MAPPING OF WATERLOGGED AREA BY REMOTE SENSING TECHNIQUES

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Abstract *Waterlogging is becoming a serious problem in irrigated command area of India; the study area is SriRam Sagar command, which is about 120 km north of Hyderabad. An attempt has been made to make an assessment of waterlogged areas during pre & post monsoon period in the SriRam Sagar command using remotely sensed and field data. IRS-1A-LISS-II digital data (CCT's) of April 12 and October 6, 1989 were analysed to assess the waterlogged areas in SriRam Sagar command. The validation of the IRS derived waterlogged area was done with the available water table depth data and other field informations. The result obtained from this study indicate that in April and October, 1989, an area of 388 and 540 sq.km was waterlogged. It is suggested that periodic assessment of waterlogging using remotely sensed data should be carried out in the SriRam Sagar command. The IRS data have been proved to be very successful for the assessment of waterlogging. Gray level slicing is useful technique to make an assessment of waterlogged areas in irrigated command area.*

INTRODUCTION

Unscientific management of water, soil and crops in irrigated command areas and obstruction of natural drainage system by various man made activities are the reasons to disrupt the balance of water inflow-outflow culminate into waterlogging and salinity (Joshi and Dinkar 1996). Under irrigated conditions, farmers resort to uncontrolled irrigation that in turn leads to excess water getting added to the ground water table. With subsequent irrigation done unjudiciously, the excess water induces the raising of water table (Bouwer et al 1990). Waterlogging in the low lying areas is also created due to seepage from irrigated upland and seepage from canal system (Chitale, 1991). The National Commission on Agriculture (1976) reported that 6.0 million hectares is waterlogged including both unirrigated and irrigated lands. Out of this 3.4 million hectares is affected by water stagnation and 2.6 million hectares through rise in water table. Ministry of Water Resources (1991) estimated an area of about 2.5 m. ha suffering from waterlogging in different irrigation command areas.

Remote sensing techniques have the potential to overcome the manpower and fiscal restrictions that now limit large scale mapping of waterlogged area (Smith et al., 1990). Visible and near infra-red multi-spectral images are the most useful data currently available to map vegetation pattern, waterlogged area, dry soils etc., and corresponding hydrological processes at regional and global scale (Tucker et al., 1986). Landsat, IRS images have been successfully used by the researchers for the assessment of waterlogged areas in different irrigated command of India (Kalubarme et al., 1983; Balakrishnan, 1986; Sidhu et al., 1991; and Choubey, 1995; 1996). Remote sensing survey could be conducted to study the effect of waterlogging on different soil types on a long term basis coupled with cropping pattern.

A survey conducted by Bownder and Ravi (1983) in the SriRam Sagar command area indicated that out of 2000 hectares of irrigated area surveyed 400 hectares is severely waterlogged. Only paddy can be grown in these lands and the yields are lower compared to those in non waterlogged area. No attempt has been made so far by Government of Andhra Pradesh, Irrigation and Ground Water Department and other organisations to assess and monitor waterlogging problem in the SriRam Sagar command by remotely sensed data. This study is an attempt to assess the areas affected by waterlogging and area sensitive to waterlogging during pre & post monsoon period of SriRam Sagar command using IRS data.

STUDY AREA

The SriRam Sagar project is on Godavari river at Pochampad, in Andhra Pradesh. The reservoir water spread area is 453 km^2, with a capacity of 3.17 TM cubic meters (Subramanyam 1979). The reservoir irrigates 178,000 hectares of land (Fig. 1).

