CHAPTER - 5

SUMMARY AND CONCLUSIONS
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The summary of the work done and the brief conclusions made from the benchmarking study of an irrigation system through RS & GIS approach is presented in this chapter.

- Utilisation of satellite data of various spatial and spectral resolutions for baseline inventory viz. inventory of irrigated crop areas, irrigation water dynamics, inventory of irrigation infrastructure, etc. to generate the irrigation spatial database required for benchmarking of irrigation systems has been evaluated in this study.

- Availability of satellite data with varying spatial, spectral and temporal resolutions are found to be useful in inventorying agricultural system: inventory of irrigated crop areas viz. cropping pattern analysis, crop condition & productivity assessment, estimation of irrigation intensity, cropping pattern violations, etc.; water dynamics: monitoring the dynamic / temporal changes in water bodies – water spread area estimation for reservoirs of major, medium reservoirs and tanks for minor projects, capacity estimation of reservoirs, etc., water utilisation index, water productivity, uniformity coefficient etc which can reveal the overall water utilisation pattern in irrigation systems; and irrigation infrastructure system: comprising of identification and delineation of irrigation infrastructure existing on the ground (dam components, reservoir, canal network – main canal, branch canals,
distributaries, laterals and sub laterals, cross drainage structures, footcart bridges, etc).

- It was observed that, low resolution satellite data like IRS WIFS can be used for discrimination of crop/non crop areas at irrigation project level/river basin level, however paddy and non paddy areas can be separated by following the crop calendar and procuring the suitable images which can capture the crop growth regime. Medium resolution satellite data like IRS AWIFS can be used similarly for identification of crop/non crop areas and also major crops like paddy/non paddy, two seasonal crops, annual crops, perennials like orchards can be classified through hierarchical crop classification techniques. Satellite data of 23m resolution like IRS LISS III can be used for improved cropping pattern by discrimination of various crops existing in the irrigation command or major crops and crop groups can be done with high accuracy. This is very much relevant in estimating the crop areas and crop and water related parameters in an irrigation command at disaggregated levels i.e. irrigation block/major, which are prime requisite in benchmarking of irrigation commands. Satellite data of 5.6m like IRS LISS IV can be used to analyse the cropping pattern at cadastral level with multi-temporal satellite data which could be input for assessing the performance of Water Users Associations formed under participatory irrigation management.

- It is clear that there are several crop and water related benchmarking indices required for benchmarking study of an irrigation systems that can be derived by integrating satellite and other collateral data are mostly dependent on the
spatial cropping pattern at disaggregated level and hence accuracy of estimation of crop areas is important which depends on the spatial resolution of satellite data used for the analysis.

- Similarly study of water dynamics can be taken up using satellite data of various spatial, spectral resolutions in view of recent advancements in satellites with better repetivity of ~ 5 days like Resourcesat-1 with wide footprint (~800Km). Water spread area estimation in reservoirs of major, medium irrigation projects and tanks used for minor irrigation projects can be regularly assessed with present situation of satellite data acquisition opportunities at weekly, fortnight, monthly intervals. Water spread area estimating in reservoirs can be made use for estimation of capacity of reservoirs and also for updation of elevation – area – capacity curves developed for a particular reservoir. To monitor the temporal changes in water bodies, an automatic extraction algorithm is worked out for identification of water pixels from satellite images which can facilitate the quick processing and dissemination of water spread information to water resource planners through which large tracts of irrigation projects, regions can be covered.

- Water utilisation pattern can be addressed with the above information on the dynamic changes in water bodies corresponding to major, medium and minor irrigation projects. Since the water is diverted into main canals, branch canals, distributaries, etc to deliver the water upto the individual fields. Water supplies varies with the demand for water based on the water requirement which depends mainly on the cropping pattern in an irrigation system. How best the
water is utilised in an irrigated system can be done by analysis on spatial
cropping pattern, production estimates, crop condition etc in relation with the
corresponding water releases into canals at disaggregated level. Use of
spatial information derived from satellite data and analysis will help for the
above purpose.

- A case study of Nagarjuna Sagar Left Canal command is taken up for
demonstrating the benchmarking study of an irrigation system. Multi-
temporal satellite data of ~ 23m resolution for the years 1998-99 and 1990-
91 is during rabi season are selected for estimation of crop and water
related indices at disaggregated level for benchmarking is carried out. the
brief results are presented below:

- Analysis of multi-temporal satellite data across two time periods in a decade
span revealed the response of the irrigation system to two different water
regimes of 1998-99 and 1990-91 at disaggregated level. Spatial irrigation
database at disaggregated level has been derived with the spatial
information technologies used in this study and are used or spatial analysis
various benchmarking indices across the irrigation command. Applications
of RS & GIS techniques are found be much useful for benchmarking study
of an irrigation alongwith integration of the collateral information obtained
form the field.

