

WATER MANAGEMENT IN CHENNAI – A FUZZY STUDY

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Abstract:

Pollution is avoidable but was not avoided, still it continues. Due to different types of pollution occurring all over the world, it integrally causes the proportional global warming. Upcoming global warming causes monsoon rainfall differently unseasonal one, which could not be predictable. Thus we usually receive rain fall, not in a breathing interval, Sometimes it rains unexpectedly hefty in short period of time. In this paper, we discussed about major factors which had caused the flood in Chennai city during December 2015. Using Fuzzy Logic Control, the article is précised to identify which of the factors have played the major role in recent flood.

Keywords: Kosasthalaiyar, Adyar, Cooum, Illegal Mining, Trans-boundary, River basin factor

Introduction:

So many number of natural and manmade factors are found to be the reason for flood. As we have already discussed related to flood; the factors of flood alert applications which were discussed in the paper “IMPLEMENTATION OF FUZZY LOGIC CONTROL FOR FLOOD ANALYSIS” is further enhanced in this article. The main discussion of this paper is that when the discharge of heavy rain water (flood) to sea, through the main discharge channels like Cooum, Adyar and Kosasthalaiyar River Babuska, R. [1998]. The following impacts and causes are being observed as follows.

• Literature survey:

SaravananJ, Neveen Chandrer K written in their article "Chennai floods (2015) and possible solutions from developed countries" that they concluded metropolitan city like Chennai can be developed with the latest possible guidelines observed by various from the developed countries Baldwin, J.E [1981]. "Disasters in Asia and the Pacific:2015 year in Review" is written as "Better Understanding of the Weather is obvious that flood risk can be minimized if one can predict the occurrence of major precipitation events well in advance". This is especially in need for cities like Chennai, where major reservoirs are for drinking water, and one tending source to store as much water as possible when the rains come, and little storage is left for flood mitigation Baldwin, J.E[1980], Baldwin, J.E [1986].

• Description of study area:

Water body encroachments are identified as the major root cause/ reason for the recent flood. The Chennai city has seen the highest rainfall in 100 years. In Chennai and its urban area, each of its lakes has a natural flood discharge channel which could drain the spillover sufficiently Berenji, H.R[1992]. But we have built concrete jungle over many of these water bodies, blocking the smooth flow of water. We have forgotten the art of drainage. We see land for buildings, not far water resources Dijkman, J.G[1971].

In the absence of the water bodies on its real size and capacity, which primarily acts as a natural drainage system, the runoff water from the excess rains fall finds no place to go, which eventually causes floods Bezdek, J.C. (ed.). [1989]. Further, the lack of water bodies creates scarcity of water during the time of drought. The recent floods in Chennai have once again highlighted the importance of protecting our water bodies.

• The present condition of Chennai water bodies:

The water bodies which are presently in and around Chennai are showing the varying degrees of environmental degradation. The most affected water bodies are the lakes and wetlands. Rapid urbanization with scant regard for ecological concerns has destroyed most of these water bodies. Recent years, many of the water bodies are being encroached and overfed with full of sewage and garbage. The greater metropolitan Chennai where recent floods have caused huge damage to life and property. Buckley, J.J. [1988b] In the 19th century the madras (Chennai) area had at least 43,000 functioning water tanks. And It was also estimated that just two decades ago, there were at least 650 water bodies. But today only a fraction (less than 30) of them remain left Buckley, J.J. [1992].

According to records of the Water Resources Department (WRD), the area of 19 major lakes has been shrunken from a total of 1,130 hectares to nearly 645 hectares and hence reduced their storage capacity. For example, Maduravoyal Lake, which was once spread across 120 acres, has now shrunken to 25 acres. Campos, L[1982].

Rivers

• Cooum:

The cooum river originates in Tiruvallur district about 70 Kilometres (43 miles) far from Chennai. In the Chennai district, the river flows through three corporation zones like Kilpauk, Nungambakkam, and Triplicane for a total length of 16 Kilometres (10 miles). The total catchment area of the river is about 400 Sq.Km (650 Sq. miles). The capacity of the river flow is assessed as 19,500 cubic

meters per second (690,000 cu.ft/s) and the anticipated flood discharge is around 22,000 cubic meters per second (780,000 cu.ft/s) on an average of every year since 2010 Chang, S [1972].

