

Micro-Macro Irrigation Design and Planning

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Increase in population and near constancy of cultivated land and water resources have imparted much pressure on the quality of irrigation, viz., its efficiency and effectiveness. The recent practice has to carry the water right upto the individual farm gate level through the micro network of water courses and field channels for better efficiency dropping out the traditional way of storing and/or diverting river flows into the major conveyance and distribution irrigation channels. This paper provides use of computer in the field of irrigation planning and design and also discusses the major short comings in conventional approach. A Dynamic Database of the total environment of the irrigation system which can be maintained, upgraded, processed, and analysed conveniently by the implementing engineers and operating managers. Design, drawing, estimation and report writing of various irrigation structures are a major output of the system that helps the field engineers to execute the task more efficiently within the shortest time period.

This paper is the result of the experience of the authors developing an actual prototype covering a command area of six villages under Rengali Irrigation Project of Orissa in Parjang block.

1. Introduction

While computer technology can be applied to develop information system on natural resources and related factors its potential in the area of agricultural activities in its various facets needs great emphasis.

Our economy, as a whole, depends upon our effective agriculture practices and increased productivity. With water availability as a major factor for crop productivity, a complete foolproof online irrigation information system is needed. For the first time in India a digital planning and design system for irrigation network is being implemented in ten major and medium irrigation project in the state of Orissa. Satellite Communication (SATCOM) & Very Small Aperture Terminal (VSAT) technology can be used to get the weather and operational data for an Irrigation Information System.

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2. System Design

In conventional practice of irrigation planning, first Cadastral Maps (CM) are collected. These individual CMs are then joined to form Survey Number Mosaics (SNM). SNMs are then taken into individual fields and the levels of each plot are marked on it. The contours are then drawn on it by experienced engineers. These contour maps are the base maps for irrigation planning. Valley lines and ridge lines are traced on contour maps. Minor service areas are then determined and lay out of conveyance and distribution channels are marked.

Many problems are faced by this traditional way of irrigation planning. Some of the major problems are

- (i) The operations are done manually, hence it is tedious, time consuming and less accurate.
- (ii) These maps and documents, prepared with lot of inputs, are useful only upto the extent of next stage, i.e., the design of the channels and structures.
- (iii) These paper maps and the documents are not amenable to modifications or easy updations commensurating with the change in environment of the command area which changes considerably on the implementation of the project.
- (iv) There are also physical constraints, such as unmanageable huge size of Survey Number Mosaics and the problem of storage.

Now the advent of micro-computers, tremendous enhancement of their storage and processing power and consequential reduction in computing cost, have made it possible for the irrigation planning go digital. Further, the development of graphics software as well as database software provides a suitable platform to make digital planning of irrigation physically feasible and economically viable. The micro-macro planning process is mainly divided in to three major parts,

- (a) Design of a Land Information system,
- (b) Preparation of Digital Village Map & Linking with Village/Land Database.
- (c) Design, drawing and estimation software for Various irrigation structures .

The development of three subsystem is being carried out independently. The integration of the subsystems is possible with help of the ASCII output of different subsystems.



2.1. Environmental Database Design

For this type of major irrigation project environmental database is designed considering following socio-economic environment. This consists of different database developed under Foxpro 2.6. The database for major areas are

- (a) Land database which includes data related to Agricultural plots (Area and Topography), Soil (Type and Extent), Crop (Type, Duration and Extent).
- (b) Irrigation Database consists of fields as Run off (inflow) Reservoirs (Canal-headwork), Conveyance Canals, Micro and Macro network distributions, Operating and Maintenance Sub systems.
- (c) Atmospheric Environment Database with record fields as Rain Fall, Temperature, Humidity and Sunshine.
- (d) Socio-Economic Database with water user units, Farmers/ Owners, Operators (Irrigation, command area and agriculture), Market Price as information fields.

The necessary information for creation of Land Database of the command area is obtained from Record of Rights (ROR) from revenue department for different minors. The land database which also includes Ridge Line values recorded by field survey group related to a reference point. These RL values are input to the contouring software (SURFER) to obtain a contour for a command area. Many of the environment are considered in the preconstruction planning of the irrigation network. Some are used during implementation and most of them are to be made available to the irrigation managers for the operation and evaluation of the system.