- Satellite derived cropping pattern indicate that the total irrigated cropped
area during 1998-99 and 1990-91 is 3, 35,027 and 2, 80,730 ha.,
respectively. The Paddy crop accounts for 18 per cent (50,342 ha) of the
total cropped area during 1990-91, has increased to 55 per cent per cent (1,87,526 ha) in 1998-99. Here the benchmark is the designed cropping pattern and observed cropping pattern is compared with the designed cropping pattern and is evaluated. Performance across the time period in a decade span is studied. Cotton, Chhillies, tobacco, Pulses, Other irrigated dry (I.D) crops constitute the principal irrigated dry (I.D) crops. Sugarcane and Orchard / Plantation crops constitute the perennial crops in the command area. The deviations in the cropping pattern observed at disaggregated level are studied and presented in this study.

It is observed that the irrigation intensity during 1990-91 is 71 per cent and it is 84 per cent during 1998-99. Actual irrigation potential is to be utilised fully to improve the efficiency of irrigation system and for sustainable production. From the observations, it is clear that irrigation potential is not utilised fully with respect to localisation. This is also analysed at disaggregated level.

The paddy crop condition during both the years has been classified into three categories viz., good condition (NDVI >0.50), average (NDVI = 0.40 to 0.50) and poor condition (NDVI <0.40) and their variation across the command is also shown. It is observed that the condition of the paddy crop (NDVI value of 0.47 during 1990-91) at NSLC command level is better than the paddy crop (NDVI, 0.41) during 1998-99.

The water utilization Index during 1990-91 is 65 ha/MCM and is 92 ha/MCM during 1998-99 indicating a better water management during 1998-99 than 1990-91. Comparison of equivalent wet area vis-a-vis water drawls in NSLC (at off take points) during both the years indicate that, the increase in
equivalent area is doubled from 1990-91 to 1998-99, whereas, the water drawls have increased by only 42 per cent.

The uniformity coefficient at block level indicate that there is wide variation in Uniformity of water distribution and it appears that more proportion is high for smaller command areas. It is observed that the water productivity is much low in 1990-91 compared to 1989-99 though the average productivity at project level is high. It shows the intensity of irrigation is high (excess irrigation) during 1990-91 compared to 1998-99.

Repetitive coverage of satellite data is assessed to be useful information for temporal monitoring the water spread in the major and medium reservoirs from which the water is diverted to major and medium projects and also in tanks from which water is diverted to minor irrigation projects. Study of water dynamics through space based monitoring is found to be a time cost effective method as the conventional method is by ground survey which is a cumbersome task. The water availability and releases pattern in an irrigation system influences the efficiency of an irrigation system which is reflected through the estimation of benchmarking indices.

High resolution satellite data is very much useful for inventory of irrigation infrastructure viz. entire canal network including primary, secondary & tertiary canal networks, outlets, cross drainage structures, other infrastructure etc. in an irrigation command which act as backbone for efficient delivery of water upto individual fields. This is done with the identification and delineation of various irrigation infrastructure elements of
an irrigation system through image interpretation of high resolution satellite data of (~1m to 2.5~). Spatial information obtained from the above is compared with respect to planned / design of irrigation of infrastructure and corresponding irrigation potential (ha) information. This has proved to be the best alternative for monitoring the status of ongoing projects or verification of existing projects and to identify the infrastructural requirements in the existing projects. The additional requirements of irrigation infrastructure can be identified for better irrigation water management / maintenance requirements can be understood with high resolution satellite data if used during the benchmarking studies of irrigation systems. Total Irrigation Potential as assessed from satellite data in IBC Command is 66,938 ha. and the balance IP to be created in IBC is estimated to be 3,601ha. This balance IP is observed to be distributed in Distributary commands viz. D22, D25, D26, and D46. The Status of IP created in rest of the Distributaries is observed to be complete. The satellite data analysis indicate a deviation of ha in IP creation from the field reported (or) conventional monitoring mechanism

Development of Spatial Irrigation System through the geodatabase preparation by using the satellite derived data on irrigated agricultural system and irrigation infrastructure system as mentioned above is very much useful for understanding the performance of irrigation command at disaggregated level by visualizing the spatial variation in the individual benchmarking indices used. This has also helped to generate the
customized query tools with preset conditions for the spatial analysis in the irrigation system.

- An unified approach for the applications of spatial information technologies namely Remote sensing, GIS and GPS and concept of Spatial Irrigation Information System defined in this study can be followed for benchmarking study of an irrigation system by deriving the irrigation spatial database from space based inputs integrated with other collateral data. This approach can be implemented in any irrigation command with the acquisition of suitable satellite data and required field data.