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Factor Analytic Modelling for Participatory Irrigation Management

Reeta Joshi
Assistant Professor
Dept. of Civil Engineering, Quantum University
Uttarakhand, India

Jagdish Kandpal
Lecturer
Dept. of Mechanical Engineering, R. I. T Roorkee,
Uttarakhand, India

***Abstract*— Any developmental project in a canal command have augmented the water availability at the head reach and condensed the opportunity in the down stream reach. These changes in turn generate divergence between water users in a command. Consequently irrigation management policy to be sustained efforts is to be made to blend the social aspects of water users and the physical aspects of the water resources. An attempt has been made in this study to develop an analytical model for blending these aspects to obtain the most acceptable alternative of irrigation water allocation for water users in a command. The rationale of this method is to involve the stakeholders in the decision making process. In a canal order the disparities between mind and tail make situations between water users. An attempt has been manufactured in that study to produce an systematic design for mixing the inspirations of the stakeholders to obtain probably the most adequate substitute of allocation of irrigation water. The explanation of this technique is always to include the stakeholders in your decision making process**

Key Words: Command, canal, irrigation ,water, aspects

1.INTRODUCTION

Water allocation in a canal command area is a common tight spot due to conflicting water demand. It is subjective by conglomeration of interlaced land characteristics, ambient environment, agricultural practices and social fabric of the local populace. This situation is experienced more frequently in areas where the command area is an open system. Provision of irrigation system and its subsequent up gradation has increased the water availability to upstream users. In tandem it has reduced the water availability to downstream users. The situation is further aggravated due to lack of inappropriate water allocation. This may be attributed to the fact that the data collection its storage, processing and subsequent analysis is difficult, costly, and time consuming job. Even if adequate data is available one of the problems arises as to how to blend the available information for acceptable decision. It is a general observation that decision making considering all the significant parameters in one go is a Herculean task. To simplify the efforts the analysis and decision making is generally based on many assumptions.

It is worth mentioning that the remotely sensed data has proven capability in providing many above surface, surface and sub surface characteristics of a land unit. Synergistic use of remote sensing and ancillary data can be made for the development of the database required for the water allocation Further the capabilities of the GIS can be used to store, process and retrieve the developed database

Keeping above in view an attempt has been made to develop an Analytic Model as "a decision support tool" that will be able to help all the stake holders to get the best alternative for water management.

1.1 THE ANALYTICAL MODEL

As mentioned earlier water allocation is a multi-concept phenomena encompassing multi off takes, multi crops, and multiple set of plantation date. For conversing to an acceptable decision of water allocation a Linear Mixing Modeling (**LMM**) may be done.

Let us assume that the multivariate water allocation system consists of 'p' random observable responses as $x_1, x_2, x_3... x_p.$ Further let us assume that the observed responses are linearly dependent upon observable random variables, f_1, f2, f3…f3, and additional source of variations $e_1, e_2... e_p$. Under these circumstances the linear mixing of the observable variable to yield the observable responses may be mathematically represented as:

$x = c1\ f1 + e1$

In matrix form it may be simplified as:

$\mathbf{X = F\ C + e}$

Where, **X** is a vector having p elements containing the observed responses, **C** is an operator matrix; **F** is a matrix containing the observed random variable influencing the system response. The specific factor vector **e**, sometimes known as error vector contains is random in nature. Further if number of observation and its domain is large the mean value of vector **e** tends to zero. Under this condition the water allocation system may be in **L**inear **M**ixing **M**odel (**LMM**) form may be represented as:

$\mathbf{X = FC}$

Further the system may be made robust and compatible by following operation.

$\mathbf{F^TX = F^TFC}$

For estimating the numerical value of the **C** following operation may be made.

$\mathbf{(F^TF)^{-1} F^TX = (F^TF)^{-1} (FTF)\ C}$

If numerical value of $\mathbf{(F^TF)^{-1} (FTF) = I}$, The numerical value of C in least square sense may be obtained as:

$\mathbf{C = (F^TF)^{-1} F^TX}$

The estimated numerical value of **C** may be suitably used to predict the unobserved the system response **Xp** from the observed system variable as under.

$\mathbf{Xp = F\ (F^TF)^{-1} F^TX}$

From above formulation it is clear that the loading matrix is evaluated from the covariance matrix. It is worth mentioning

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that in water resources allocation studies many times it is difficult to measure and assign numerical value to social parameters. Therefore in this study the covariance matrix from the subjective information has been developed using the following the approach proposed by Satty 1996. The step by step procedure is being described below:

(1) Selection of acceptable solutions to resolve the conflict is based on impact of the alternatives on water availability and equality of water distribution. Following objective criteria has been considered.

(i)The average water availability
(ii)The average regional income
(iii)The equality of water distribution
(iv)The equality of regional income distribution
(v)Water availability sensitivity to changes in water supply
(vi)Regional income sensitivity to changes in water supply

It is worth mentioning that all the alternatives identified by water users are not feasible solution

As there is little room to increase the quantity of available water in the basin. Therefore, the most feasible alternative is changing the pattern of water demand. In this regard, this study has identified four plausible water demand-management alternatives to be analyzed:

(a) Enduring the existing water demand Pattern
(b) Embracing Water Sharing Allocation System
(c) Adopting Staggered Planting Schedule
(d)Adopting Staggered Planting Schedule and Water Sharing
(d) Adopting Diversified Crop
(e) Adopting Diversified Crop and Water Sharing

(2) In the second phase, pair wise comparisons of the alternatives are made. For this the scale proposed by Satty 1996 may be adopted. Based on this scale, comparative judgments are expressed as ratios resulting in a square reciprocal matrix (Covariance Matrix).

(3) In the third phase, the covariance matrix is decomposed spectrally. The decomposition proceeds by imposing conditions that allows to uniquely estimate the Eigen values and Eigen vector or the parameter provides an estimate of the Relative Influence Weight (RIW) for a particular alternative.

(4) The relative importance weight (RIW) corresponding to each alternative is determined by normalizing the eigen vector.

- The developed model was calibrated using historical database consisting of 100 memory records. The database was subjected to Factor Analysis. Weights or membership function each cascade level for different alternatives has been developed
- The importance or acceptability of a particular alternative has been decided on the basis of a linguistic measure of importance. The confusion matrix was decomposed spectrally in to components.

3. CONCLUSIONS

In a canal command the disparities between head and tail generate conflicts between water users. An attempt has been made in this study to develop an analytical model for blending the inspirations of the stakeholders to obtain the most acceptable alternative of allocation of irrigation water. The rationale of this method is to involve the stakeholders in the decision making process.

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