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DEPARTMENT OF AGRICULTURAL ENGINEERING

AI3701 – REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYATEM

UNIT 5 APLLICATION OF REMOTE SENSING AND GIS IN AGRICULTURE

5.3 CROP WATER REQUIREMENT

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5.3 Remote sensing and geographic information system data requirements

Application of remote sensing techniques has the potential to provide irrigation command resource inventory. The following information can be extracted from remote sensing data for any canal system:

- Crop types, acreage, condition and yield.
- Soil types, soil salinity and alkalinity, waterlogging.
- Main land use and land cover.

Besides this, other basic information needs to be collected from an irrigation project or an operation manual to create a database in geographic information system platforms:

- Irrigation command area boundary, gross command area and cultivable command area, hierarchic system of canal networks, canal control points.
- Crop seasons, crop calendar, cropping pattern, cropping intensity, pattern of cropland holdings, crop cutting experiment plots.
- Water supplies in canals, water withdrawal from groundwater, rainfall amount and spatial distribution in the irrigation command during the crop season.

Tools for evaluation

The following three steps are required:

1. Estimation of crop areas. This is done by multiple-date satellite-based digital estimates of the main land-use and land-cover classes, including crop types and acreage. To evaluate the accuracy and reliability of satellite-derived information, a comparison can be made with similar information obtained from the agricultural census abstracts kept by the government departments.

2. Estimation of irrigation water requirements. Monthly crop water requirements for all the main crops using daily pan-evaporation data and crop coefficient values during the various growth stages to calculate the water requirements of each crop.

3. Use of efficiency factors for water conveyance, field applications. Total irrigation water requirements are estimated by adding up monthly demand for irrigation requirements for all crops during all the crop seasons (rainy season, winter and summer).

Assessment of water availability

The estimation of the irrigation water available from canals is straightforward. Daily flows into canals are totalled up to give monthly and annual supplies. The total groundwater draft is estimated from the tube-well or dug-well inventory data, by adopting suitable norms for dug wells and wells fitted with pump sets. Irrigation tanks and ponds are also sources of irrigation in the command area. Satellite data provide a very precise picture of the water spread of tanks and of the area irrigated by each tank. With this information, and following established norms, the total water available from tanks and ponds for irrigation can be arrived at.

Expected results

Satellite data thus provide spatial information about the main crop types and crop area estimates which are used to assess total irrigation water requirements as described above. They also provide information for the irrigation cropland inventory classified by source, i.e. canal, well or tank. Monthly canal supplies are then compared with total monthly demand to identify any surplus or deficit in any segment of the irrigation command on a canal system basis. A similar comparison is made between supply from all irrigation sources (canals, wells and tanks) and the total demand estimated from all the crops, irrespective of source of irrigation in the command area, on a monthly, seasonal or annual basis.

A diagnostic analysis can be made based on the above procedure to know precisely:

- percentage of the water demand per crop;
- total water demand in the irrigation command;
- period of high water demand for irrigation water;
- pattern of canal water releases (surplus or deficit) with respect to crop water demand;
- designed cropland versus actual crop area, crop by crop; and
- any deviation in the designed cropping pattern.

Ultimately, remote sensing and geographic information techniques help in the evaluation of the irrigation system performance and in redefining guidelines to improve water use efficiency and crop productivity on a sustainable basis.

Case study

Study area and satellite data

<table>
<tr><th>Study area</th><th colspan="2">Geographical co-ordinates</th><th>Satellite data used</th></tr>
<tr><td>17 minors of the Mahendragarh canal distributary in Haryana State</td><td colspan="2">28° 9'20" - 28° 21' 57" N Lat.
76° 4'23" - 76° 13' 7"E. Long.</td><td>IRS-1B LISS II/3.10.1992
- for kharif season
IRS-1B LISS-II / 6.3.1993
- for rabi season</td></tr>
<tr><td rowspan="2">Topography: gentle slope

Annual rainfall average: 446 mm</td><td colspan="3">Major crops & duration (days) of total growing period</td></tr>
<tr><td>Kharif

Rabi</td><td>Guar 115

Wheat 135</td><td>Bajra 90

Mustard 145</td></tr>
</table>

Method applied

For each of the 17 minors of Mahendragarh distributary, crop acreage is estimated from the IRS-1B LISS-II satellite image-derived irrigation command land use-land cover and crop classification maps for both the rainy and the winter crop seasons, known in India as *kharif* and *rabi*. Following FAO guidelines, crop coefficient factors (Kc) are selected for each of four main crops and their monthly water requirements are calculated based on crop consumptive use (ET mm/d) multiplied by Kc (per month). The monthly net irrigation requirement for each of the four main crops is calculated. The monthly and seasonal net irrigation water requirements for each canal minor are then arrived at by multiplying monthly net irrigation water requirements with satellite data-derived crop acreage. The irrigation efficiency of a canal system depends on the type of channel, material used and its discharge. Since all the canals are lined, canal delivery efficiency is taken as 0.93 and the field channel efficiency as 0.80. Field data of the irrigation water supply (canal and tube well) and satellite data-based net irrigation water requirements are used to arrive at the net irrigation water deficit or surplus in each of the canal minor command areas in both *kharif* and *rabi* seasons of the year 1992-1993 (see Table 1 for the *kharif* season as a typical example).

Result

This study indicates that there exists deficiency of water for irrigation in all minors but four during the kharif season and five during the rabi season. Water deficiency varies from 6 to 57 percent of total crop water requirement during the kharif season and 0.7 to 48 percent during the rabi season. As an illustration, the irrigation water requirement and canal supplies of the Deroli minor during kharif and rabi seasons are shown in Figures 1a and 1b. The data obviously indicates the necessity of more canal supplies. Total crop water requirement, canal supplies and tube-well supplies (seasonal and yearly) are shown in Figure 1c. It is seen that crop water requirements are mainly met with the tube-well supplies only. The canal supply is very modest. However, few canal minors have adequate water supply during both seasons, due to extensive tube-well irrigation in these areas.

Conclusion

The average agreement between satellite-derived crop acreage and ground information (government records) is of the order of -7.8 percent to + 10.6 percent. The net irrigation water requirement estimation from satellite data, when compared with irrigation water supplies (canal and tube well), shows large-scale deficiencies, which will ultimately affect the crop yield. Crop yield estimation, which also can be done using satellite data through the normalized difference vegetation index values of crops and field information of CCE data, would validate the effect of water deficiencies on crop yield at de-aggregated level across the irrigation command.