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Drainage and Water Logging Problems in India

by

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Abstract : *In the absence of any means of draining the irrigated water adequately, the water table begins to rise. Seepages from canals, tanks. irrigation fields, etc. further add to water table, which ultimately reaches the root zones of the crop and create water logging hazard. Water logging is not only agricultural menace but it is environmental disturbance. When the water reaches root zones it prohibits the crop growth by interfering with crop 'Osmosis' process. To remove excess water from the surface or sub-soil a properly designed drainage system with the aid of computers is recommended.*

1.0 Introduction

When the soil pores in the crop root zone get saturated with water, the land is said to be water logged. This is usually caused by a rise of the ground water table. Hence water logging is the problem of rising water table which may cause increase in salinity of the soil. Water logging can also be caused by excess soil moisture due to periodic flooding, overflow by run off, over irrigation, canal seepage, artesian water and impeded sub-surface drainage. Shallow water table, heavy rainfall, perennial irrigation and the flat nature of the terrain all add to the cause of water logging and makes drainage difficult.

When the soil in the crop root zone becomes saturated, the plant roots are denied normal circulation of air ; the level of oxygen declines and that of carbondioxide increases, as organic matter decomposes with the saturation of the soil. The cutting off, or depletion of the oxygen supply to plant roots results in wilting and ultimately in the death of the plants. These conditions affect the growth and yield of crops. In course of time, such land turns saline or alkaline and ultimately becomes unfit for cultivation.

In an arid region, the soils contain salts and when the water evaporates, these are left on the surface as deposits. Rise of water table causes in most cases secondary soil salinization, either due to high salinity of the ground water or due to dissolution of solid phase salt by rising ground water. In such areas when the capillary water, comes to the surface, increases solubility of harmful salts from the soil or those present in the ground water. This heavy concentration of salts renders the soil infertile. The most effective answer to water logging is a properly designed drainage system. The drainage system of an area is the reverse of the irrigation system. Just as the main canal takes off from the river, branches off into distributaries and minors and finally ends in field channels supplying water to individual fields, in reverse order, the

drainage is collected from the indivdual fields through small field drains.

A knowledge of the water table and its fluctuations (Briz-Kishore, 1931) and the quality of ground water in the area proposed for irrigation is essential in assessing the possibilities of water logging through mass balance (Briz-Kishore, 1983). The depth of the sub-soil water level has to be observed in selected open wells distributed over the ayacut, with a greater concentration in low lying areas. Data regarding precipitation in the past and its intensity distribution, will have to be collected and the drainage system suitably designed.

2.0 Causes and Remedial Measures of Water Logging

(a) Soil Conditions :

If the soil is impervious, the water applied for irrigation will be retained only in the soil creating water logging problems. Highly pervious material in the canals also creates heavy seepage into the ground water system and contributes to the rising of ground water table. Hence growing of crops, cropping pattern and intensity should be planned keeping in view invariable soil conditions.

(b) Topography and drainage :

When the lands are not levelled properly and the topography is undulating the fields are usually flooded with water, especially, in semi-arid region in the absence of efficient drainage system. To transport excess water applied for irrigation, the low lying areas are inevitably being water logged. An efficient drainage system is, therefore essential for conveying water to the individual holding and to remove excess water applied for irrigation. Proper land grading and maintenance of surface slopes will interconnect all farm field drains which may ultimately lead to the natural water course to transport away the water from rechanging the ground water system. Simultaneously, the natural drains have to be desilted which may otherwise become ineffective for transportation of water due to heavy silting.

(c) Excess application of water :

It is a common observation that water is applied more than the requirements, since farmers think high yields will be obtained with application of excess water. Excess application of water is as detrimental to crop growth as inadequate water. Over a long run, the practice of excess application of irrigated water increases water table in low lying regions, which may ultimately disturb the entire ecological system. Hence planning and controlled use of water deeping on actual crop requirements is very important. Another measure for restricting water application is to resort to sprinkler or drip irrigation in selective regions.

(d) Seepage from the canals

Seepage losses from unlined canals, distributories and field channels significantly contribute to ground water recharge. Spreading the impervious layer or lining the canals are necessary to prevent the seepage to the ground water and consequently water logging.

(e) Conjunctive Use of Water :

If adequate ground water is exploited and utilised in conjunction with surface water for irrigation, the ground water level can be maintained to avoid water logging. Further ground water can be fed to the canal from the wells at chosen locations along the canals, so that the extraction not only serve the lowering of the water table but also regulates adequate supply to the areas where heavy improper distribution exists. Depending upon the cost benefit effectiveness of the water it can even be thought of supplying to urban population for drinking or to the nearest industries. The causes for water logging, consequent effects and the suggested preventive measures are presented diagramatically in Figure 1.