2.2. Irrigation Planning

Irrigation planning for a particular command area starts by obtaining Cadastral Maps (CM) [Fig.3] and those maps are used as base maps for planning and designing of canal course and different canal structures. The different phases in process of development are

- (a) Collection of Cadastral Maps (CM) of the command area used as base maps.
- (b) Collection of Land Records (Records of Rights, ROR) for creation of land Database.
- (c) Digitization of CMs and creation of Digital Village Map(DVM) as in Fig. 4. This has been done by using the scanned image of village maps and by using CAD-OVERLAY.
- (d) The created village Database (VDB) are linked with respective Digital village Maps (DVM).
- (e) Joining of individual village maps to form Survey Number Mosaic (SNM) [Fig.5].
- (f) Creation of grid corresponding to reference point so that each intersect point represents the position on the actual field where level was recorded by survey group.

(g) Drawing of contours on the DVM and preparation of a Digital Land Map (DLM) as shown in Fig.6.

2.3 Canal Planning and Design

The final design of canals (macro and micro) [Fig.1] system and the design of 35 nos of different canal structures were developed with help of Computer Aided Design S/W using AUTOCAD(R.10). The Programme written in Autolisp executed in presence of AUTOCAD generated design on screen. The process is described in Fig.2. A complete automated process was developed to obtain hard copies of the drawing, estimation, and design statement in prescribed report format for each irrigation structure. Once some irrigation parameters are chosen, this report can be obtained, for onward submission, in minutes by Engineers (customers) having little or nearly no idea of complex computer operational knowledge. The major design activity includes the following.

- (a) Marking of the valley lines from the study of contours in the DLM.
- (b) Marking of the Ridge lines from the contours in the DLM.
- (c) Delineation of the Irrigation block boundaries (a block of 40 Ha.) in the DLM.
- (d) Preparation of cut-off (discharge) statement with control levels of each block put in the plot database (area, soil type, crop type and controlling levels).
- (e) Preparation of design statement with help of report writing software using design data stored in an ASCII file (as the result of Design software).
- (f) Generation of land profile from the DLM along the canal drainage alignments.
- (g) Preparation of longitudinal sections of canal and drains.
- (h) Estimation of earth work and cost involved.
- (i) Preparation of land acquisition plan.
- (j) Preparation of the detailed site contour maps of structures
- (k) Design of irrigation Structures.

2.4. Integrated MIS

An integrated system implies that all the functional sub-systems are linked together in to one entity. The three individual systems designed are to meet the restricted area of irrigation activity. The Integrated Information System for Water Resource Department can be developed on realization of their relationship with the total system. Management and control of water to be released from various reservoir can be managed optimally basing on information generated by Irrigation Management Information System(IMIS). These information are based on rainfall data at various catchments, water requirement by different types of corps and rain fall data on agricultural land. The water traffic commands various canal control point to release water through various minors. Long distance