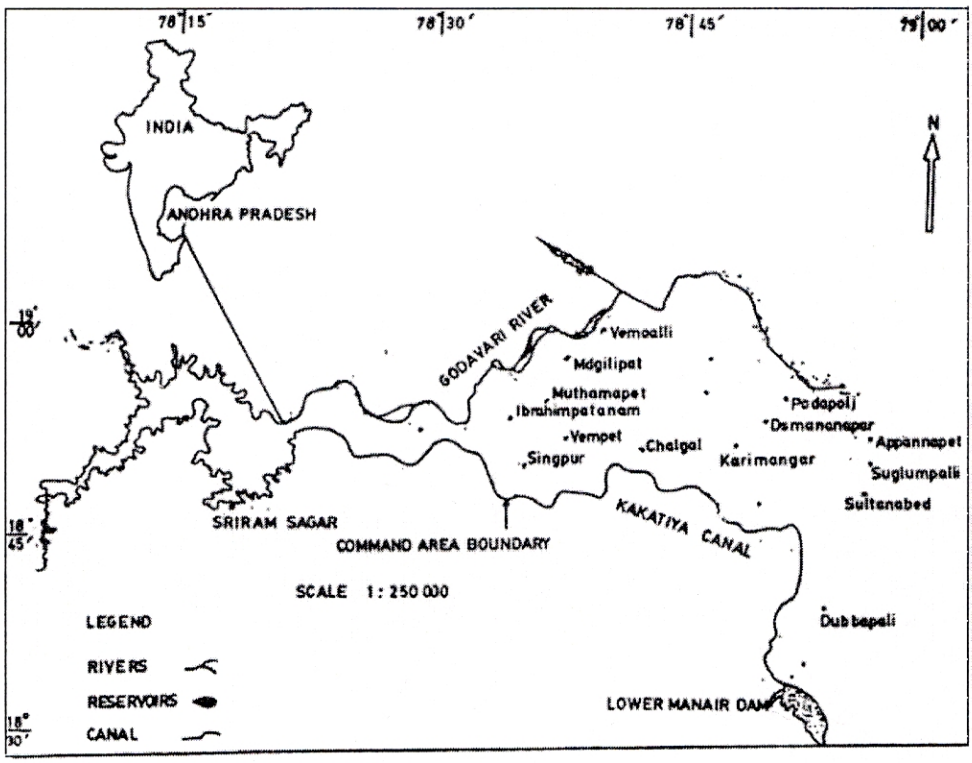

Fig. 1 Location map of SriRam Sagar command area showing field verification locations.

About 95% of the command area has a slope less than 1.5% . The annual rainfall is about 986 mm (Murty 1990). The predominant soil type is red sandy loam of good permeability. The black sandy, silty loam was found in low lying area stretching along the streams. Paddy is the principal crop grown extensively in the areas receiving canal water. The main rock type occurring in command area is granite. Wells are found to be excavated to maximum depth 2.5-4.0 m to meet the water demand during canal off season.

METHODOLOGY

Data Used

The Indian Remote Sensing Satellite data that were used in this study, are given in Table 1.

Table 1 Indian Remote Sensing Satellite data used in the study

S.No.	Path Row	CCT	Date
1.	25-55,26-55	CCT	April 12, 1989
2.	25-55,26-55	CCT	October 6, 1989

Analysis

Subscene of SriRam Sagar command area was extracted from IRS-1A-LISS-I computer compatible tapes for April 12 and October 6, 1989. ILWIS image processing system was used for image analysis. Gray level slicing was carried out for all the scenes.

The first step was to chose pixel from the image that best represent specific parameter of the surface material such as soil, wetland, water and vegetation. Pixel value for each band of water, dry and wet soils, and vegetation were used for the SriRam Sagar images in analysis.A field trip was made in the month of April 1996 to carryout field checks and collection of hydrometeorological and water table depth data. The low response for water and highest for dry soil is used to obtain the corresponding IRS pixel values. Gray level slicing techniques have been primarily used to map standing water in command area. The resulting images were than calibrated to field measurement of dry and wet soils. Finally results were compared to data and maps collected from Ground Water Department, Govt. of Andhra Pradesh, Hyderabad.

RESULTS AND DISCUSSIONS

The soils in the command area are classified as loamy sand, silty loam and silty clay loams. Loamy sands having high percentage of coarse particles show low field capacity and porosity whereas silty clay loams having low percentage of coarse particles show high field capacity. It has been reported that 66.10%, 31.59% and 22.90% of the command area is waterlogged during October, April and June 1989 respectively (GWD,1989). The depth to water table varied between 0.0-6.0 m and 0.0-3.0 m during pre and post monsoon period respectively. The annual rise in groundwater level is 2.0 to 4.0 m (Shetty 1995). Hydrograph of selected observation wells (Fig. 2) indicate that the water level in the observation wells have shown an increasing trend. The areas free from waterlogging have been decreasing in the command area.

