THEME 8

GENERAL ASPECTS OF FLOODS AND LOW FLOWS

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AN INTEGRATED STRATEGY FOR WATER CONSERVATION AND DEVELOPMENT FOR DROUGHT EXTREMES

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SYNOPSIS

In the recent past droughts of exceptional severity have caused major hardship in many areas of the country. The remedial measures that are being taken so far on an area basis or programme basis to mitigate the effects of drought are not yielding productive results for water conservation and development. To plan and implement the concept of integrated approach to water conservation and provide relief measures under extreme conditions a typical drought prone region of Andhra Pradesh is chosen for thorough and interdisciplinary investigations. The total quantum of surface and subsurface water as single integrated system is demonstrated. The available water potential in the watershed is estimated by different methods for arriving at medium and long term planning for development. These studies resulted in developing a crop calender involving various components of relief and evolving a plan of action for implementation of the integrated concept for drought extreme situations.

1.0 INTRODUCTION

The drought relief measures that are being taken on an area basis or programme basis for assured supply of water resources are not yielding adequate results for arriving at any effective measures of relief. Even some areas, when considered on watershed basis, are also not providing the correct assessment in the absence of well defined surface drainage and subsurface ground water boundaries. Further the limitation on the availability of water resources in these areas makes it inevitable to seek integration of alternative methodologies such as modified cropping pattern, soil and water conservation, economic and commercial assistance to optimise the available resources so that effects of drought are minimised, continued sustenance is provided and repetitive investments for relief are avoided.

To demonstrate the concept of total water resource management as a single component and further to integrate, translate and implement various practices of relief, a typical drought prone region of Andhra Pradesh in Mahaboobnagar district is chosen for a well planned, systematic, integrated and interdisciplinary investiga tions.

2.0 WATERSHED AND ITS ENVIRONMENT

Burgul watershed situated in Mahaboobnagar district lying in the rain shadow of the Deccan Plateau is one of the drought affected regions of Andhra Pradesh. The area lies between latitudes 16°55 - 17°05 'N and longitudes 78°10'-78°10' - 78°60' 'E and falls in the toposheet No. 5/6/L/1 & K/4. It extends over an area of 3200 hectares comprising of Balanagar, Burgul, Gantlavelli and Timmajipally villages. The area is about 8 KM south-east of Shadnagar which is situated on Hyderabad-Kurnool National Highway No.7. Most of the villages in this region can be approached only through weathered roads.

The climate of the watershed is generally warm and dry. The maximum temperature in summer varies from 38°C to 43°C and the minimum temperature during the winter ranges from 10°C to 16°C. The watershed does not enjoy the full benefits of either southwest or north-east monsoon. Usually, the maximum rainfall is experienced between, June to September and the average annual rainfall is around 788mm.

The watershed is drained by rivulets passing centrally in the area through Balanagar, Burgul, Gantlavelli and Timmajipally villages. Balanagar tank forms the outlet for surface and subsurface water sources of the watershed. There are six small kuntas which intercept the runoff in the watershed.

3.0 WATER & LAND UTILISATION

Water resources in a region are normally utilised to a very large extent towards agricultural purpose and the balance being towards human and livestock consumption. The agricultural practices in the region are therefore studied in detail to assess the water and land resources utilisation pattern. The major crops grown in the watershed area are indicated in Table 1. As can be seen from the Table, the dry crops are covering 85.7% of the area by occupying about 2500 ha followed by wet crops with 9.2% and then irrigated dry crops with 5.1% of the area.

The total land utilisation particulars under various categories including the existing crops are presented in Table 2.

S.No.	Category	Area (Ha)
1.	Total geographical area	3200
2.	Gross cultivated area	3100
3.	Net cultivated area	2876
4.	Area under rainfed crops	2466
5.	Irrigated area	410
	a) Under tanks	142
	b) Under wells	268
6.	Land put to non-agricultural use	212
7.	Cultivable waste	112
8.	Forests, Pastures, fallows	NIL
9.	Barren and un-cultivable land	NIL

TABLE 2: LAND UTILISATION PARTICULARS IN WATERSHED REGION

It can be seen from the Table that no land in the region is covered under forest, pastures or fallows. The land utilised for non-cultivable purposes is around 212 ha only. The cropping intensity is just above 100%.