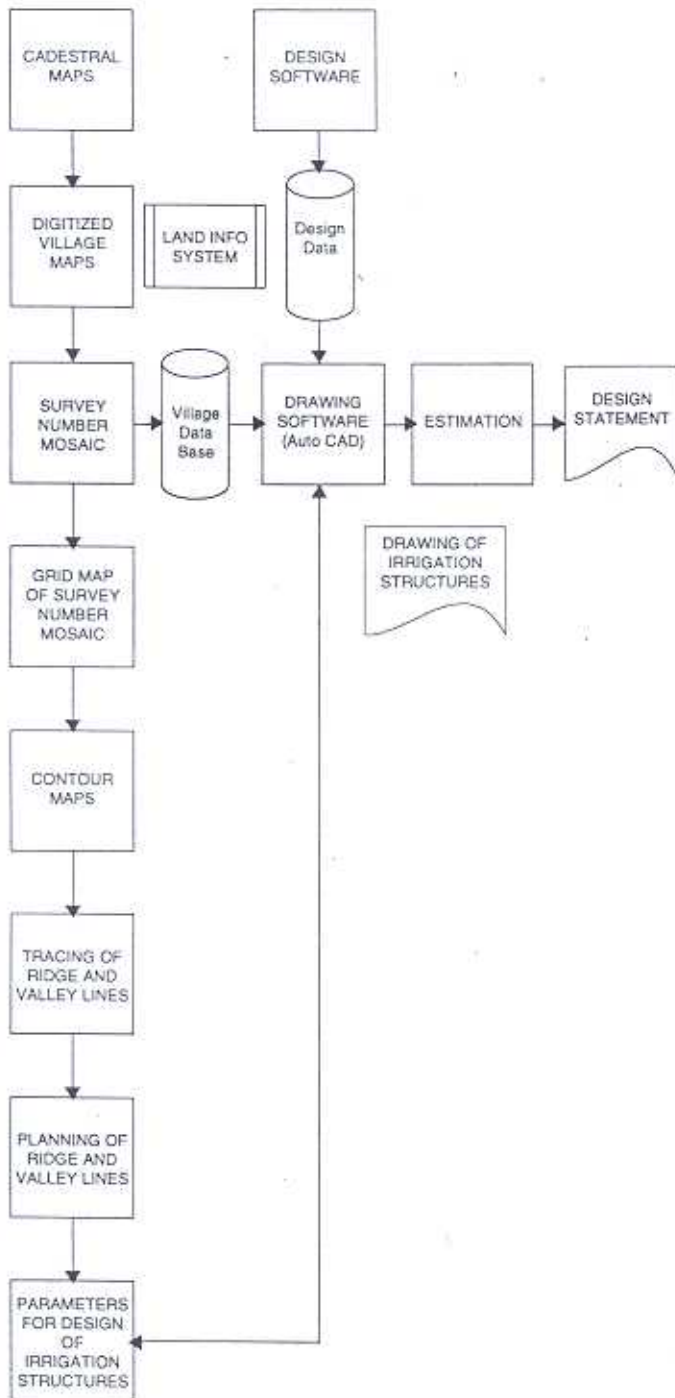


Fig.1 System Diagram : Micro-Macro Irrigation Planning

communication between water reservoir, water resource department and canal control point is possible with the help of Wide Area Network.

3. Conclusion

Fortunately, many electronic survey equipments like Electronic Leveling Instruments, Electronic Distance Measures, Total Stations, Satellite Based Global Positioning Systems etc, have been developed. These equipments have made it possible to generate and capture digital survey data right on the field and download the same onto computer. This supports as well as enhances the justification for a digital planning of irrigation system. Even though this is a massive task, the team of engineers of IGIT, Sarang used the limited resource available to achieve the optimal. The developed village database of the command area can all so be used to assist the revenue department for their application. The developed system can also be effectively used by agricultural research scientists.

Acknowledgement

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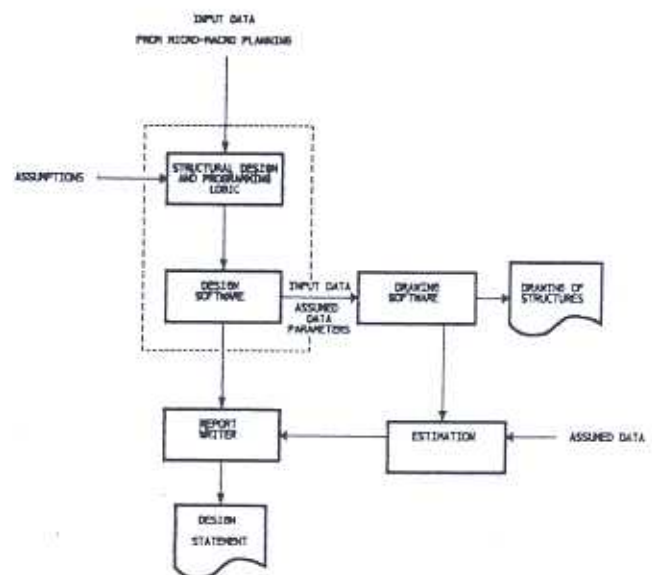


