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# OPTIMIZATION OF WATER DEMAND BY FUZZY RULE BASE APPROCH

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***Abstract:** The aim of this Research Project is to develop a fuzzy rule-based model for obtaining the optimal storage for the reservoir. The area considered for study id Khadakwasla reservoir. The data consideration for optimization will be for all 12 months of year. The inputs consider will be drinking, irrigation & industrial & storage considered as output. The fuzzy logic analysis is based on designing of if and then rules. The fuzzy logic model can handle with various kinds of data regulation, implications & defuzzification. The steps involved in the development of model include the construction of membership functions, creating the fuzzy rules, implication & defuzzification*

## I. INTRODUCTION

Our earth is called the 'Blue Planet' as of 70% of the earth is covered by water, but only 2.5% of the earth's water is fresh, while 97.5% is being in oceans. Although percentage of freshwater, only 0.3% of this freshwater is available for human and animals from rivers, lakes and reservoirs, and other 30% is in from the groundwater. According to the provisional data provided by census in 2011, population in India measured to 1.21 billion with nearby 30% of them living in cities. So as compared to population growth India seriously need water optimization for future planning. In pune there are two major rivers flowing through are Bhima and Nira. Bhima originates at Bhima Shankar in Sahyadri hills flowing towards east and river Nira originates in Sahyadri hills of bhor tehsil. The tributaries of river Nira are Gunjawani, Pushpawati and Shivganga. It flows through Bhor, Baramati, and Indapur tehsils. The confluence of river Nira and Bhima is at Narsingpur in Sholapur district. The major water sources for drinking and irrigation purpose in Pune district there are Khadakwasla, Panshet, Varasgaon, Bhatghar, Veer. Ujani and Koyana dams. We are going to study about Khadakwasala dam and try to apply the fuzzy logic base approach in this research paper

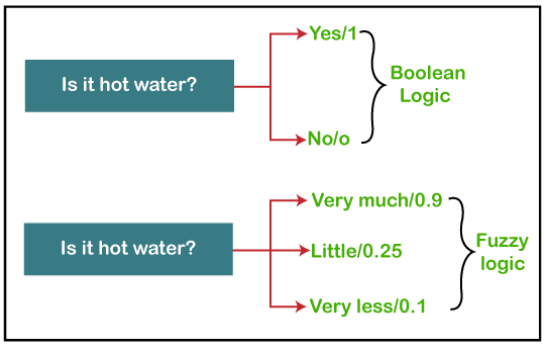
## II. INTRODUCTION TO FUZZY LOGIC

Fuzzy logic is an approach to computing, based on "degrees of truth" rather than the usual "true or false" (1 or 0). This is based on Boolean logic which is the base of modern computer. Fuzzy Logic is a rigorous methodology for dealing with elements of uncertainty and vagueness.

Fuzzy logic is a powerful problem-solving methodology and mathematically it is a superset of Boolean or Crisp logic. The term "fuzzy" refers to the logic involved which can deal with concepts that cannot be expressed as the "true" or "false" but rather as "partially true" or "partially false".

Fuzzy Logic incorporates a simple, rule-based IF X AND Y THEN Z approach to a solving control problem rather than attempting to model a system mathematically. The Fuzzy Logic model is empirically-based, relying on an operator's experience rather than their technical understanding of the system.

We can understand Fuzzy Logic by following example,

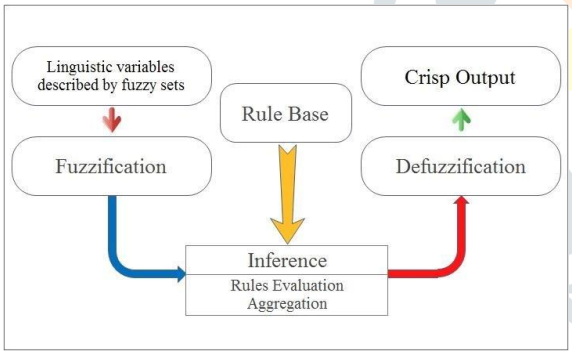



*Fuzzy Inference System (FIS):*

Fuzzy inference (reasoning) is the actual process of mapping. As described in figure 19,this process starts from a given input and finishes to an output using fuzzy logic. The process involves all the pieces that we have discussed in the previous sections: membership functions, fuzzy logic operators, and if-then rules.

Fuzzy inference systems have been successfully applied in fields such as automatic control, data classification, decision analysis, expert systems, and computer vision. Because of its multi-disciplinary nature, the fuzzy inference system is known by a number of names, such as fuzzy-rule-based system, fuzzy expert system, fuzzy model, fuzzy associative memory, fuzzy logic controller, and simply fuzzy system. The most important two types of fuzzy inference method are Mamdani and Sugeno fuzzy inference methods. Mamdani fuzzy inference is the most commonly seen inference method. This method was introduced by Mamdani and Assilian (1975). Another well-known inference method is the so-called Sugeno or Takagi-Sugeno- Kang method of fuzzy inference process. This method was introduced by Sugeno (1985). This method is also called as TS method.

