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A GIS Approach for Estimation of Irrigation Water Requirements and Scheduling in Canal Command Area

Ch Ramesh Naidu
Research Scholar, Civil Engineering Department, JNTUH
Hyderabad, India

Mvss Giridhar
Assistant Professor, Centre for Water Resources, JNTUH
Hyderabad, India

***Abstract* --Effective and efficient usage of the available water resources to meet the irrigation demand, irrigation scheduling plays a key role. The remarkable advances in computing software and hardware over the last decades, coupled with the development of digital databases, have generated a range of GIS applications that finds use in water resource management. The water allocation and scheduling in the study area is marked by blocks and sub-blocks under the canals. These blocks and sub-blocks come under the purview of Water Users Associations (WUA). Proper identification and delineation of canals and block boundaries is essential in order to evaluate water allocation and its usage in terms of irrigation demand. This study initially calculates net and gross irrigation water requirements and generates reports for irrigation scheduling in rabi season for rice crop using remote sensing images, soil and meteorological data in GIS environment. There are 11 Water Users Associations in the command area, out of which 12 Canal blocks were delineated. These blocks were in turn delineated into 212 sub-blocks. This study indicates that there exists a 5 to 20% of water deficiency in some WUAs and also water surplus in some WUAs varying from 15 to 40%. The WUAs and blocks which are occupied with sandy soils results in higher volumes of irrigation water release than the WUAs and blocks which have clayey soils.**

Keywords- Remote Sensing, GIS, WUA, CROPWAT

I. INTRODUCTION

Efficient water use for agriculture is very low in India and there is an imminent need to improve it. Irrigation in India is mainly dependent on various sources, including the availability of canal water and ground water. Water use efficiencies are comparatively less in canal command areas than command areas that depend on groundwater. In India, most of the prominent canal command areas suffer from either excessive or inadequate water supply resulting in wide gap between irrigation demand and supply. Further, most of the water allotted for irrigation is wasted at the level of farm itself either through runoff or percolation. Another significant problem that is expected in the future is the increasing need for alternative demands for water supply due to urbanization and industrialization. These demands create more pressure on water resources and in turn on irrigation sector. Irrigation in the future will certainly face the challenge of maximizing efficiency. Hence, in order to enhance the irrigation efficiency, estimation of irrigation demand is really important coupled with efficient management of water in the canal command area before releasing the water to the crops (Santhi et al, 2004).

The irrigation water requirement of a command area is dependent on the nature of the crop and the nature of the soil where the crop is grown. This shows the need to obtain up-to-date and real time information pertaining to the irrigated area, the type of soil and the type of crops being grown within the command area of each canal. Satellite images provide a scientific basis for identification of crops and when used along with other related data viz., soil and meteorological information, it provides clear information for land use and crop identification. A thorough understanding of the type of crops grown and the nature of soil helps in estimating the irrigation water requirement and proper scheduling in the command area. Detailed calculation and evaluation of irrigation demand at WUA/block/sub-block and minor level holds the key for efficient management of the water in the command area. GIS based system aids in analyzing the spatial information of command area to enable better planning by engineers and farmers followed by effective management and supply of water resources to different WUAs, blocks and canals (jayasekera and Walker, 1990).

II. STUDY AREA

Wazirabad command area falls under Zone I; block No.5 of left main canal of the Nagarjuna Sagar Project (NSP). The area is located between 16°39'2.84" and 16°56'40.81" N latitude and 79°25'16.01" and 79°40'52.90" E longitude. Wazirabad command area was selected as study area and it is bounded by Musi River in the East, Krishna River in the South, Lalbahadur canal in the North and Tungapadu vagu in the West.

III. INPUTS AND METHODOLOGY

In order to create digital data sets in GIS and tabular format, data was collected from different national and state level organizations. The list of data collected and the sources are mentioned in Table 1.