4.0 GROUND WATER POTENTIAL & DEVELOPMENT

Ground water potential in the watershed is greatly restricted to the areas of steep slopes and dissected pediments of rocks and soils, in the midslopes and low lying areas (Briz-Kishore, 1986). The potential in the area is estimated by two methods i.e. (a) Water balance and (b) Water table fluctuation method, as detailed below:

(a) Water balance method:

In this method, the total groundwater recharge is computed by considering various components, namely, rainfall, applied irrigation, contribution from surface water bodies and canal seepages. However, in the absence of major canals and surface water bodies in the region, only two components, i.e. rainfall and applied irrigation are observed to be mainly contributing to the recharge. While computing the amount of contribution for recharge due to rainfall and applied irrigation an infiltration factor of 15% is considered (Briz-Koshore, 1983) since the basin is characterised by gentle slopes with less than 2%. Based on the infiltration factor, recharge due to applied irrigation in Rabi and Khariff, the recharge to the ground water is arrived at (Briz-Kishore, 1986) by water balance method as 485 ha m.

(b) **Water Table Fluctuation Method:**

No monitoring of water levels is carried out in the watershed region. However water levels were systematically monitored over a period of five years at different locations encircling the watershed region and the average fluctuations is arrived at as 4m (Briz-Kishore, 1981).

Specific yield value as determined in analogous terrains (Briz-Kishore, 1982) is considered to be 4%. Accordingly the ground water recharge is computed taking into consideration the total geographical area, average water table fluctuation and specific yield and it is found to be 512 ha m.

It can be observed that the estimated recharge available to ground water is more or less same in both the methods. Thus, the watershed area having a net ground water potential of 512 ha m provides substantial scope for development.

GROUND WATER DEVELOPMENT

It is known that the normal draft of a dugwell fitted with 3HP pumpset, operated for about 200 days at the rate of 4 hours per day, is about 1.2 ha m per annum. The maximum number of wells additionally feasible for the watershed can be arrived at by dividing the net ground water potential with the normal draft, which works out to 426 wells.

Since 25% of the watershed area is characterised by valley bottoms and low lying areas with sufficiently thick weathered zones and fractures, 50% of the total available draft i.e. 256 ha m can be drafted from these regions. So, the number of borewells feasible with the drafting capacity of 3 ha m in this region is 256/3 = about 85 wells, and the remaining ground water can be tapped through 213 dugwells at the rate of 1.2 ha m.

The well density of the 85 potential tube wells, over 25% of the geographical area (i.e. 10 sq.KM) works out to 8.5 wells/sq.KM with the distance between the wells being about 350 m. Totally these 85 bore wells and 213 dug wells create an irrigation potential of 766 ha in Khariff, 383 ha in Rabi (Briz-Kishore 1986).

The estimated cost of the construction and development of these irrigation wells is presented in Table 3.

S.No.	Item	No's	Unit Cost (₹)	Total Cost (₹.lakhs)
1.	Drilling of 'In-Wells' bores of '10 cm' dia one each in 100 dug wells to an average depth of 100m @ ₹.150 per meter	100	3,000	3.00
2.	Drilling of 15 cm dia Bore wells to average depth of 50m and installing submersible pumps of 5 HP (average) @₹.18,000 for each pump.	85	30,000	25.50
3.	Construction of dug wells and dug-cum bore wells and installing centrifugal electric motors of 5 HP @₹.12,000/- for each motor.	213	30,000	63.90
			TOTAL:	92.40

TABLE 3: COST ESTIMATE OF CONSTRUCTION OF NEW IRRIGATION WELLS

As can be seen from the table, the total cost for development of the above wells works out to about ₹.93.00 lakhs.