Inference mechanism allows mapping given input to an output using fuzzy logic. It uses all pieces described in previous sections: membership functions, logical operations and if then rules. The most common types of inference systems are Mamdani and Sugeno. They vary in ways of determining outputs.




*Defuzzification:*

Defuzzification is the process of producing a quantifiable result in fuzzy logic, given fuzzy sets and corresponding membership degrees. It is typically needed in fuzzy control systems. These will have a number of rules that transform a number of variables into a fuzzy result, that is, the result is described in terms of membership in fuzzy sets.

For example, rules designed to decide how much pressure to apply might result in "Decrease Pressure (15% ), Maintain Pressure (34%), and Increase Pressure (72%)". Defuzzification is interpreting the membership degrees of the fuzzy sets into a specific decision or real value.

The simplest but least useful defuzzification method is to choose the set with the highest membership, in this case, "Increase Pressure" since it has a 72% membership. and ignore the others, and convert this 72% to some number. The problem with this approach is that it loses information. The rules that called for decreasing or maintaining pressure might as well have not been there in this case.

There are many different methods of defuzzification available, including the following:

Al (adaptive integration)

BADD (basic defuzzification distributions)

BOA (bisector of area)

COA (centre of area)

COG (centre of gravity)

ECOA (extended centre of area)

EQM (extended quality method)

FCD (fuzzy clustering defuzzification)

FM (fuzzy mean)

GLSD (generalized level set defuzzification)

ICOG (indexed centre of gravity)

IV (influence value)

LOM (last of maximum)

MeOM (mean of maxima)

MOM (middle of maximum)

QM (quality method)

RCOM (random choice of maximum)

SLIDE (semi-linear defuzzification)

WFM (weighted fuzzy mean)

Out of all above methods few of them are popularly being used.

A common and useful defuzzification technique is centre of gravity. First, the results of the rules must be added together in some way. The most typical fuzzy set membership function has the graph of a triangle. Now, if this triangle were to be cut in a straight horizontal line somewhere between the top and the bottom, and the top portion were to be removed, the remaining portion forms a trapezoid. The first step of defuzzification typically "chops off" parts of the graphs to form trapezoids (or other shapes if the initial shapes were not triangles). For example, if the output has "Decrease Pressure (15%)", then this triangle will be cut 15% the way up from the bottom. In the most common technique, all of these trapezoids are then superimposed one upon another. forming a single geometric shape. Then, the centroid of this shape, called the fuzzy centroid, is calculated. The x coordinate of the centroid is the defuzzified value

## III. MATERIALS AND METHODOLOGY

In this research work we are going to study about Kadakwasala dam in Pune and try to predict the optimization and water reservation need upto year 2050 by using Fuzzy rule base approach in software's like SKILAB and MATLAB.

### *A. Materials*

*1)* Watershed sheets of Khadakwasala and Pune
*2)* Pune population index
*3)* Water consumption index of Pune
*4)* SKILAB software

### *B. Methodology*

1) Study of water sheds
2) Estimation of different water supply & demands
3) Fuzzification of input data
4) Fuzzy inferencing
5) Defuzzification
6) Optimization of water demands
7) Optimize

**Study of Watersheds:**

Before proceeding with the project an extensive survey of the Khadakwasla reservoir was performed, to obtain the following information.