Image Analysis

IRS data of April and October 1989 chosen to select minimum and maximum pixel values range for the gray level slicing using infra-red band 4. For the assessment of waterlogged land pixel values measured at different sites in the field (Fig. 1) representing

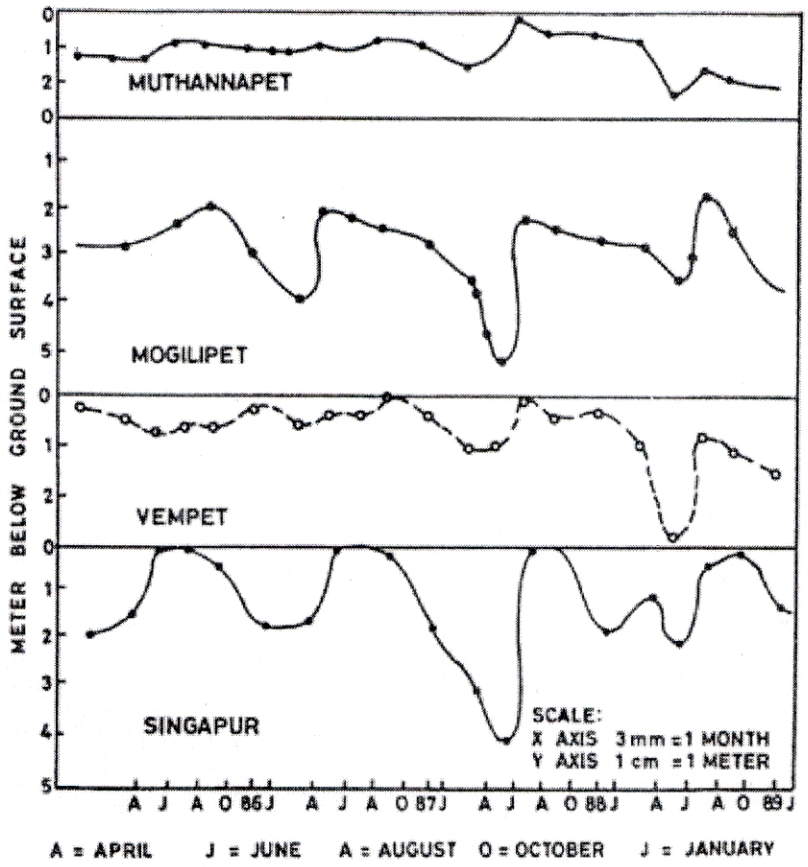

Fig. 2 Hydrograph of selected observation wells
(Source: Andhra Pradesh Ground Water Dept., Hyderabad)

water, wet and dry land were considered for selecting the pixel values range form IRS data. In order to map only waterlogged land masking function was applied. For gray level slicing the pixel range of 9-20 applied to band 4 for April 1989 scene of command area to delineate waterlogged areas. The output image exhibited waterlogged area (standing water) in the command area (Fig. 3).

Similar approach was adopted to map waterlogged land during postmonsoon month. In October 6, 1989, scene the pixel range for water was observed between 10-25, which was used in gray level slicing to map waterlogged areas (Fig. 4). The relatively high pixel values than April 1989, image may be due to turbid water during post monsoon period.

The water table depth data were transferred on the waterlogged areas map prepared from April and October 1989, IRS data. Based on the field observations, maps showing waterlogged areas were finalised. It has been found that in pre-monsoon April and post-monsoon October 1989 images, pixel ranges are the manifestation of surface (water, wetland and vegetation) suitable for the assessment of waterlogged areas. The assessment of waterlogged areas during April 12, and October 6, 1989 are tabulated in Table 2.