5.0 SOIL AND WATER CONSERVATION

5.1 SOIL CONSERVATION

Areas covered with soil conservation is shown in Fig.1 and villagewise area covered with contour bunding is presented in Table 4.

S.No.	Village	Area covered with contour bunding (ha)
1.	Balanagar	51.26
2.	Burgul	471.85
3.	Gantlavelli	27.60
4.	Timmajipalli	-
	TOTAL	550.71

TABLE 4: VILLAGEWISE AREA COVERED WITH CONTOUR BUNDING IN THE WATERSHED REGION.

It can be seen from the Table that only 18% of the total area constituting 550 ha is covered with contour bunding leading to large scale soil erosion and water losses. In order to prevent the soil erosion and augment the water conservation which helps in recharging the ground water, soil conservation measures have to be extended to the entire cultivable land. Summer ploughing and blading should be done to intercept the runoff during monsoon. Growing of crops should be done across the slopes, so that the running water can be regulated. The waterways should be grassed so that the amount of soil erosion is minimised.

5.2 SOCIAL FORESTRY

Social forestry through man-made plantation helps the water conservation, soil nutrition, protecting the land against erosion and ultimately contributing to the fuel and wood requirements. Further, the organic substances left by the social forestry will enrich the soil conditions. It is observed that a stretch of about 36Km along the road side and railway track can be conveniently utilised for social forestry. Since the region consists of lighter soils, quick growing trees like Eucalyptus, Koobabul Bet, etc. are most suitable and recommended for such purposes. These studies further indicated that there is a vast scope for aforestation in about 180 ha, particularly along the uplands of the watershed peripheries (Fig.1) where the poor denuded soil exist and do not offer any scope for raising any crop with reasonable returns.

5.3 MINOR IRRIGATION

The Minor Irrigation tanks existing under each village with their corresponding ayacut commands are studied in detail. It is observed that there are only 6 tanks (Fig.1) under which total localised ayacut is 141.63 hectares. All these tanks are utilised to irrigate in Khariff only. During recent reconnaissence it was observed that almost all the tanks are dry in Rabi period and two of them at Balanagar and Gantlavelli are breached. There is no base flow observed in any stream. This clearly indicates that there is an immediate need for restoration of all the six tanks to store adequate water. The storage can be greatly increased by desilting. It is also considered important to locate two or three precolation tanks in the area where the basement is deep, after evaluating the catchment, stream flows, permeability and porosity, yield of wells, water levels and recouperation rates.

6.0 INTEGRATION

It is mentioned in the previous sections that 512 ha m of ground water potential is available in the watershed which can irrigate 766 ha in Khariff and half the area in Rabi. Presently 2466 ha area is occupied (Table 1) by rainfed crops of which 766 ha can be converted to irrigate dry crops consuming the entire ground water potential. To have a clear understanding of the alterations of agricultural practices in water-shed, the existing and proposed cropping patterns are presented in Table 5.

S.No.	Crop type	Existing Area ha			Proposed Area ha		
		Kharif	Rabi	Total	Kharif	Rabi	Total
1.	Wet	366	124	490	366	124	490
2.	Irrigated Dry	44	100	144	810	483	1293
3.	Dry	2466	-	2466	1700	-	3483
	Total	2876	224	3100	2876	607	3483

TABLE 5: DETAILS OF EXISTING AND PROPOSED CROPPING PATTERNS.

It can clearly be seen from the Table that proposed cropping intensity is getting enhanced to about 121% from the present stage of about 107%.

With the integration of basic inputs discussed earlier, it is possible to double the yield of irrigated dry crops from the existing value of 7 quintals per hectare to 15 quintals per hectare by selectively choosing the cropping pattern as indicated in Table 6. It is further interesting to note from Table 6 with the above outlined efforts, the present revenues from agricultural produce will be improved from the existing ₹.36.94 lakhs to ₹.138 lakhs per annum, thus achieving about 400% growth in agricultural income in addition to acting as efficient drought remedial measure and thus avoiding repetitive investment in relief measures.