• **Adyar River:**

Adyar River starts from Malaipattu tank near manimangalam village in Sriperumpudur Taluk which is far offt 15km (9 miles) west from Tambaram near Chennai. It runs through Kancheepuram, Tiruvallur & Chennai districts for about 42.5km (26.4 miles) and entering the Bay of Bengal at the place of Adyar. The catchment area of the river is 530 Sq.km (200 Sq.miles). It discharges about 90 to 940 Million cubic meters (150,000 to 760, 000-acre feet) water annually to the Bay of Bengal. This discharge is seasonal which is about 7 to 33 times more than the annual average during the North-East Monsoon season between September to December. The present discharge of the river is 39,000 cubic meters per second (1,400,000 cu.ft/s) whereas the anticipated flood discharge capacity in about 60,000 cubic meters per second (2,100,000 cu. Ft/s). The flood discharge of Adyar River in almost 3 times as compared to the Cooum River Czogala, E [1982].

• **Kosasthalaiyar River:**

Kosasthalaiyar River flows into Poondi reservoir and from poondi reservoir the river flows through Tiruvallur district, enters Chennai metropolitan area, it travels to a distance of 16kms (10 miles) and arrives the sea at Ennore creek. The total catchment area of the river is 3,757kms (2,334 miles) and the bed width (490 to 820 ft). The discharge capacity of the river is 110,000 cubic metres per second (3,900,000 cu.ft/s) and the anticipated flood discharge capacity is about 125,000 cubic metres per second (4,400,000 cu.ft/s) Czogala, E[1981].

hectares and hence reduced their storage capacity. So this will allow to increase water scarcity in future, we shall definitely be longing for drinking water and water needs. The state government is in need to strictly not to allow the encroachment into water bodies and their basin Dijkman, J.G[1981], Dragan Pamucar[2014].

• **Illegal mining activities:**

Illegal mining, especially for building material such as sand, soil and stones taken from both on the catchment area and on the river bed of the water bodies, are yet another reason behind the destruction of many water bodies (eg. Adyar River) Dubois, D[1980a].

• **Encroachment:**

Encroachment is one another major reason on water bodies, particularly in urban areas like Chennai. Since a small piece of land in any metropolitan like Chennai has high economic value. These are relentlessly encroached thus shrinks the area of the water bodies. Also severely reduces the potential of ground water recharge and proportionately increases effluence. For example The water body in Mogappair has almost/completely disappeared Dumitru, V[1982].

• **Pollution:**

Generally population has been increasing without corresponding expansion of civic facilities such as adequate infrastructure for the waste disposal and management. This scenario is especially true/ happening in the urban areas Gottwald, S. [1979a]. As a result, almost all water bodies in Chennai are being polluted day by day and this is increasing are and relentlessly used to dispose untreated local sewage and solid waste materials.

• **Water Blocks: (Choking of Drains)**

Most people throw garbage, non-biodegradable polythene bags into the drains which get choked. Lake beds are often used as place of dumping yards of solid waste, woods, plastics etc. this has resulted in inundation of neighboring localities Graham, I[1988].

• **River basin(Trans-boundary):**

Most of the slum people live in and around the boundary of the river basin to achieve sustainable development of their basic needs, so they encroach and occupy the trans-boundary river basin [During Flood] Jamshidi, M.[993].

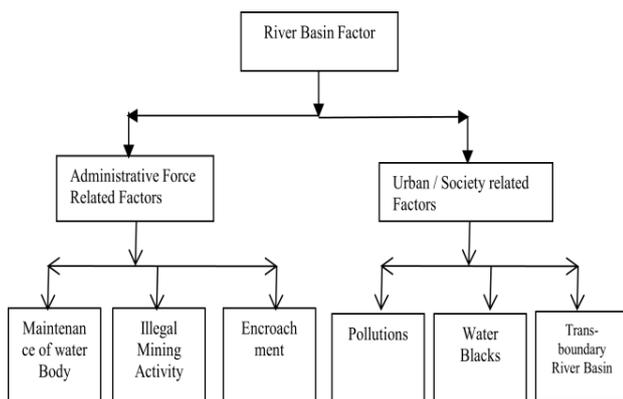


Figure: 1 Levels and classifications of factors causing flood.

