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Hydro-geological and Hydro-geomorphological Conditions of the Anantapur District (A.P), India

The Scientific study of groundwater requires a multi-disciplinary approach, and studies of geology, hydrology, hydro-metrology, hydro-geology, hydro-geomorphology, geo-physics and hydrochemistry are necessary for excavation, optimum utilization and sustainable development of groundwater. Groundwater exists wherever water percolate below land surface and recharge the saturated zone in depth. Different factors like morphology, slope, drainage pattern, rock types, joints, texture and structural control determine the occurrence and distribution of ground water. Remote sensing data is of immense help to evaluate the hydro-geomorphic and hydro-geological zones of any region based on physical, geological, hydrological and geo-morphological characteristics. Remote sensing data were extensively used in the present study.

Study and Data

The Anantapur district is located in the state of Andhra Pradesh of southern India within the co-ordinates of 13° 14′ N and 15° 15′ N and 76° 50′ E and 78° 30′ E. The total geographical area of the district is 19,125 sq km. The total population of the district as per 1991 census is 3.18 millions.

The main objectives of the present study are: to describe the geological, geo-morphological, and hydro-geological conditions of the district in different geological formations; to delineate the hydro-geomorphological features of the district, and to study the ground water variations, fluctuations, recharge and ground water potentials at taluk level.

Landsat imagery and FCCs on scale 1: 250,000 and geocoded data on scale 1: 50,000 have been used to delineate the major geomorphic units, and structural elements of the district based on total variations, structure, textural characteristics, and geomorphic processes. The groundwater level data over a period of ten years have been collected from 25 controlled wells to workout groundwater level data over a period of ten years have been collected from 25 controlled wells to workout ground water level variations, fluctuations, recharge and potential. The recharge has been worked out adopting U.S. Geological survey method and the methods developed by Seghal (8), Krishna Rao (2) and Radhakrishna (4). Groundwater potential has been workedout at taluk level adopting groundwater recharge and specific yield methods. The hydro-geological characteristics in major lithological units have been discussed.

Lithology

The lithological formations of Anantapur district belong to two distinct groups. They are Archean metamorphics represented by gneisses, schits, granite and proterozoics. The western part of the district is occupied by younger granites (intrusives into Archeans). The central part by Archean and the eastern part by the proterozoics i.e., the rocks belonging to the Cuddapah Super Group and Kurnool Group. Major part of the district is occupied by the crystalline rocks of schists and gneisses, and younger granites, pegmatites, quartz veins and basic dykes. Only the north eastern parts, (Tadipatri, Gooty and Anantapur taluks) are occupied by the sedimentary rocks such as quartzite, conglomerate, limestones and shales (Fig. 1).

Geomorphology

The major geographic units of Anantapur district are denudational hills, dissected pediments, pediplains, colluvial and alluvial fills. Denudational hills are remanents of the