TABLE 1 DETAILS OF THE INPUTS

S.No	Data	Scale/resolution	Source
1	SOI Topomap	1:25000	Survey of India
2	Block maps of NSP	1m	Irrigation Dept, Mirialaguda
3	Block boundary	Not to Scale	Irrigation Dept, Mirialaguda
4	Sub -block boundary	Not to Scale	Irrigation Dept, Mirialaguda
5	WUA boundary	1:250000	WALAMTARI
6	DC boundary	Not to Scale	WALAMTARI
7	Mandal boundary	1:50000	SOI, Irrigation Dept, Mirialaguda
8	Soil map-refined	1:50,000	NBSS&LUP
9	IRS P6 LISS III	24 m	NRSC
10	Rainfall data	NA	District Statistics Department
11	Cropping pattern and crop calendar	NA	District Statistics Department, Department of Agriculture
12	Meteorological data	NA	Agriculture Research Institute(ARI), Rajendranagar & Garikapadu, MRO office, Mirialaguda

The study relies on data from Remote Sensing combined with ground observations and primary data. All sources of information were integrated through GIS for analysis. Different types of inputs were collected from diversified of sources for the purpose of the study. To arrive at canal wise, block wise and WUA wise water requirements, the canals and WUA boundaries were identified, delineated and digitized from the 1:25,000 Survey of India (SOI) topo maps and existing WUA maps and the digitized canal data is converted in GIS platform using ARC GIS network model. The WUA and canal map of the study area was shown in Fig.1 and Fig.2. Aspect map, contour map, stream map along with the canals were overlaid to identify and delineate the block, sub-block and WUA boundaries and extents have been digitized and converted to GIS database for the entire study area (Nitin Dubey et al, 2005). Utilizing the GIS software each component of crop water requirements were calculated and linked to the command area spatial database. Using two LISS-III images in the year 2007 Rabi season crop acreage estimates were calculated using Remote Sensing based digital classification techniques (Chakraborty et al, 1997) Daily meteorological data and mandal wise daily rainfall data was used to calculate the crop evapotranspiration and net irrigation water requirements using CROPWAT software. The losses due to the conveyance of water through canals and seepage and percolation losses at field level are calculated interactively using GIS techniques to estimate gross irrigation water requirements to plan the irrigation scheduling (Walker W.R. (1989). Fig. 3 and Fig.4 shows the irrigation schedule for each WUAs and Canals.

IV. RESULTS AND DISCUSSIONS

The statistics generated from GIS for WUAs and WUA wise gross irrigation water requirements are shown in Table 2 and Table 3. Six soil units have been recognized and mapped in the study locale. All six units are further categorized into three units. Clay soils occupied 49% of the study area where as sandy and loamy soils occupied 29% and 22%. WUAs Appalammagudem, Kalleyapalle and Dameracherla, the Net Irrigation Water Requirements (NIWR) is 55% and percolation losses are 41% of the total irrigation demand within those WUAs. This has resulted almost 0.45 to 0.60 million litres /day/ha of irrigation demand for these blocks. On the contrary, where as in the blocks WL6 and WR6 the NIWR is 60% and percolation losses are 37% of the total irrigation demand within those blocks. The blocks which are occupied with sandy soils results in higher percolation losses than NIWR and where as the blocks which have clayey soils results less percolation and eventually the command area that contains clayey soils has less irrigation demand. However, in case of silt and loamy soils the demand is around 0.6 to 1.20 million litres /day/ha.

TABLE 2 WUA AREA STATISTICS AND CORRESPONDING CANAL LENGTHS

S.No	WUA	Area (ha)	Reach	Canal Length (metres)
1	Chillapuram	1340	Head	13627
2	Venkatadripalem	1879	Head	11072
3	Chinthapalle	2124	Head	15475
4	Kothagudem	1180	Head	8054
5	Borrayapalem	1753	Head	15388
6	Appalammagudem	3253	Middle	24011
7	Kalleyapalle	6482	Tail	16905
8	Kondrapole	2740	Middle	15010
9	Dameracherla	3324	Tail	14400
10	Kesavapuram	2366	Tail	19417
11	Mirialguda	279	Head	2481

