bgl in pre-monsoon period.

6. Conclusions :

In order to study the effects of drought on ground water resources, analysis of water level data for June, 1987 (Pre-monsoon period) is made. Rainfall amounting to less than normal, occured in the State during the last three years. Because of this and increased demand for groundwater, the water levels have gone down beyond 10. m. bgl. in 15 districts. The water level data for June, 1987 is compared with average pre-monsoon level of past 13 years. Progressive decline of water table is found in these 15 districts (Tables 3, 4 & 5). Most of the open wells have gone dry in these areas indicating need for artificial recharge measures in these areas and to impose certain restrictions on the use of groundwater for irrigation purpose. Inspite of drought situation, rise in water table is noticed in few coastal districts and Irrigation Project Command Areas. Conjunctive use of groundwater with surface water is recommended in these areas.

The water level data is thus useful in groundwater investigations in many ways. Groundwater is a dynamic resource. It varies with complex climatalogical factors like precipitation and also with other man made changes. As such continuous records of data for representative wells is essential to plan for proper use of total water resources.

The Ground Water Department of Andhra Pradesh is striving to modernise the data collection system by employing latest instruments and also use computers for storage and retrieval of data. This will enhance the importance of network of observation wells and help planners in arriving at a realistic assesment of Ground Water Resources of the State.

Table 3 : Statement Showing the Water Level Fluctuation in Andhra Pradesh

Sl. No.	District	Average depth to water level in mts. below ground level during pre-monsoon	Depth to water level in mts. below ground level in a drought year	Rise in water level with reference to Col. 3.	Fall in water level with reference to Col. 3.
1	2	3	4	5	6
1.	Adilabad	7.35	7.23	0.12	—
2.	Nizamabad	6.84	6.60	0.24	—
3.	Karimnagar	8.27	12.85	—	4.58
4.	Medak	9.46	10.46	—	1.00
5.	Warangal	7.30	8.48	—	1.18
5.	Ranga Reddy	10.58	10.10	0.48	—
7.	Nalgonda	6.79	7.05	—	0.26
8.	Khammam	9.68	11.53	—	1.85
9.	Mahabubnagar	6.62	7.88	—	1.26
10.	Guntur	6,82	10.69	—	3.87
11.	Krishna	5.26	7.11	—	1.85
12.	West Godavari	4.31	6.13	—	1.82
13.	East Godavari	6.03	8.40	—	2.37
14.	Visakhapatnam	7.16	6.58	0.58	—
15.	Vizianagaram	5.80	7.05	—	1.25
16.	Srikakulam	8.42	9.11	—	0.69
17.	Prakasam	8.00	9.00	—	1.00
18.	Kurnool	7.19	7.00	0.19	—
20.	Nellore	4.73	5.30	—	0.57
20.	Cuddapah	8.70	10.95	—	2.25
21.	Ananthapur	8.91	9.70	—	0.79
22.	Chittoor	6.43	7.23	—	0.80

Table 4 : Statement Showing Extent of Area Having Rise/Decline of Water Table in June, 1987 as Compared to Normal Level in Andhra Pradesh

Sl. No.	Name of District	Decline in water table level in ('000) Sq. km.	No. change of water table level in ('000) Sq. km.	Rise of water table level in ('000) Sq. km.	Total area in Sq. km. in ('000)
1	2	3	4	5	6
1.	Srikakulam	0.50	0.50	4.8	5.8
2.	Vizianagaram	0.40	5.40	0.7	6.5
3.	Visakhapatnam	0.80	8.00	2.4	11.2
4.	East Godavari	0.30	9.9	0.6	10.8
5.	West Godavari	1.40	5.4	1.0	7.8
6.	Krishna	1.00	5.6	2.1	8.7
7.	Guntur	5.6	4.6	1.2	11.4
8.	Prakasam	4.0	10.1	3.5	17.6
9.	Nellore	0.3	6.8	6.0	13.1
10.	Kurnool	7.3	10.4	—	17.7
11.	Ananthapur	2.6	16.5	—	19.1
12.	Cuddapah	11.5	3.6	0.3	15.4
13.	Chittoor	0.2	13.2	1.8	15.2
14.	Rangareddy	5.15	2.1	0.45	7.5
15.	Hyderabad	—	—	—	0.2
16.	Nizamabad	2.7	5.1	0.2	8.0
17.	Medak	4.7	5.0	—	9.7
18.	Mahabubnagar	17.3	1.1	—	18.4
19.	Nalgonda	11.9	2.3	—	14.2
20.	Warangal	7.9	3.3	1.7	12.9
21.	Khammam	3.3	10.5	2.2	16.0
22.	Karimnagar	1.6	10.0	0.25	11.8
23.	Adilabad	1.0	8.8	6.3	16.1
		91.45	148.2	35.5	275.1
		33.2%	53.9%	12.9%	

TABLE—5

Table 5 : Statement Showing Area Falling Under Various D.T.W. Ranges in June, 1987 in ANDHRA PRADESH (Area in Sq. km.)

Sl. No.	Name of District	Range of D.T.W. in Mts.									
		0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-20	Total
1	2	3	4	5	6	7	8	9	10	11	12
	Coastal Andhra :										
1.	Srikakulam	—	0.7	1.60	2.6	0 5	0.2	0.2	—	—	5.8
2.	Vizianagaram	0.3	0.9	3.1	2.2	—	—	—	—	—	6.5
3.	Visakhapatnam	—	0.8	4.0	3.3	—	0.9	0.7	1.2	—	11.2
4.	East Godavari	—	3.5	3.3	4.3	—	—	—	—	—	10.8
5.	West Godavari	—	2.3	1.4	4.1	—	—	—	—	—	7.8
6.	Krishna	0.6	1.6	0.5	2.0	0.6	3.4	—	—	—	8.7
7.	Guntur	0.2	3.2	1.0	1.3	2.4	0.7	2.6	—	—	11.4
8.	Prakasam	0.1	3.0	6.4	2.4	3.2	2.5	—	—	—	17.6
9.	Nellore	—	5.0	5.0	1.9	1.0	—	—	—	—	13.1
	Rayalaseema :										
10.	Kurnool	—	—	4.6	5.8	3.0	4.3	—	—	—	17.7
11.	Ananthapur	—	—	—	5.6	4.4	5.2	2.9	—	—	19.1
12.	Cuddapah	—	—	0.3	2.8	6.0	3.8	2.1	0.4	—	15.4
13.	Chittoor	—	—	6.9	2.3	4.1	1.9	—	—	—	10.2
	Telengana :										
14.	Rangareddy										) 7.5
15.	Hyderabad				0.4	2.0	1.25	2.1	1.6	0.30	) 0.2
16.	Nizamabad	—	—	2.00	1.15	4.70	—	0.15	—	—	8.0
17.	Medak	—	—	0.1	0.5	1.85	2.70	1.2	2.8	0.4	9.7
18.	Mahabubnagar	—	—	0.8	1.9	7.0	1.9	3.6	3.0	0.2	18.4
19.	Nalgonda	—	—	—	3.5	2.0	4.7	2.1	0.4	1.5	14.2
20.	Warangal	—	—	—	4.7	4.6	2.0	0.30	1.3	—	12.9
21.	Khammam	—	—	—	6.0	1.8	2.7	4.3	8.5	—	16.0
22.	Karimnagar	—	—	—	2.4	6.0	2.0	0.6	0.8	—	11.8
23.	Adilabad	—	0.6	4.0	5.6	5.0	0.6	—	—	—	16.1
	Total :	1.2	21.6	45.3	65.95	63.15	40.75	20.85	13.0	2.4	