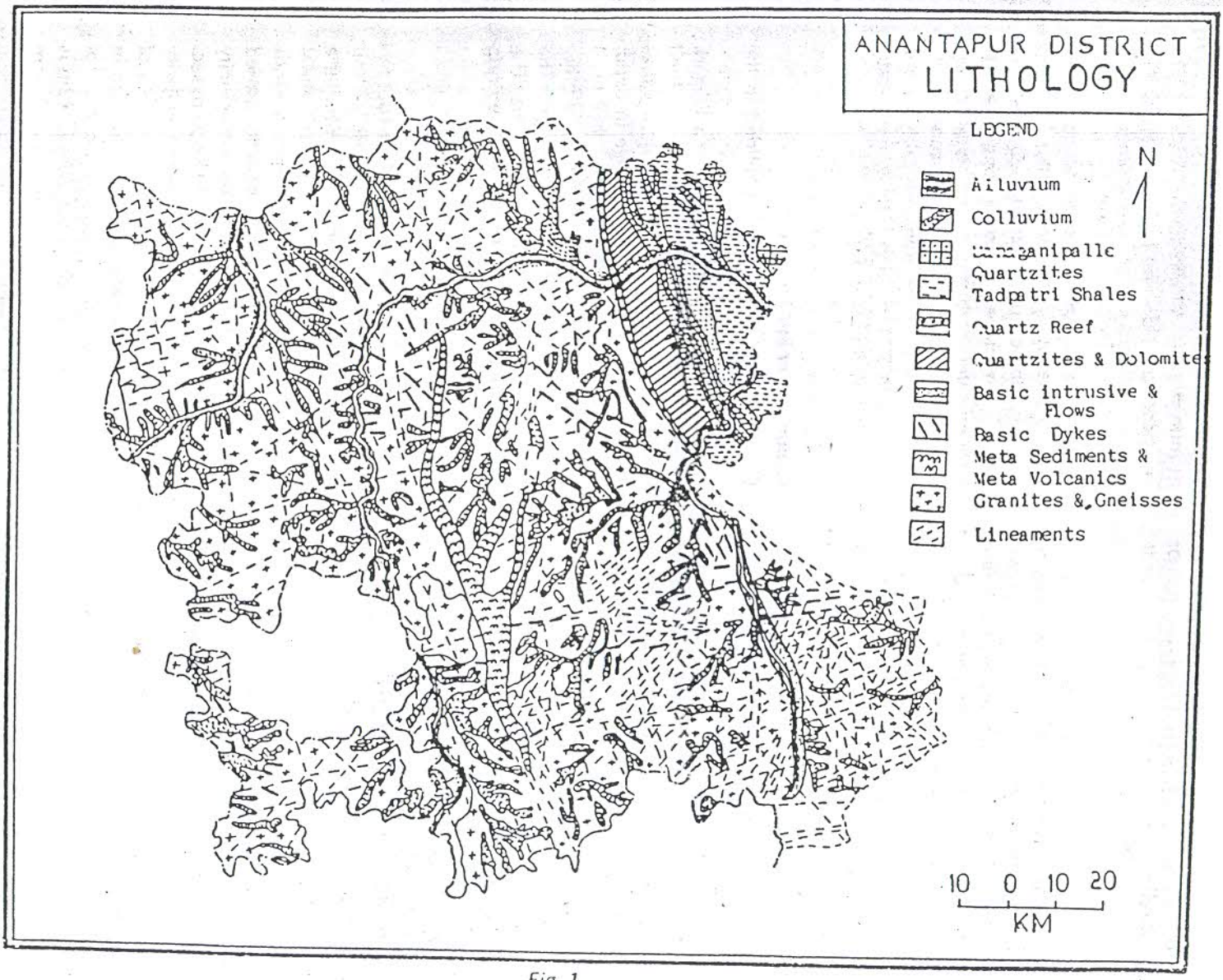
ANANTAPUR DISTRICT
LITHOLOGY
LEGEND
N
Alluvium
Colluvium
Gani pallc
Quartzites
Tadpatri Shales
Quartz Reef
Quartzites & Dolomites
Basic intrusive & Flows
Basic Dykes
Meta Sediments & Meta Volcanics
Granites & Gneisses
Lineaments
10 0 10 20
KM

Fig. 1

natural dynamic processes of weathering and denudation aided by later fluvial action; there are inselbergs, exfoliation domes, bornhardts, linear ridges, mesas, knolls, mounds and tors. The dissected pediments formed by the process of sheet flow or sheet wash overlies on granite, gneisses, and schists, and are characterised by low lying that terrain with less than 5^{o} slope. The sediments derived from the catchment areas are transported and deposited along the river courses like Pennar, Chitravati, Hagari and Papaghni and grouped under alluvial fills and consist of fluvial plains, natural levees and river terrace. The colluvium is a sheet-wash materials derived from adjoining uplands, transported over short distances into shallow valleys, and occurs along the minor streams with in the pediplains and dissected pediments.

Hydro-Geological Characteristics

Groundwater in Archaean Rocks

Groundwater in granite, gneisses, Dharwar pegmatite, schist and calcic-granite or megmatite occurs under in semi-confined conditions in weathered, fractured and jointed zones. The ground water is extracted in these zones by means of dugwells, dug bore wells, and bore wells. The depth of ground water varies from 4 to 16 m below ground level. The transmissibility ranges from 34 to 413 m^3/d/m. The groundwater yield varies from 4,500 to 34,000 lph.