TABLE 3 WUA WISE GROSS IRRIGATION WATER REQUIREMENTS IN M.LITRES

S No	WUA	Net Irrigation Water Requirements	Percolation Losses	Conveyance Losses	Gross Irrigation Water Requirements
1	Chillapuram	5588	9069	781	1543
2	Venkatadripalem	7162	11624	635	19422
3	Chinthapalle	8682	14091	887	23661
4	Kothagudem	3276	5317	462	9056
5	Borrayapalem	8902	14190	882	23976
6	Appalammagudem	9245	7435	1377	18058
7	Kalleyapalle	2262	1921	969	5153
8	Kondrapole	4088	4511	861	9460
9	Dameracherla	134	55	826	1015
10	Kesavapuram	374	5146	1113	10003
11	Mirialguda	1040	1688	142	2870

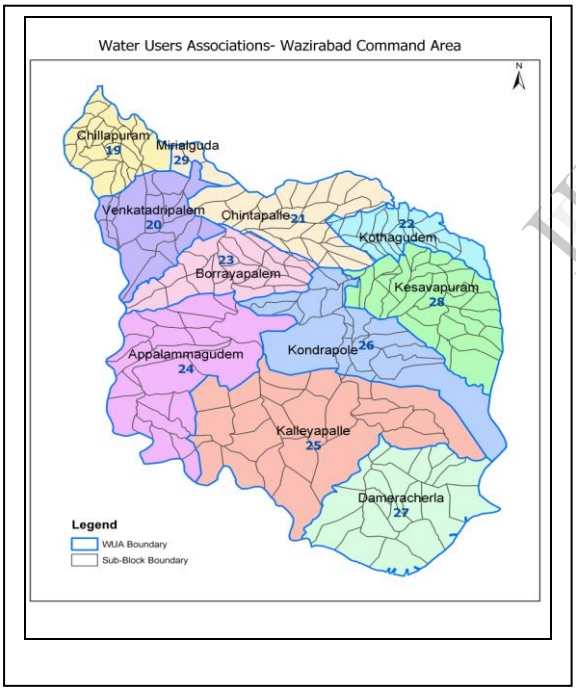

FIGURE1: WUA MAP OF STUDY AREA

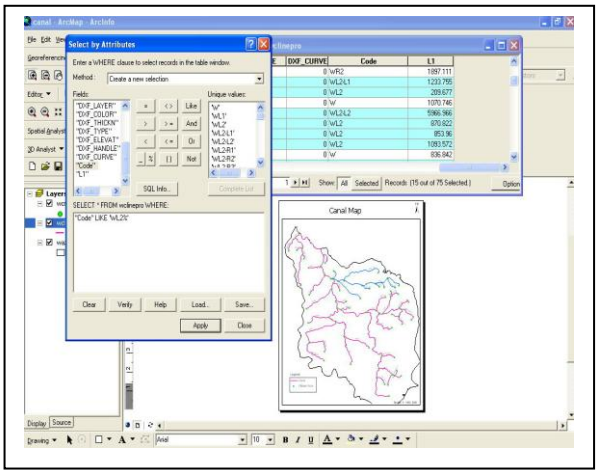

FIGURE2: CANAL MAP OF STUDY AREA IN GIS

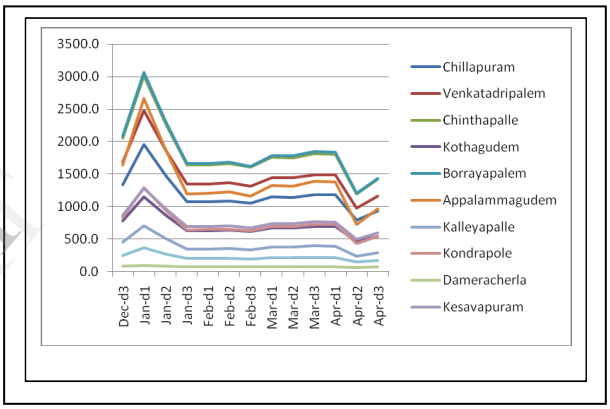

FIGURE3: WUA WISE IRRIGATION SCHEDULING IN MILLION LITRES

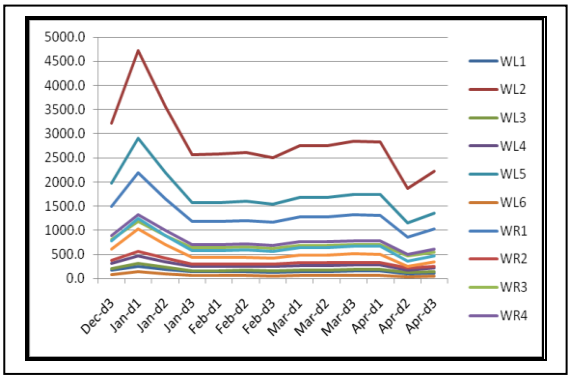

FIGURE4: CANAL/BLOCK WISE IRRIGATION SCHEDULING IN MILLION LITRES

V. CONCLUSIONS

The gross irrigation water requirements (GIWR) for entire command area is estimated from the GIS analysis in rabi season is 1, 38,117 million litres. The average gross irrigation water requirements for entire command area per hectare of crop area is 16 million litres. The average GIWR for

Chillapuram, Venkatadripalem, Chinthapalle, Kothagudem, Borrayapalem, Kesavapuram and Mirialguda WUAs is 17 million litres per hectare of crop area. Where as in Kalleyapalle and Kondrapole the average GIWR is 14 million litres per hectare of crop area. But, for Dameracherla WUA the average GIWR for one hectare of crop area is 48 million litres which is much higher than the other WUAs. This is due to the location of the WUA which is at tail end reach and also due to the lengthy canal system. Irrigation requirements for entire command area in the first decadal (Dec 20th to Jan 4th is 12,103 million litres. The maximum irrigation demand observed in the second decade for the command area is 18074 million litres. But in the 12th decade, the irrigation requirement is considerably less due to rainfall and is observed as 6756 million litres.

REFERENCES