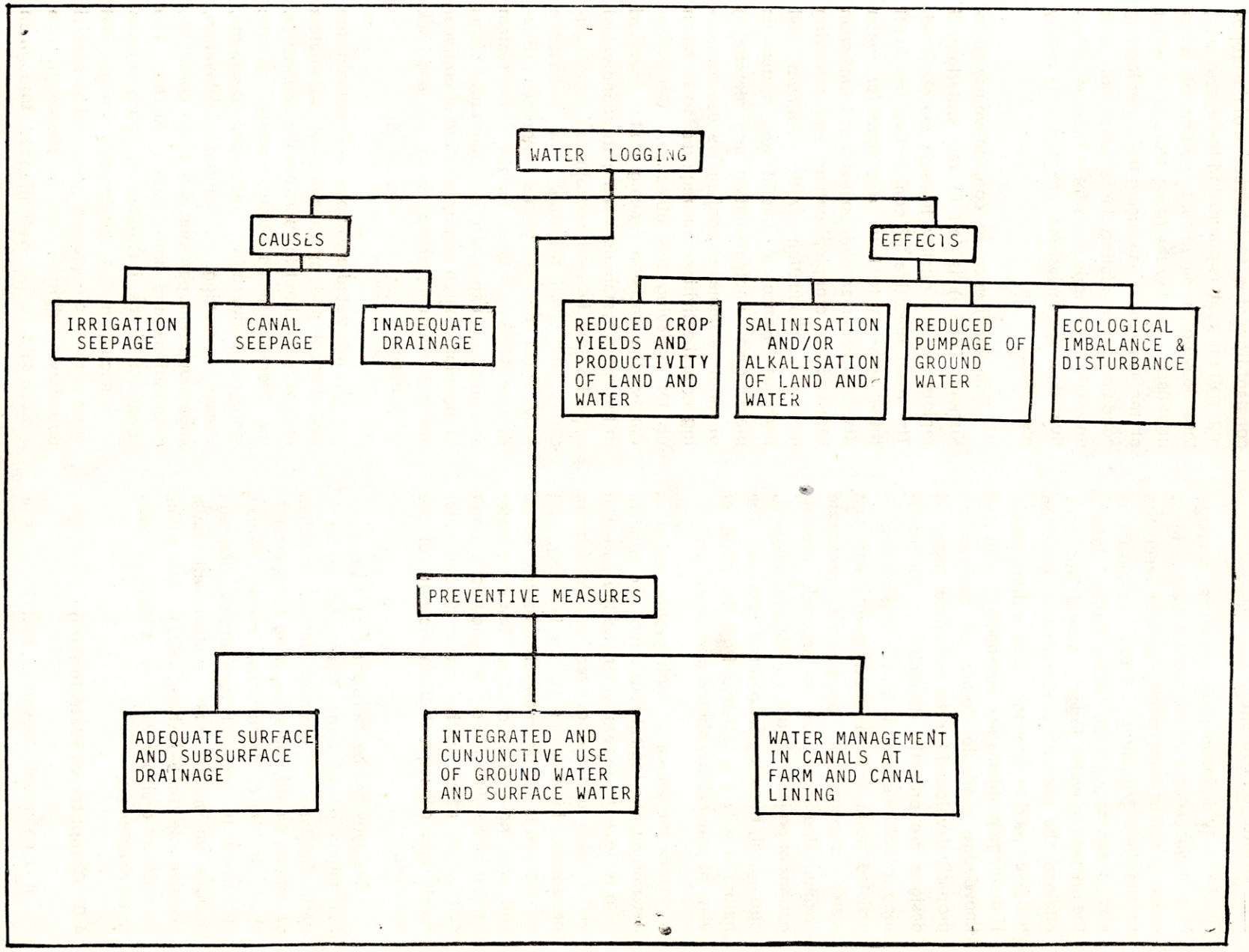

Fig. 1 : Causes, Effects & Preventive Measures of Waterlogging

3.0 Drainage Problem

In many drainage problem areas, seepage is a major source of the ground water. Most seepage comes from canals, surface reservoirs or the field irrigation. Artesian pressure is also a source of high water tables. Infact, the menace of water logging would not have attained the present proportions if attention had been paid to drainage along with irrigation. If drainage problems are approached with the knowledge available today, if designs are properly developed for the prevailing today, if designs are properly developed for the prevailing conditions and if good construction is insisted upon with a good maintenance and water management programme, profitable farming operations can be assured. Investigations of projects should include topographical, geological, hydrological and soil surveys. The nature of soils and sub-soils from the point of view of permeability should also be studied.