SUGGESTIVE APPROACHES:

• **Maintenance of water body:**

According to records of the Water Resources Department (WRD), the area of 19 major lakes has been shrunken from a total of 1,130 hectares to nearly 645

Mathematical Approach / Analysis

1 .Fuzzy Logic Controller (Flc) Method

The cause factor is one of the major input which is used as crisp values into fuzzy values. In this stage all the cause factors are fuzzified. On the next stage of FLC, this fuzzified factor is then used by the inference engine to evaluate the control rules stored in the fuzzy rule base method Jayawardena, A.W[2014]. The result of this evaluation is a fuzzy set which is defined on the universe of possible actions. In the final step unique value is obtained as a step of defuzzification. This leads to the final decision of the problem distinctively.

The basic structure of fuzzy modeling, which is known as fuzzy inference system(FIS), is a rule based or knowledge-based system, consisting of three conceptual components: a rule base that consists of a collection of fuzzy if-then rules; a database that defines the membership function(MF) used in these fuzzy rules; and a reasoning mechanism that combines these rules into a mapping routine from the inputs to the outputs of the system to drive a reasonable output Lee, C.c. [1990]. There are basically two types of rule system, namely, the Mamdani (Mamdani and Assilian,1975)type and the Takagi-Sugeno-Kang(TSK) type (Takagi and Sugeno,1974,1985).In the Mamdani type, the fuzzy rule is expressed in linguistic form. In the Takagi-Sugeno-Kang rule system, the fuzzy rule is expressed as a mathematical function of the input variables which is more appropriate for neuro-fuzzy systems(Sen,1998).

2. Mamdani fuzzy inference system

Step 1

Fuzzification of input: Classifying and scaling of inputs from 0 to 1 by using a set of input membership functions.

Step2

Evaluation of the antecedent: If the antecedent of the rule has more than one part, a fuzzy operator is applied to obtain a single membership value that represents the result of the antecedent for the rule.

Step 3

Creating fuzzy rules formation: Finding the position of existence by formulating fuzzy rules.Generally, the rules_formation needs the background Knowledge in judgment, which is derived from the historical occurrences, to make the fuzzy inference Loo, S.G. [1977]. The definition of the fuzzy operator(And or Or) is used to obtain a single number that represents the results of the antecedent evaluation.

Step 4

Aggregation: Procedure that integrates the output fuzzy set of each rule with the implication step. Some of the most commonly used aggregation operators are maximum, the sum and the probabilistic sum operators Lowen, R. [1978]. The operator combines various output of fuzzy sets associated with each rule, using the fuzzy aggregation operators.

Step 5

This is the last procedure in the fuzzy inference process and it consists in fetching the normalized output by using the defuzzification method.Five commonly used defuzzification method exist: Centroid of area (COA) or Centroid of Gravity method (COG), Bisector of area (BOA), Mean of maximum (MOM), Smallest of maximum (SOM), Largest of maximum (LOM) Lee, C. [1990]. The COG method is used for the defuzzification process discussed in this paper as it is the most used, prevalent and physically appealing of all the defuzzification methods.

Mathematical Model

Using Fuzzytech software, applying below factors to find the solution of problem. Our first variable 1 discussed Maintenance of water body, our second variable 2 discussed Illegal mining activities our third variable 3 discussed Encroachment. These variable 1 , variable 2 and variable 3 are government related factors and unavoidable reason for flood. Urban related factors are, Fourth is variable 4 Pollution, Fifth is variable 5 Water Blocks and Sixth is variable 6 Trans-boundary. The above factor are described using linguistic scale defining from 1to 3 how serious the flood disaster is: low, medium, high Mamdani, E.H. [1977a].