[1] Chakraborty M., Panigrahy M.S. and Sharma S.A. (1997). "Discrimination of rice crop grown under different cultural practices using temporal ERS-1 synthetic aperture radar data". ISPRS Journal of Photogrammetry and Remote Sensing, 152(4): 183-191.

[2] Dadhwal V.K. and Ray SS. (2000). "Crop Assessment using Remote sensing-Part II: Crop condition and yield assessment". Indian Journal of Agricultural Economics, 55(2): 55-67.

[3] jayasekera and Walker. (1990). "Remotely sensed data and geographic information system for management and appraisal of large scale irrigation projects in the developing countries". Advances in planning, design and management of irrigation systems as related to sustainable land use, Leuven (Belgium), 14-17 Sep 1992.

[4] Krishna Rao M.V., Hebbar R. and Venkatartnam L.(1997). "Evaluation of IRS-1C data for discrimination and acreage estimation of crops grown under multiple cropping situation". Remote Sensing for Natural Resources, Joint publication of ISRS & NNRMS, 205-211.

[5] Navalgund R.R. and Ray SS. (2000). "Geomatics in natural resources management". Proceedings of Geomatics-2000, Pune, India, NRI-NR14.I.S. Jacobs and C.P. Bean, "Fine particles, thin films and exchange anisotropy," in Magnetism, vol. III, G.T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271-350.

[6] Nitin Dubey., Nema R. K., Awasthi M. K. and Tiwari.(2005). "Topographic analysis through Digital Elevation Model (DEM) for Patan Branch Canal command area using RS and GIS". Land and Water Management, Book 1, Conference paper, Command area development and management , pp. 136-141.

[7] Santhi., Muttiah. and Arnold. (2004). "A GIS−Based regional planning tool for irrigation demand assessment and savings using SWAT". Soil and water division of ASAE.

[8] Van Lieshout A.M. and Brouwer.(2009). "Irrigation water requirement". Department, Earth Resources Surveys, International Institute for Aerospace Survey and Earth Sciences (ITC), P.O. Box 6, 7500 AA Enschede, The Netherlands.

[9] Walker W.R. (1989). "FAO Guidelines for designing and evaluation of surface irrigation systems". FAO Irrigation and drainage paper 45.