The proposed integrated development of watershed calls for the involvement of various agencies and requires co-ordinated efforts of a centralised organisation so as to minimise the redundancy of works and plan ahead for effective drought relief measures. It is appropriate that the Rural Development Authority, which is mainly concerned with the relief works acts as the centralised organisation (nodal centre) at State level in integrating the various departmental activities for systematically designing, implementing and monitoring relief measures, as indicated in Fig.2.

The figure vividly depicts the organisation and distribution of the works related to relief activities in areas with hydrology of extremes among different departments. A crop calender involving all these components of relief is designed to translate the schematic design given in Fig.2. into an action plan and thus pave way for accruing all the benefits of the efforts and the expenditure incurred on relief measures. The crop calender designed based on these studies is presented in Table 7.

7.0 CONCLUSIONS & RECOMMENDATIONS

The investigations reveal that the approach to drought extremes with the concept of total water Resources as a single system and integration of various other measures will yield much better results when compared to the concept of relief measures taken up on programme basis or area basis in terms of (a) Improving economic conditions of the region (b) minimising the repetetive investments on the region beside providing adequate relief.

The plan of action emerged out of the above integrated approach is enshrined as follows:

1) Undertake studies on climate, hydrometeorology, agronomy and on local management techniques in order to define the best means of extending and intensifying irrigated dry cultivation while incurring a minimum of risk from scarcity of rainfall.

2. Make an inventory of all available water resources, and formulate long-term plans for their development as an integral part of the development of other natural resources, and within this framework prepare medium-term and long-term plans for the development of these water resources.

3) Consider the transfer of water from areas where surplus water resources are available to areas of deficiency.

4) Intensify the exploration of ground water through geophysical and hydrogeological investigations and undertake regionwise large-scale programmes for the development of wells and boreholes to be explored in groups wherever appropriate, for water for human and live-stock consumption, taking into account the needs of pastures while preventing overgrazing and avoiding over-exploitation of underground aquifers.

5) Determine the effect of drought on aquifers and assess the response of ground water systems to drought, basing such assessment on concepts such as storage/flow ratio in order to characterise ground water flow regions in periods of drought.

6) Arrange to complete the feasibility reports for well defined surface water sources as expeditiously as possible for the implementation of projects deemed to be feasible.

7) Make arrangements for the proper maintenance of existing wells and for the construction and development of new ones, using the resources and energies of the affected population in rural areas on the basis of self-help, supplemented by State assistance and external resources.

8) Undertake studies on technologies geared to the improvement of water pumps, efficiency of usage and the reduction of losses from evaporation, seepage, transpiration etc.

9) Study the potential role of integration of surface and underground phases of water basins utilizing the stocks of water stored in ground water formations in order to maintain a minimum supply under drought conditions.

10) Carryout research on the basic causes of drought and develop the drought-resistant plant species as a part of social Forestry Programme.

11) Strengthen institutional arrangements, including cooperation among various agencies for the preparation and disemination of hydrological, hydrometeorological and agricultural forecasts and for the use of this information the management of water resources and disaster relief.

12) Eolve contingency plans to deal with emergency situations in drought affected areas, with a view to reduce harmful effects on the ecosystem.

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S.No.	Crop Type / village	Paddy		Total	Irrigated Dry					Dry or rainfed (Kharif)					
		K	R		Ground nut	Wheat	Chillis	Veg.	Total	Jowar	Bajra	Ragi	Castor*	Pulses	Total
					K R	K R	K R	K R							
1)	Balanagar	73	50	123	30	-	8	5	43	134	5	50	150	74	413
2)	Burgul	168	86	254	40	10	8	20	78	750	42	300	400	700	2192
3)	Gantlavelli	8	-	8	-	-	8	10	18	140	16	50	100	151	457
4)	Timmajipally	17	-	17	5	-	-	-	5	90	-	40	24	20	174
	Total	266	136	402	75	10	24	35	144	1114	63	440	674	945*	3236
	*Less Inter crop pulses														770
															2466

TABLE 1: EXISTING AGRICULTURAL PATTERN IN WATERSHED REGION.