Water Blocks	Outflow water level
Low	High speed
Medium	Normal speed
High	Low/Below speed

Table:1 Water Blocks are inversely proportionate to outflow water level

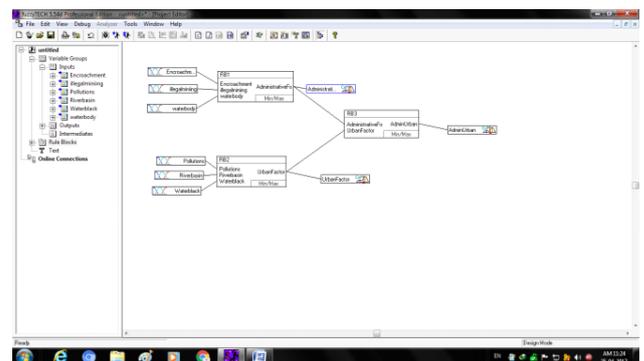


Figure 2. Input and output diagram

Rule	Encroachment	Illegal Mining	Waterbody	Administrative force factor
1	low	low	low	low
2	low	low	medium	medium
3	low	low	high	high
4	low	medium	low	medium
5	low	medium	medium	medium
6	low	medium	high	medium
7	low	high	low	medium
8	low	high	medium	medium
9	low	high	high	medium
10	medium	low	low	medium
11	medium	low	medium	medium
12	medium	low	high	medium
13	medium	medium	low	medium
14	medium	medium	medium	medium
15	medium	medium	high	medium
16	medium	high	low	medium
17	medium	high	medium	medium
18	medium	high	high	medium
19	high	low	low	medium
20	high	low	medium	medium
21	high	low	high	medium
22	high	medium	low	medium
23	high	medium	medium	medium
24	high	medium	high	medium
25	high	high	low	medium
26	high	high	medium	medium
27	high	high	high	medium
28				
29				
30				