Groundwater in Cuddapah Super Group

The Cuddapah Super Group is composed of Chitravati and Papaghni Series and are formed of Tadipatri shales, Pulivendula quartzite, Vempalle dolomite and Gulcheru Quartzite. Groundwater occurs in weathered, jointed and fissured zones in semi-confined conditions. The quartzitic rocks stand as ridges and occupy hilly region. Therefore, these is no development of groundwater in quartzites. In limestone terrain groundwater is found in bedding plains and solution features act as good aquifers. The transmissibility varies from 150 to 386 m^3/min/m of drawn-down water. The groundwater yield varies 12,600 to 45,000 lph.

Groundwater in Kurnool Group

The Kurnool group comprises Panyam, Jammulamadugu and Banaganapalli series and are composed of quartzites, Owk shales, Nerji limestone and conglomerates. Groundwater occurs in weathered zones, joints, fractures, caverness zones and bedding plains. The transmissibility ranges from 50 to 271 m^3/d/m. The ground water yield is low and varies from 3000 to 18,000 lph.

Groundwater in Alluvium

Groundwater in alluvium is confided to the major river belt plains of Pennar, Hagari, Chitravati, Jayamangala and Chinna Hagari. It is found under water table in semi-confined conditions. The thickness of alluvium varies from 5m to 20 m. The wells range in depth from 5 m to 9m and depth of water level varies from 4 m to 7.8 m. The transmissibility varies from 1,200 to 17,060 m^3/d/m. The irrigation capacity of wells is 8 to 15 ha. The yield of the groundwater varies from 27,000 to 1,00,000 lph.

Geo-Physical Studies

Geophysical studies were carried out to determine the nature and thickness of soil and weathered mantle and to conform that a new fractures from the study of aerial photographs and Landsat imagery. In sands and sandy soils the sesmic velocity varied from 350 to 700 m/sec. The sesmic velocity in weathered zones varies 600 to 800 m/sec. In the fractured zones the sesmic velocity ranges 5000 to 6000 m/sec. The thickness of weathered zones varied from 3 m to 15m in general. The maximum thickness of weathered zone ranging from 20m to 22m is noticed in Kanganapalli and Konapuram areas. In Bathalapalli and Dharmavaram zones the thickness varies from 10m to 15m.

Hydro-Geomorphological Characteristics

The approach adopted to hydro-geomorphological mapping is to identify various landforms and their ground-water prospects from tapping ground water resources. The IRS-IA data of the study area was interpreted on 1: 50,000 scale to derive hydro-geomorphological information. The details derived from remote sensing data has been coupled with elevation, slope and drainage information from the Survey of India (SOI) toposheets to delineate potential zones for ground water development, and further verification in the field has also been carried out.

The hydro-geomorphic units of Anantapur district have been delineated based on terrain characteristics, hydrological and geo-hydrological conditions in different geological formations. The various hydro-geomorphic units of Anantapur district arranged in their hierarchy are alluvial plains (excellent), terrace plains (very good), colluvial plain (good), black soil plains (very fair), pediplain (fair), dissected pediments (poor) and hilly terrain (unproductive and runoff zones) (Fig. 2).