Once the source of high ground water is determined, the logical solution of the problem is to remove the excess water and the salt. The water table can be lowered and the salt can be removed by leaching it. In leaching, still more water is put on to dissolve the salt in the soil and move it to depths. But more water cannot be applied if the soil conditions don't suit which cause further rise in ground water levels and consequent intensification of the problem.

Drainage can be horizontal or vertical or a combination of two. The suitability of a particular type of drainage in an irrigation command, would, therefore, have to be established. In these evaluations, model studies structured to respond to various drainage options on ground water system will play a decisive role (Brize-Kishore, 1987). Also plans for reuse of drainage water or its disposal need to be considered.

4.0 Computer vs Waterlogging

It is commonly observed that there is a constant flow of water irrespective of the cropping pattern that is planned in the ayacut area, thus leaving a significant portion of water unutilised. Further the heavy storage of water at the reservoirs, is causing the water logging conditions, invalidating large areas of land unsuitable for agriculture for which the effective remedial measures are not yet totally identified.

The significance of conjunctive use (Briz-Kishore, 1986 a) is felt in the waterlogged regions, where quality hazards are observed. The main objective of conjunctive use in all these areas is to have a system for water distribution spread over an extended time span to have better cropping pattern and achieving maximum production with minimum soil damages. Hence, a careful and systematic planning and implementation and monitoring of various schemes of conjunctive use containing several activities are required to be taken up for achieving this objective. Correspondingly, the decision making that is involved in the entire system containing these individual activities must be well coordinated, communicative and result oriented. This is possible only when the integrated approach (Briz-Kishore, 1988 a) is taken for the entire system and precisely expressed in quantitative terms in planning, design and installation of engineering sub-systems along with a feed-back mechanism.

The integrated equations will contain the hydrological and hydrogeological parameters like inflow and outflows across the boundaries, the hydraulic heads. transmissivity, specific storage, permeability, recharge, discharge, stream gauging, aquifer elevation, impervious semi pervious and leaky condition, evaporations and transpiration losses. The equations for the integrated approach involve items such as partial differentials integral and other arithmetic operators governed by several boundary conditions, Hence, the conjunctive use can said to be well planned, through an

integrated approach only when the set of equations of the total system is solved for different present and projected estimates simultaneously, so that the net implicit effect on each parameter due to all other parameters is expressed quantitatively,

A thorough analysis of computerised procedures for conjunctive management (Figure 2) indicates the necessity of development of software for information systems and simulation systems. The information system contain huge volume of data pertaining to hydrological, hydrogeological, hydrometeorological and cropping agronomical pattern parameters. For this purpose a data base is operated to provide instantaneous information about the various activities under conjunction operation. The data base can be created in the form of hierarchical, netwoork or relational type (Briz-Kishore, 1986 b, 1988 b). The hierarchical type is utilised where there is large amount of dependency among the variables involved while the network and relational types are utilised where different parameters involved are independent. However, in all these cases the entire data that is simulated in the computer provides an integrated picture of the total system.

For its efficient operations, the information systems require powerful software which is normally referred to as Data Base Management System (DBMS). The DBMS requires random access oriented secondary memory devices like the magnetic discs or catridges for its operation. The effective functioning of information systems, therefore envisage a high speed and large processing capacity computers, data storage capacity disc drives and DBMS software.

As can be seen from the Figure 2, the second component of water logging management system, namely, simulation systems is of mostly computational in nature and contain complex equations involved in the process. These computations can be handled through direct solution techniques and/or approximation techniques. The direct solution techniques contain matrices of high order for each parameter which in turn require large amount of memory and time for their solution. The approximation techniques normally involve iterative methods for solving the equations. The iterative solutions are better than the direct methods since they take into account various boundary conditions and dynamics of of overall hydrological system. It is further seen that the methodology of iterative solution require less computational time with adequate accuracy depending on the prescribed accuracy limits. Hence for any computerised conjunctive operation for water logging, iterative technique are preferred to the direct methods.

For efficient handling of engineering systems it is further essential for the computer system to have a powerful mathematical library containing software programmes for various numerical techniques and solutions of statistical problems. These engineering systems in view of their computational nature require a faster CPU (Central Processing Unit) as indicated in Table 1.

5.0 Recommendations

1. Various managerial techniques to over come the acute problems of waterlogging and other quality hazards have to proposed as part of a master plan before execution of irrigation projects.
2. Implicit methods of numerical solution of conjunctive use should be preferred since they are more closer to the real system and require minimum computer configuration.
3. The obvious advantage of such a computerised system will be that the advance information with respect to the water logging conditions can be known so that the suitable cropping pattern can be before hand.