Sl. No.	Crop Type	Cultivated area		Yield per ha (quintals)		Total production (quintals)		Value of agricultural produce per ha (Rs)	Total value	
		Existing	Proposed	Existing	Proposed	Existing	Proposed		Existing	Proposed
1.	Wet	490	490	14	30	6,860	14,700	300	20.58	44.10
2.	Irrigated Dry	144	1,293	7	15	1,008	19,395	400	4.03	77.50
3.	Dry	2,466	1,700	5	10	12,330	17,000	100	12.33	17.00
	Total	3,100	3,483			20,198	51.095		36.94	138.60

TABLE 6: DETAILS OF EXISTING AND PROPOSED AGRICULTURAL PRODUCTION AND ITS VALUE

DEPARTMENT	Dec,Jan,Feb.	Mar,Apr,May	June,July,Aug	Sept,Oct,Nov.
1. AGRICULTURE	1.Collection of soil samples. 2.Preparation of individual plans for farmers. 3.Survey for soils conservation work.	1.Arranging training camps for farmers for Kharif. 2.Assessment of input requirements. 3.Arranging summer ploughing. 4. Supply of seeds. 5.Supply of credits. 6.Communication of soil testing results.	1.Raising community paddy nurseries. 2.Arranging mass scale sowings of Jowar in entire watershed area with onset of monsoon preferably within 8 days. 3.Sowing of other I.D.and dry crops and transplanting paddy. 4.Interculture operations and top dressing of Wet & I.D.Crops with fertilizers. 5.Post Management. 6.Assessment of input requirement for Rabi. 7.Supply of seed during Aug.for Rabi. 8.Training camps for Rabi.	1.Supply of credits for fertilizers. 2.Intercultural operations for Rabi. 3.Post Management for Rabi crops.

DEPARTMENT	Dec, Jan, Feb	Mar, Apr, May	June, July, Aug	Sept, Oct, Nov.
II. SOCIAL FORESTRY	1.Identification of areas for afore-station. 2.Raising of required number of seedings.	---	1.Planting of seedings for social forestry.	
III. COOPERATIVE DEPARTMENT	1. Collection of applications for credit requirements from individual cultivators for Kharif.	1.Processing of applications and according sanctions. 2. Issue of loan amounts. 3.Collection of applications for Rabi loans.	1.Processing of application for Rabi and according sanctions. 2.Issue of loan amounts.	
IV. MINOR IRRIGATION	1.Preparation of estimates for the repairs of minor irrigation tanks.	1.Restoration tanks. 2.Desilting		
V. STATE GROUND WATER DEPARTMENT	1.Survey for declination of aquifers. 2.Geophysical investigations for demarcation of bed rock profile. 3.Site selection for various types of wells.	1.Drilling of pilot bore-wells. 2.Drilling of production borewells. 3.Digging of open wells. 4.Collection of meteoro-logical data.	1.Stream flow measurement. 2.Chemical analysis 3.Collection of meteoro-logical data.	1.Stream flow measurement. 2.Chemical quality monitoring. 3.Collection of Meteorological data.

DEPARTMENT	Dec,Jan,Feb.	Mar.Apr,May.	June,July,Aug	Sept,Oct,Nov.
	4. Establishment of Hydrometeorological stations.			
	5. Selection of observatory wells wells for ground water monitoring.			
VI. A.P.S.I.D.C. & A.P.S.E.B.	1. Installation of Conveyance system by A.P.S.E.B.	1. Construction of borewells.	Continued	Continued
		2. Energisation of borewells & dugwells.		
		3. Installation of conveyance system by A.P.S.E.B.		
VII. MARKET AVENUES DEPT.	1. Arranging disposal of Rabi Agricultural produce.			Arranging disposal of Khariff produce.
	2. Preparation of preservative techniques.			