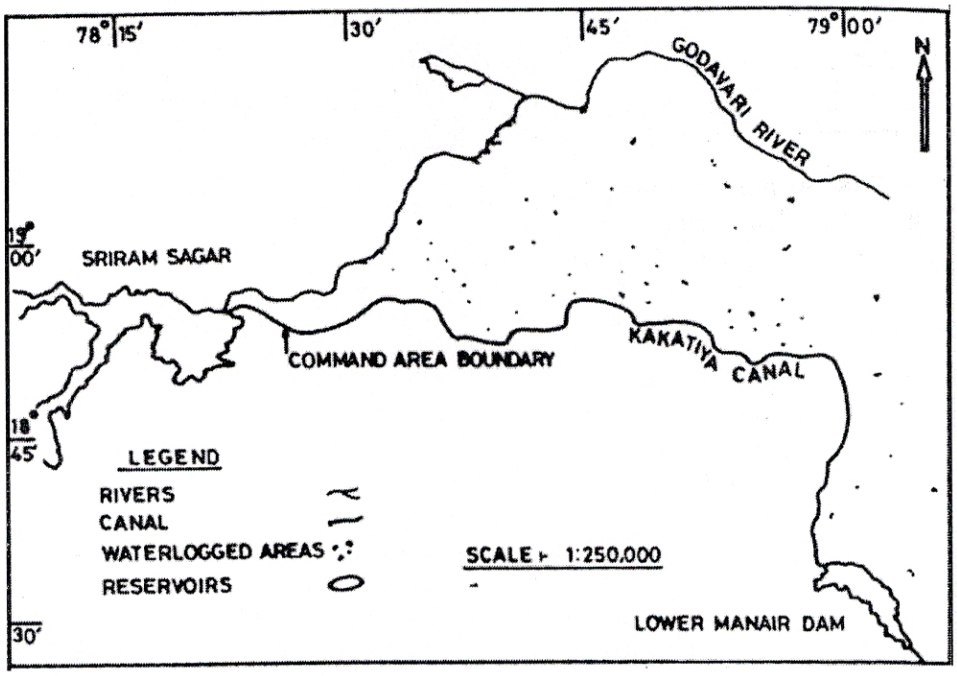

Fig. 3 Map showing waterlogged areas in SriRam Sagar command areas on April 2, 1989

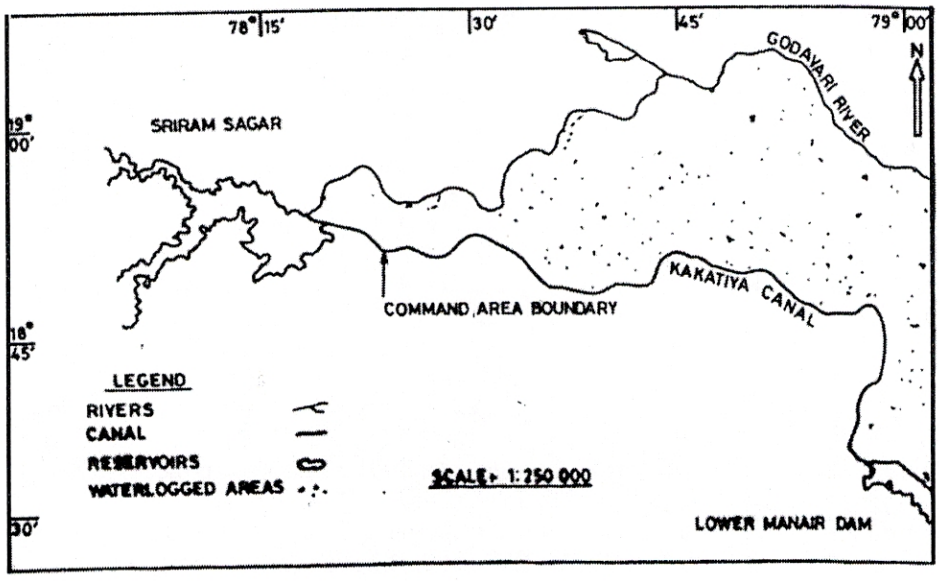

Fig. 4 Map showing waterlogged areas in SriRam Sagar command area on Oct. 6, 1989.

Table 2 Waterlogged areas in SriRam Sagar Command obtained form gray level slicing.

S.No.	Date of satellite overpass	Area (sq. km.)
1	12.04.1989	388
2.	06.10.1989	540

The results obtained from this study indicate that during pre and post monsoon months i.e., April and October 1989, the waterlogged areas (standing water) were approximately 388 and 540 sq.km respectively.

CONCLUSIONS

This investigation has shown that IRS images have great potential in making rapid and reliable quantitative assessment of waterlogged areas in the command area. Further investigation of IRS-1A-LISS-I infra-red band 4 data has been proved to be very useful for the assessment of waterlogging. Gray level slicing is a useful technique to make an assessment of waterlogged area in the irrigated command in different seasons. Selection of pixel value range based on field informations such as topography (low lying areas) soil moisture and vegetation may help in the identification on sensitive area for waterlogging.

If the appropriate field measured radiometric data available or can be measured based on the spectral characteristics of the water, dry & wet soils and vegetation, then it will be possible to determine degree of soil moisture at different times of the year for the irrigation scheduling and to combat the menace of waterlogging in the irrigated command areas.

The probable reasons for the increase in water level in the command area are: overuse of water; farmers are not aware of optimum water-use management practices; none of the distributaries of the main canal are lined, hence seepages occur, causing a rise in the water table and aggravates the incidence of waterlogging. The result obtained from this study indicate that in April and October 1989, an area of 388 and 540 sq.km was affected by waterlogging. It is suggested that periodic assessment of waterlogging using remotely sensed data should be carried out in the SriRam Sagar command.

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