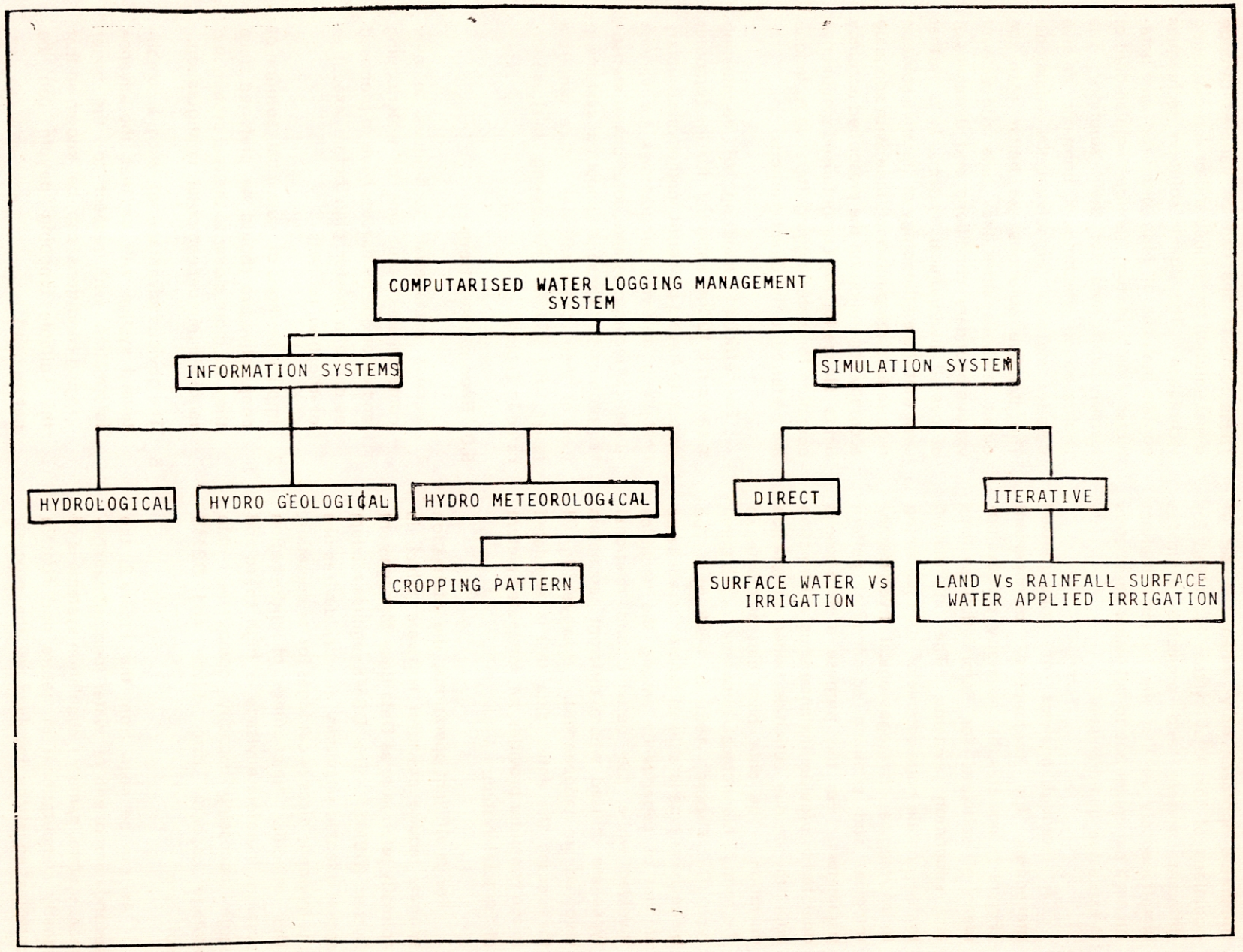

Fig. 2 : Computerised Water logging Management System

Table 1 : Typical Computer Configuration

Description	Capacity
Central Processing Unit	Any 80386 based system or its equivalent
Main Memory	2 MB-16 MB
Floppy Discs	1 Nos. (1.2 MB)
Winchester Disc	2 Nos. (160 MB each)
Magnetic tape	1 No. (Streamer type)
Terminals	4 Nos. view terminals with communication multi-plaxer
Line Printer	300 lines per minute
Scaner	Graphics
Laser Printer	
Light Pen	
High Resolution Monitor	1
Intelligent Terminals (with PC/XT configuration)	2

4. Since the information retrieval is from the same computer which can be updated periodically the generated outputs on land and water resource will be an integrated and coherent one which will act as a prediction tool.

5. It will be possible to get all historical information on any particular aspect like the beneficial cropping pattern in any selected area for cultivation. This will be useful for making a plan for the future so that similar actions can be initiated under similar situations elsewhere.

6. It becomes simplified to review the achievements against and also evaluate the target balances with the available resources well, in advance.

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