TABLE 7: PROPOSED CROPPING CALENDER

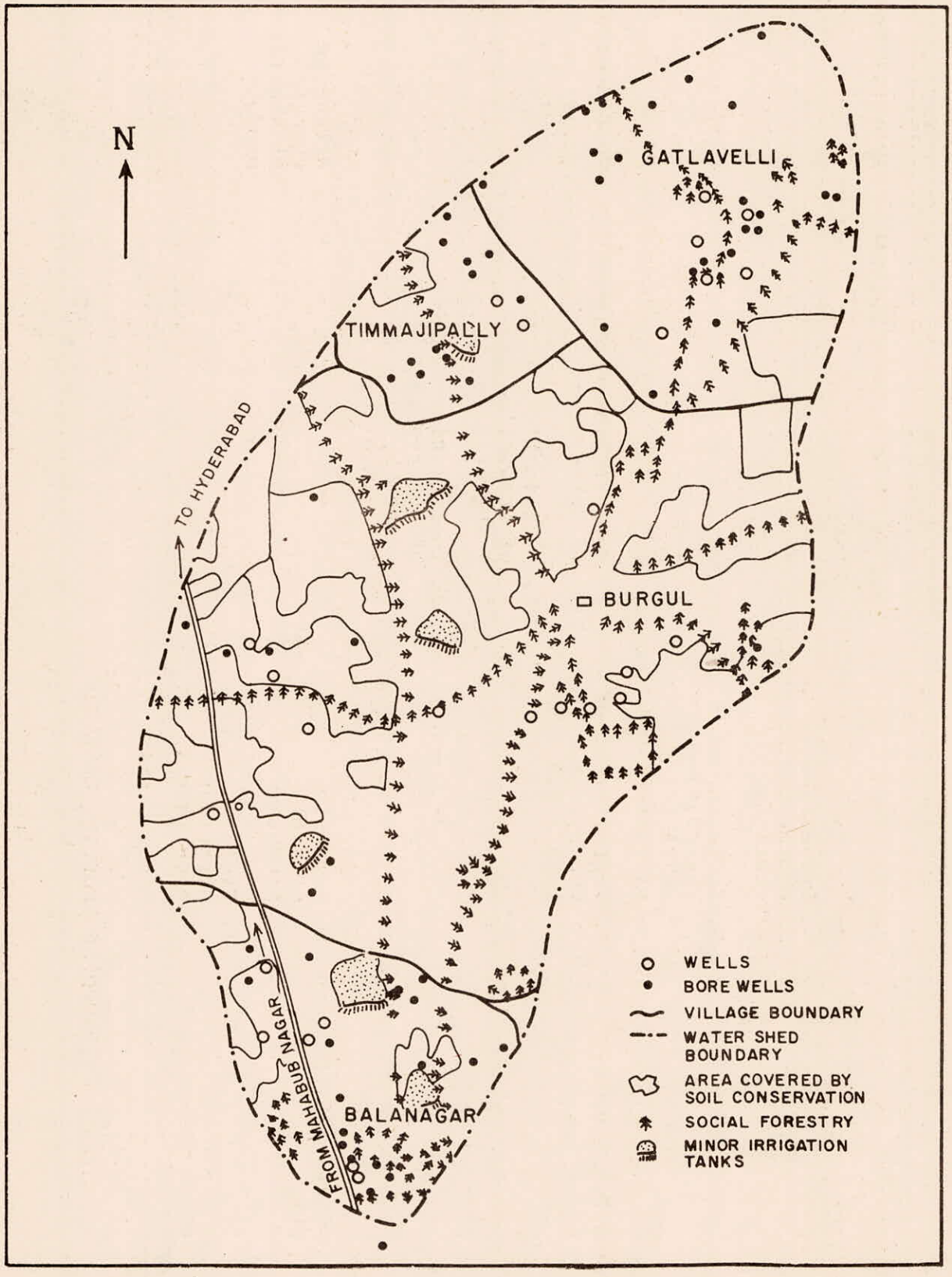

Figure 1 : Location Map