Ground Water Level Variations

The seasonal and annual groundwater level

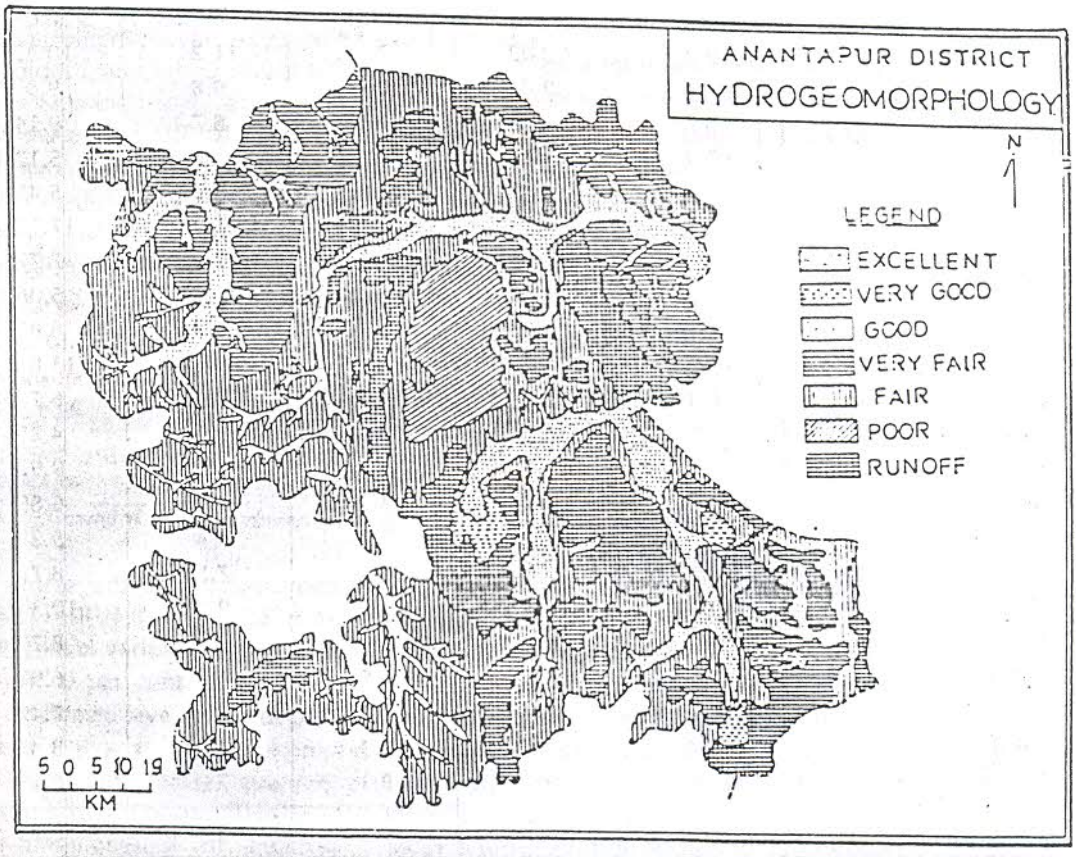

Fig. 2

variations have been computed for about 25 controlled wells based on monthly data collected over a period of 10 years. The analysis reveals (Table 1) that the average groundwater level of the district in winter period is 8.63 m. The groundwater level varies from 4.7m to 17.5m. In the majority of the wells the groundwater is above 7 m. In the summer period the average groundwater level is 8.99 m. The mean groundwater level varies from 3.33m to 19.1m. The groundwater level has exceeded 7 m in about 90 per cent of the wells. During southwest monsoon period the average groundwater level of the district is 19.23 m. In about 80 percent of the wells the groundwater level exceeded 7 m depth. During northeast monsoon period the mean groundwater level

Table 1
Groundwater Level Variations in the Controlled Wells of Anantapur District

(All values in meters)

Well Location	Winter	Summer	S.W. Monsoon	N.E. Monsoon	Annual
Anantapur	9.1	8.6	9.82	9.62	9.28
Jallipalli	17.5	17.4	16.1	16.00	16.75
Marur	6.45	7.63	9.36	8.72	8.04
Rolla	9.9	10.02	12.4	11.2	10.92
Konakondala	9.9	9.8	9.9	9.8	9.85
Tadimarri	8.23	9.73	10.33	8.7	9.14
Polthur	5.4	5.1	5.3	4.7	5.12
Gooty	4.7	6.1	5.3	4.9	5.45
Kadavakallu	16.7	19.1	19.2	13.7	17.17
Karhaparthy	7.9	7.9	7.8	7.8	7.77
Adavibramhanapa	6.25	7.45	4.1	2.67	5.06
Jonnlakothapalli	7.16	7.93	6.91	5.34	6.83
Kundurpi	10.6	11.6	12.4	20.6	13.8
Golla	6.3	7.1	6.9	6.5	6.7
Kistipadu	5.2	3.3	5.4	3.5	4.35
Veerapuram	10.2	10.2	9.5	9.8	9.92
Bommanahal	6.83	7.1	7.04	6.49	6.85
Beluguppa	11.3	7.5	9.9	8.4	9.27
Dharmavaram	9.2	9.3	8.9	7.5	8.72
Nallacheruvu	9.7	10.6	11.5	9.7	10.37
O.D. Cheruvu	7.9	8.7	9.6	8.7	8.72
Penukonda	7	7.3	7.5	6.1	6.97
C.K. Palli	6.6	8	8.3	7	7.47
Tanakal	8.4	8.7	9.3	7.4	8.45
Talapula	7.4	9.7	8.3	7	8.1
Average	8.63	8.99	9.23	8.47	8.83

Source : Ground Water Department, Anantapur.