Catchment details

Capacity of reservoir

Storage capacity in adverse condition

Purpose of constructing dam

Dimensional details of dam

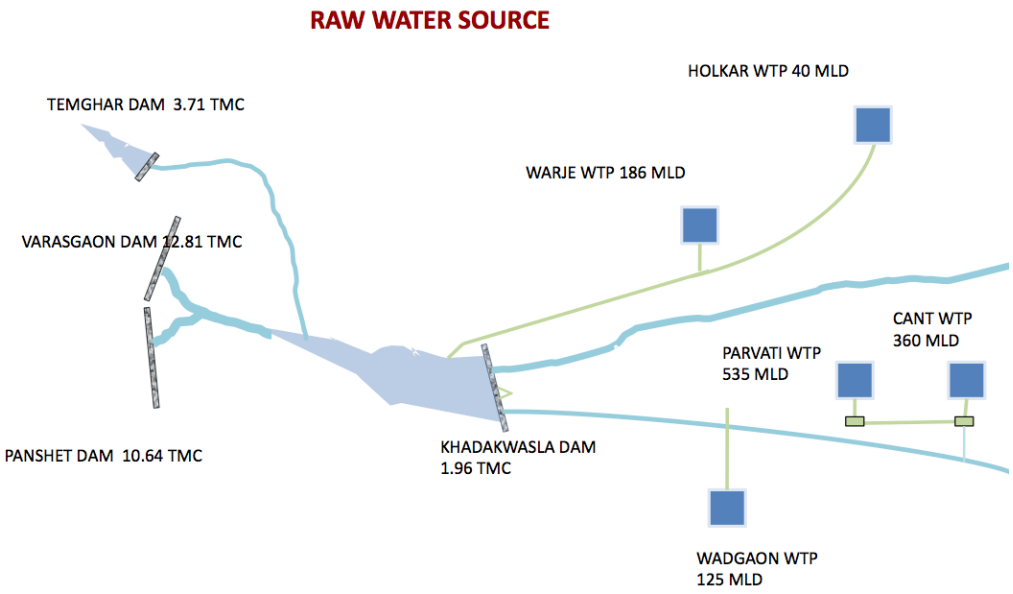
Khadakwasla dam is a dam on the Mutha river, 21km(13mi) from the centre of the city of Pune in Maharashtra, India. The dam created a reservoir known as Khadakwasla lake, which is the main source of water in Pune. The dam was constructed with Earthen Gravity & Masonry. Ogee spillway was preferred for construction with 11 gates. Spillway gates are radial. It is owed by Government of Maharashtra by Pune Municipal Corporation. The catchment area of is 14800(103cu.m). Latitudinally it is located at 18.442697 & longitudinally at 73.763713. Total storage capacity of the dam is 374(million cu.m). The dam serves the purpose of irrigation only. The height of dam is 31.79m & length is 1939m. Volume content of dam is 1170tem

*Estimation of different water supply & demands:*

Water demand in Pune region

| | REGION | WATER DEMAND (MLD) | PERCENTAGE |
|---|---|---|---|
| 1 | PMC | 531.94 | 64.87 |
| 2 | Pune Cantonment | 13.30 | 1.62 |
| 3 | Khadki Cantonment | 12.35 | 1.51 |
| 4 | PCMC | 239.32 | 29.19 |
| 5 | Rest of PMR | 23.43 | 2.86 |

Basic flow and distribution of water from Khadakwasala as show below,




*Population And Water Demand:*

Pune has developed from a quiet, peaceful educational and cultural centre into one of the fastest developing urban centres in India. Therefore, with increase in population need of water demand also increases.

The population projections are carried out by using conventional methods, recommended by the CPHEEO Manual on Water supply and Treatment. These are described below,

1) Arithmetical Increase Method
2) Geometrical Increase Method

**Fuzzification of input data**

**Fuzzy inferencing**

**Defuzzification**

Two types of (FIS) can be applied in fuzzy logic, the most commonly and widely used Mamdani type (1977) and Takagi Sugeno type (1985); both methods are similar in many aspects: however the main difference between them is the output membership functions (MF) in Sugeno type are linear or constant. Since the output membership functions in this paper (namely reservoir release) are not necessarily linear, the FIS Mamdani has been adopted as it represents the output (release) more realistically

1.Input and output variables fuzzification using convenient linguistics subsets such as high, medium, low, etc.

2 Based on expert knowledge and available information. IF-Then rules constructed to combine the linguistic inputs subsets to the output fuzzy sets using the logical conjunction such as "and" 3. The implication part of fuzzy system is defined as the shape of the consequent based

the premise (antecedent) part.

4. Finally, to have a crisp value, the resulted fuzzy set is defuzzied using the

appropriate defuzzification method such as “and”

The inputs to the fuzzy system are Drinking, Irrigation and Industrial for the reservoir The output is the optimal release from the reservoir. The model is developed in the FISPRO. The main objective of the study is to compute the quantity of the water that should be released to meet the monthly irrigation demand and also an attempt has been made in developing the model that obtained optimal releases from the FRB model should be less than actual releases of the reservoir while satisfying the demand completely

To apply Fuzzy Rules to the above formulated model, the data used are Drinking Irrigation, Industrial & Storage. In modelling of reservoir operation with fuzzy logic the following distinct steps are followed

(a) Fuzzification of inputs, where the crisp inputs such as the Drinking, Irrigation & Industrial, are transformed into fuzzy variables.
(b) Formulation of the fuzzy rule set, based on an expert knowledge base,
(c) Application of a fuzzy operator, to obtain one number representing the premise of each rule.
(d) Shaping of the consequence of the rule by implication, and
(e) Defuzzification.

**Optimization Of Water Demand**
**Optimize**

After collecting all necessary data and obtaining all information by Fuzzy logic, we can optimize water demand

## IV. CONCLUSION

A rule base approach for optimization provides a simplest approach to forecast the water demand. The optimization obtained will define the water demand monthly drinking, Irrigation and Industrial

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