of the Watershed

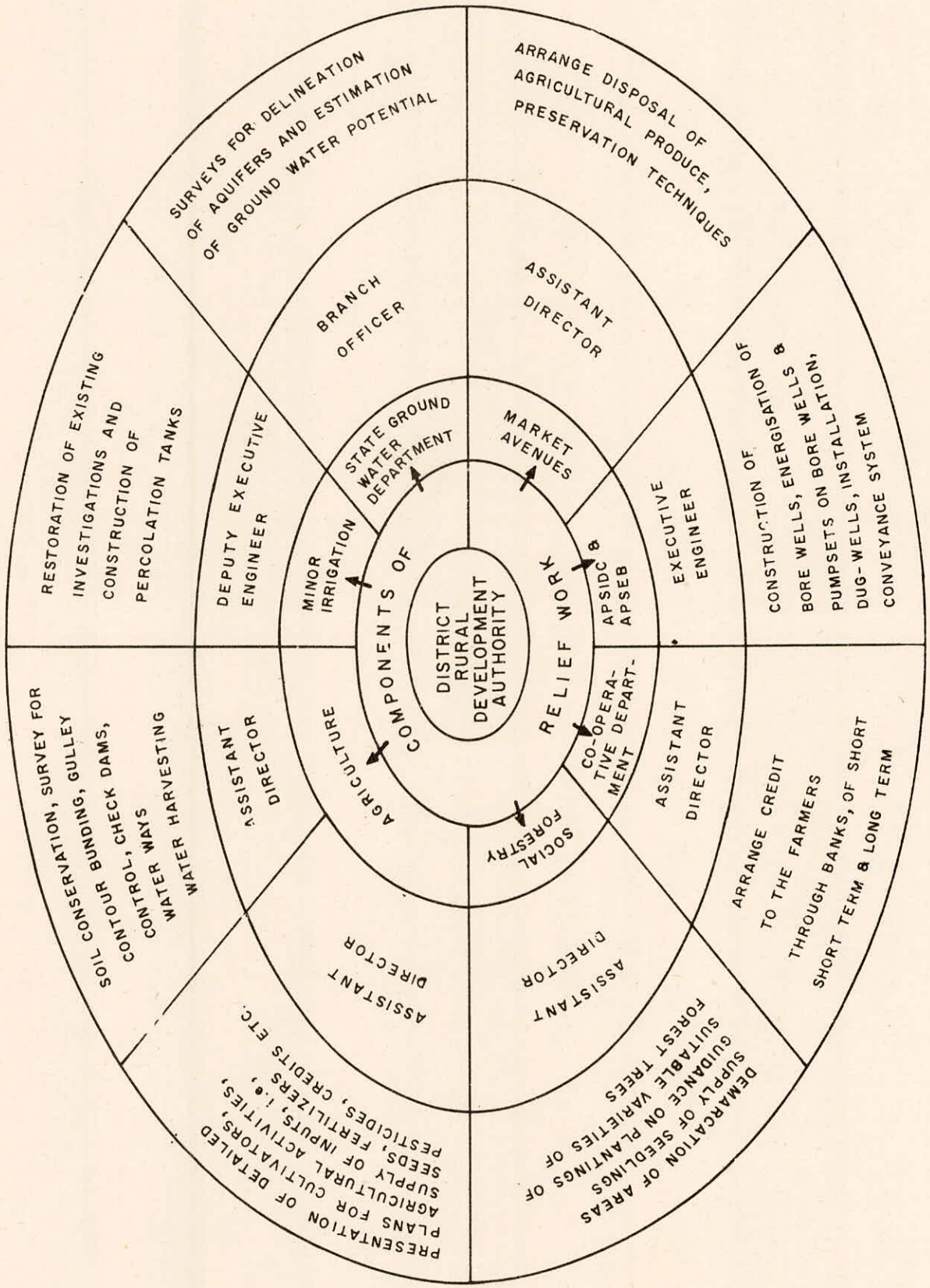

Figure 2 : Integrated Plan of Drought Relief