Table 2
Groundwater Level Fluctuations in the Controlled Wells of Anantapur District

(All values in meters)

Well Location	Winter	Summer	S.W. Monsoon	N.E. Monsoon	Annual
Anantapur	0.2	1.3	0.84	0.42	2.34
Jallipalli	0.2	0.3	1.7	2.1	2.7
Marur	0.52	1.28	0.45	4.78	3.28
Rolla	1	0.3	2.4	0.6	3.9
Konakondala	0.2	0.3	0.3	1.5	1
Tadimarri	0.1	0.4	0.6	1.3	1.5
Polthur	0.1	0.63	1.35	1.9	3
Gooty	1.9	1.6	1.7	0.1	1.32
Kadavakallu	1	2.1	1.2	0.9	3.1
Karhaparthy	0.2	0.2	0.4	0.1	0.5
Adavibramhanapa	0.5	3	1.8	2.5	3.5
Jonnlakothapalli	0.4	0.32	2.24	0.17	2.83
Kundurpi	0.2	0.9	1	0.4	3.4
Golla	0.2	0.4	0.7	0.7	1.2
Kistipadu	0.5	0.1	0.7	0.2	1.5
Veerapuram	0.1	0.2	4.2	0.3	2.3
Bommanahal	0.1	0.3	0.6	0.3	0.9
Beluguppa	0.2	0.3	2	0.3	0.7
Dharmavaram	0.1	0.5	0.4	0.83	2.4
Nallacheruvu	1.2	0.5	1.3	0.6	3
O.D. Cheruvu	0.4	0.8	0.7	0.7	2.2
Penukonda	0.4	0.9	1.2	0.5	2.1
C.K. Palli	0.6	2.3	0.5	1.2	2.5
Tanakal	0.25	0.2	1.3	0.8	2.7
Talapula	1.4	0.7	1.2	0.3	3.2

Source : Ground Water Department, Anantapur.

of the district is 8.47 m. The average ground water level varies from 2.67 m to 20.6 m. In about 70 per cent of the wells, the average groundwater level exceeded 7m. The mean annual groundwater level in the district is 8.83 m. The annual average groundwater level ranges from 4.75 m to 17.17 m. In about 18 wells the ground water level has exceeded 7 m depth from the ground level.

Groundwater Level Fluctuations

The average groundwater level of the district has been computed for seasonal and annual basis for 25 controlled wells based on differences from maximum and minimum water level in each season and year (Table 2). During the winter period the groundwater level fluctuations vary from 0.1 m to 1.9 m. In about 15 controlled wells the fluctuations in winter period is less than 0.5 m. It exceeds

Table 3
Groundwater Recharge in Selected Stations of Anantapur District

(All values in meters)

Name of the Station	Seghal Method (8)	Krishna Rao Method (2)	Radha Krishan (4)	U.S. Geological Survey Method	Average
Anantapur	144.8	27.9	53.9	80.9	76.8
Gooty	160	33.5	56.8	85.1	83.9
Bukkapatnam	182.9	42.7	61.4	92	94.8
Yadiki	114.3	17.5	48.8	73.2	63.5
Dharmavaram	139.7	25.4	52.7	79.1	74.2
Rayadurg	121.9	20	50	75	66.7
Kadiri	182.9	42.9	61.5	62.2	94.9
Kalyandurg	132.1	23	51.5	77.3	71
Hindupur	167.6	36.7	58.3	87.5	87.5
Madakasira	162.6	34.7	57.3	86	85.2
Penudonda	172.7	38.6	59.3	89	89.9
Uravakonda	137.2	24.8	52.4	78.6	73.7
Tadpatri	149.9	29.1	54.6	81.8	78.9

Source : Ground Water Department, Anantapur.