Figure 3. Rule base for administrative force factor

Figure 7. Output Result for both (administrative force & urban) factors

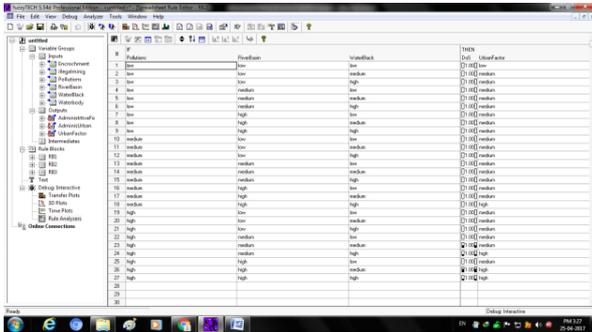


Figure 4. Rule base for Urban related factor

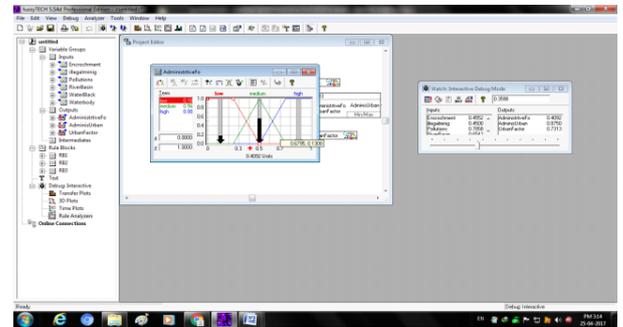


Figure 8. Output result diagram for administrative force factor

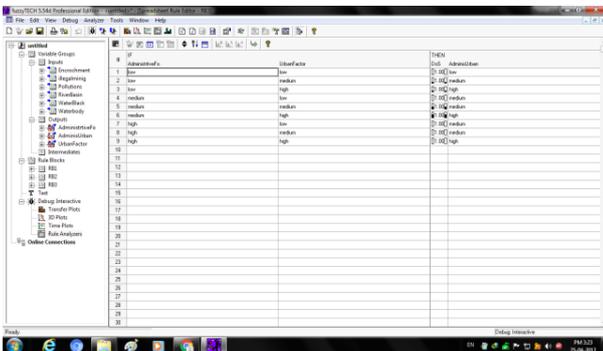


Figure 5. Rule base for administrative force and Urban related factor

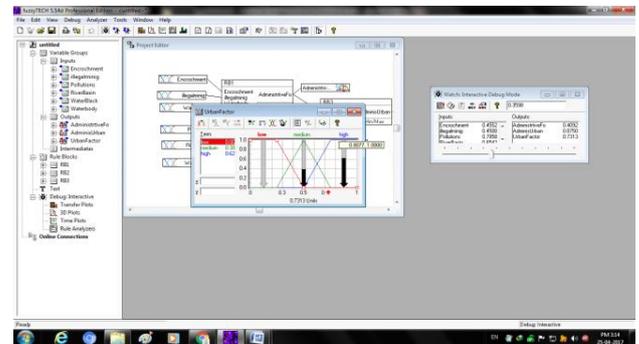


Figure 9. Output result diagram Urban related factor

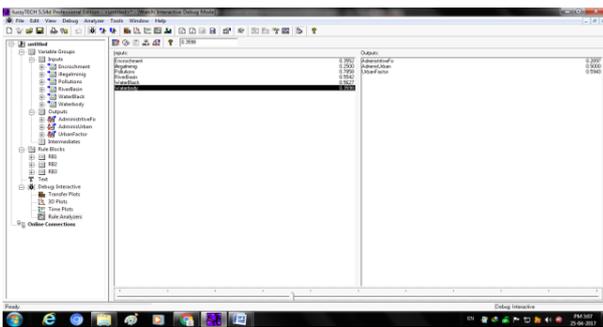


Figure 6. Output Result for both (administrative force & urban) factors

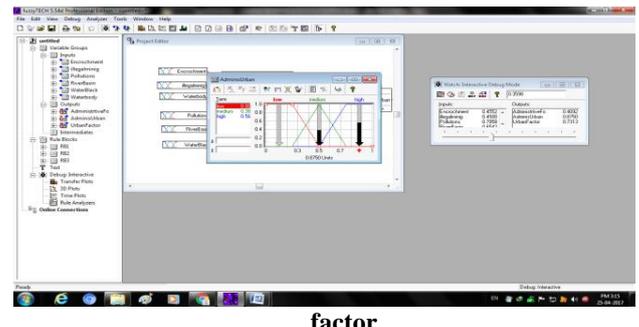


Figure 10. Output result diagram of both (administrative force & urban) factors

Result:

The result of output6 shows that when the administrative forces are low and urban factors are medium then the flood factor is medium. And the result of output7 shows if the administrative forces are low and urban factors are high then the flood factor is high. This is understood that the urban-related factors are not controlled strictly to the core. We shall definitely expect the major hydrological problem that is totally affected the natural

setup and geographical structure of many metropolians. Its consequences on global warming and other related disasters. So the public must be certainly sure to keep proper maintenance of water bodies, and watershed.

Conclusion:

In the years 2015 and 2016 beginning, we were affected by flood. Particularly during 1st and 2nd December the capital city of Tamil Nadu was in stone age days. The Chennai people cannot forget the days; they lost almost all the basic needs, properties and comfort life. The floods that had hit Chennai in November and early December 2015 have damaged the assets costing around an estimate of Rs 20,034crore as per the report. The major reason is common people do not maintain the public property as they do for their own property. The government of Tamilnadu started implementing so many new schemes like a) Every Building, House or an Apartment should maintain "Rain Water Harvesting" right from 2001. b) Disbursal of domestic waste to be classified as recyclable and decomposable, etc, c) Recycling plastics production industries need to maintain the range of microns as advised as per regulations, during their production d) The TWAD (Tamilnadu water supply and Drainage) Board should monitor the given standards in their territory e) The PWD (Public works Department) should be vigilant in keeping the boundaries of the public property, especially the water bodies. f) The TNFD (Tamilnadu forest department) should keep away the forest from destruction and they should also improve the plantation of tree and Herbs etc,

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