Fig. 2 : Flow Chart showing Design, Drawing, Estimation and Report Writing of Hydraulic Structures



Fig. 3 Cadastral Map of the Command Area

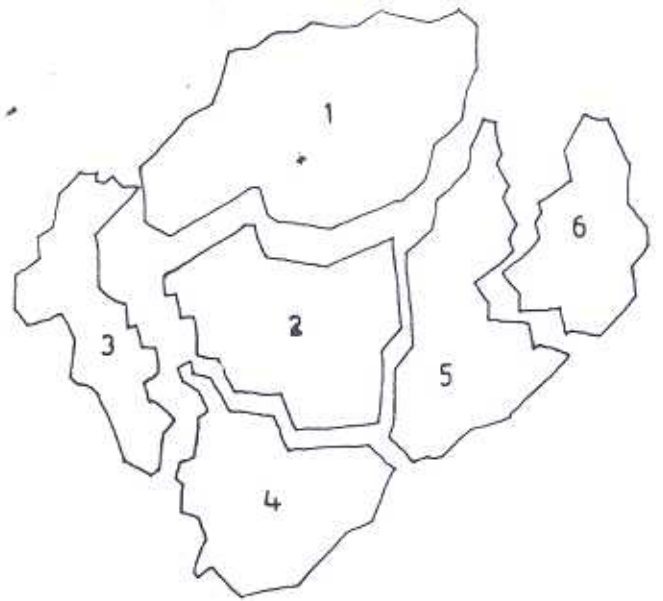


Fig. 4 Digitized Village Map (DVM)

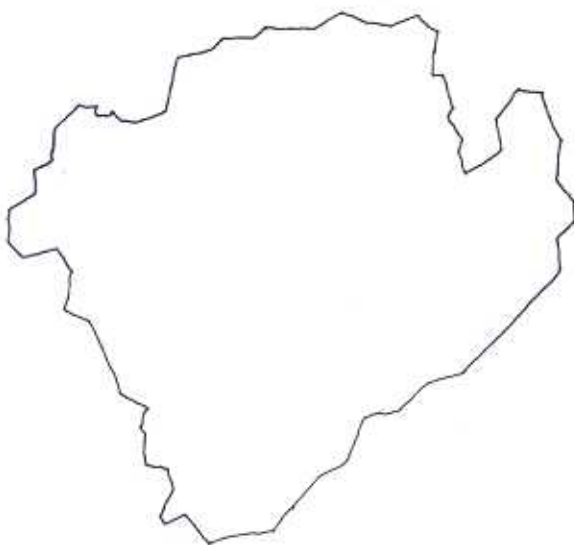


Fig. 5 Survey Number Mosaic (SNM)

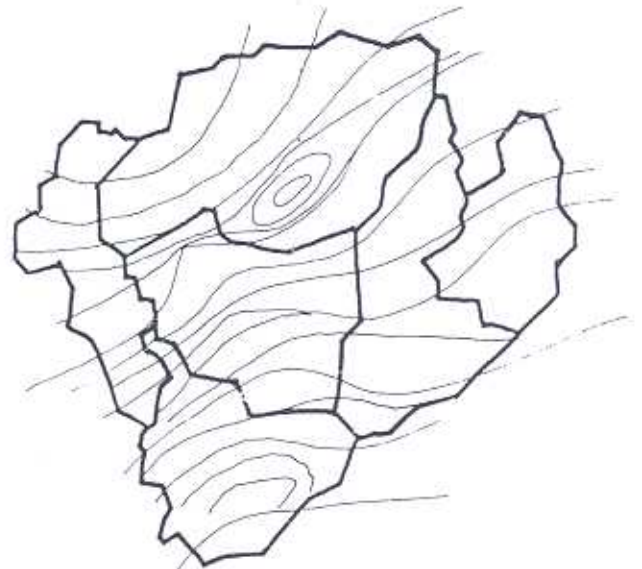


Fig. 6 Digital Village Map with Contour