0.1 m in three wells and in other wells it ranges from 0.5 m to 1.0 m. During summer period the fluctuations of groundwater level vary from 0.1 m to 3.0 m. In about 13 wells it is less than 0.5 m. It exceeds 1.0 m in 5 wells and in other wells it ranges from 0.5 m to 1.5 m. During southwest monsoon period the fluctuation in ground water level varies from 0.3 m to 4.2 m. In about 3 wells the fluctuation is less than 0.5 m. It exceeds 1.0 m in 7 wells. The annual groundwater level fluctuation in the district ranges from 0.5 m to 3.9 m in 3 wells. The ground water level fluctuation is less than 0.1 m in 3 wells. It varies from 1.0 m to 2.0 m in 4 controlled wells and exceeds 2.0 m in other controlled wells.

Groundwater Recharge

The groundwater recharge has been worked out by Seghal (8), Krishna Rao (2), Radhakrishna (4) and U.S. Geological methods. The average of the four methods is taken as annual groundwater recharge (Table 3). In Seghal method the annual recharge varies from 114.33 mm to 182.90 mm. In Krishna Rao (2) method the recharge values obtained are low and vary from 17.5 mm to 42.9 mm. In Radhakrishna (4) method the ten per cent of the annual rainfall is taken as annual recharge for each station. The annual recharge worked by this method ranges from 48.8 mm to 61.5 mm. In U.S. Geological method 15 per cent of annual rainfall is considered as annual recharge. The recharge in the method varies from 73.2 mm to 92.2 mm. From the average values of the above said four methods, it is found that the annual recharge varied from 634.55 mm to 94.9 mm. The average annual recharge of the district is 80.07 mm which worked out to be 14.32 percent. In other words about 14.32 per cent of total surface water resources is recharged annually to the groundwater.

Table 4
Groundwater Potential of Anantapur District

Name of the Taluk	Ground-water potential in million cubic meters	Number of wells feasible
Anantapur	149.1	12118
Dharmavaram	90.1	7325
Gooty	75.0	6098
Hindupur	34.5	2805
Kadiri	171.9	13975
Kalyandurg	106.6	8667
Madakasira	67.0	5442
Penukonda	78.1	6346
Rayadurg	126.8	10305
Tadipatri	95.1	7728
Uravakonda	59.5	4832

Source : Groundwater Department, Anantapur

Groundwater Potential

The groundwater potential has been worked out by adopting rainfall recharge and specific yield methods (Table 4). The total groundwater potential of the district is estimated to be 1,054 million m^3. The groundwater potential varies from 34.5 million m^3 in Hindupur taluk to 171.9 million m^3 in Kadiri taluk to in seven taluks the groundwater potential is less than 100 million m^3.

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Geo-medical Analysis of Leprosy Patients in Tamil Nadu

Leprosy is a chronic infectious disease caused by Mycobacterium Leprae (6). It is one of the major social diseases and today it continues to remain as an important public health problem among poor socio-economic strata of society (1, 4). The monotherapy treatment as a standard drug in all forms of leprosy has remained important for long. Treatment with monotherapy is a prolonged one because the drug kills the leprosy germ slowly (5). The Multidrug Therapy (MDT), an improved treatment regiment, was introduced and this has made leprosy treatment far more effective and capable of solving the problem of drug resistance (2, 3). The MDT programme was implemented in various districts of Tamil Nadu in a phased manner since 1983.

Methodology

The present investigation based on primary data was attempted with the help of a questionnaire survey by direct observation method. The questionnaire survey is suitably designed through open and closed questions. The behavioural and psychological dimensions of monotherapy patients were based on the survey of 600 leprosy patients drawn on the basis of stratified random sampling. As much as 33 variables explaining the behavioural and psychosocial characteristics of leprosy patients were extracted from the questionnaire survey. The behavioural and psychosocial variables were studied with the help of the application of multivariate statistical technique known as Factor Analysis.

The application of factor analysis has identified the fourteen major dimensions (Table 1) with an eigen value ranging from 1.00 to 3.23, accounting for a total variance