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TAMILNADU (CHENNAI & CUDDALORE) HAD SEEN ITS WORST FLOODS

[1]C.JESURAJ, [2]G.MURUGAN, [3]M.ANANDHKUMAR

[1, 2, 3] IFET College of Engineering Villupuram

Abstract: **In this paper, we determine the various causes of floods, where the floods in Tamil Nadu (Chennai & Cuddalore). There are numerous factors which affects the people who are living in Chennai and Cuddalore and affect the standard of living. We analyze some of the main areas of problems due to heavy rain. The data given in this paper are based on the several reports; articles come up in magazines .The data reapplied in Markovian process, which is one of the circumstances of random process. The impact of flood in Chennai and Cuddalore were analyzed in this paper using Markovian process.**

Keywords: **Living Standard, floods, Markovian, Chennai & Cuddalore.**

I. INTRODUCTION

Flood is a widespread natural risk. During the period of 1973 and 1997 and average of 66 million people a year suffered flood damages (Douben, 2002). In 1998 the death toll from floods hit almost 30,000 (Douben, 2002). Following are some of the major flood events of the recent past: Floods in more than 80 countries have killed almost 3000 people and caused hardships for more than 17 million worldwide since the beginning of 2002 according to the reports published by the World Meteorological Organization (WMO) a specialized organization of United Nations based in Switzerland (www.reliefweb.int). WMO estimated the total property damage is more than 30 billion US dollars with over 8 million square kilometers of the total area affected by floods during the first eight months in 2002. The area affected by flood is almost the size of the United States of America. During the August 2002, worst ever recorded floods disasters occurred in Central Europe affecting mainly Germany, Czech Republic and Austria. Similarly, the flood events in China, Nepal, and Bangladesh Now in India (Chennai & Cuddalore) have affected the regions severely. What is flood? A flood is a natural event that can have far reaching effects on people and the environment. Put simply, a flood is too much water in the 'wrong' place!

A. Flood in Tamil Nadu (Chennai & Cuddalore) (November 2015):

On 9–10 November 2015, Neyveli received 483 mm (19.0 in) of rainfall, rains continued to lash Cuddalore, Chidambaram and Chennai. Continuing rains led to low-lying parts of Chennai becoming inundated by 13 November, resulting in the evacuation of over 1000 people from their homes. On 15–16 November, Chennai received 246.5 mm (9.70 in) of rainfall, the highest amount recorded since November 2005, flooding most areas of the city.[9] The flooding in Chennai city was worsened by years of illegal development and inadequate levels of flood preparedness.[19] Much of the city remained flooded on 17 November, though rainfall had largely ceased.[20] Chennai received 1,049 mm (41.3 in) of rainfall in November, the highest since receiving 1,088 mm (42.8 in) in November 1918.[21][22]

The flooding in Chennai city was described as the worst in a century.[23] The continued rains led to schools and colleges remaining closed across Puducherry and Chennai, Kancheepuram and Tiruvallur districts in Tamil Nadu and fishermen were warned against sailing because of high waters and rough seas.[24]

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Though rainfall from the earlier low pressure system ended on 25 November, another system developed on 29 November, bringing additional rain and the Department predicted heavy rainfall over Tamil Nadu until the end of the week.[18][25] On 1 December, heavy rains led to inundation in many areas of Chennai. By afternoon, power supplies were suspended to 60% of the city while several city hospitals stopped functioning.[27] The same day, Chief Minister of Tamil Nadu J.Jayalalithaa announced that, because of the continued flooding and rains, half-yearly school examinations originally scheduled for 7 December would be postponed until the first week in January.[28] For the first time since its founding in 1878, the major newspaper The Hindu did not publish a print edition on 2 December, as workers were unable to reach the press building.[29] The Southern Railways cancelled major train services and Chennai International Airport was closed until 6 December.[27]

Chennai was officially declared a disaster area on the evening of 2 December.[23] At the MIOT Hospital, 14 patients died after power and oxygen supplies failed. With a letup in rainfall, floodwaters gradually began to recede in Chennai on 4 December, though 40 percent of the city's districts remained submerged and safe food and drinking water remained in short supply.[30] Though relief efforts were well underway across most of the area by 3 December, the lack of any coordinated relief response in North Chennai forced thousands of its residents to evacuate on their own. As intermittent rains returned, thousands of displaced residents from Chennai, Kancheepuram and Tiruvallur districts attempted to flee the stricken region by bus or train and travel to their family homes. Chennai International Airport was partly reopened for cargo flights on 5 December, with passenger flights scheduled to resume from the following morning. By 6 December, rescue efforts had largely concluded and relief efforts were intensifying, with the Chennai Corporation beginning to disburse relief packages. Mobile, banking and power services were gradually being restored; fuel and food supplies were getting through, the airport had fully reopened and rail services were slowly resuming. Many city neighborhoods', however, remained flooded with some lacking basic necessities due to the uncoordinated distribution of relief material. Schools and colleges, which had been closed for nearly a month, were scheduled to remain closed through the following week, as further rainfall was predicted for the following four days. With the city slowly beginning to recover, state and national health officials remained watchful against disease outbreaks, warning conditions were right for epidemics of water-borne illnesses. Chennai Corporation officials reported at least 57,000 homes in the city had suffered structural damage, mostly those of low-income people. State housing boards said they would conduct safety inspections of both public and residential buildings.

South of Chennai, heavy rains and flooding persisted into the second week of December. In Kancheepuram district, Chengalpattu, Guduvanchery, Perungalathur, Tambaram, Mudichur and Anakaputhur were inundated with up to 7 meters of water by 5 December, which washed away roads and severed rail links; 98 people from the district were reported to have died. During 4-5 December, parts of Villupuram and Tiruvarur districts received up to 10 centimeters of rain, while some towns in Cuddalore district saw up to nine centimeters. Flood alerts were broadcast to 12 villages in the neighborhood of the Tirumurthy dam in Tirupur district on 7 December, as the dam was likely to reach capacity within two days; the residents of those villages were urged to evacuate. Due to rainfall in Tirunelveli district, all of its dams had reached or were approaching full capacity by 7 December, forcing local authorities to discharge thousands of cusecs of water from reservoirs and causing the Tamirabharani River to reach flood stage. Torrential rains inundated hundreds of acres of paddy fields in Thanjavur district, and caused residential areas to flood by 8 December. Large parts of Thanjavur city were marooned by rising waters, while several houses collapsed under the brunt of rainfall in Kumbakonam and Veppathoor.

After Chennai district, Cuddalore district was among those most severely affected by the flooding. Six of the district's 13 blocks suffered extensive damage during the floods in November. The resumption of heavy rainfall from 1 December again inundated the Cuddalore municipality and the district, displacing tens of thousands of people. Rains continued through 9 December. Despite the state government and individuals sending rescue teams and tones of relief materials to the district, thousands of those affected continued to lack basic supplies due to inadequate distribution efforts; this resulted in several relief lorries being stopped and looted by survivors. Large swaths of Cuddalore city and the district remained inundated as of 10 December, with thousands of residents marooned by floodwaters and over 60,000 hectares of farmland inundated; over 30,000 people had been evacuated to relief camps.

II. PROBLEMS

A. Introduction to Markov Process:

A random process, in which the future value depends only on the present value and not on the past values, is called a Markov process.

B. Definition:

A random process {X (t)} is said to be Markovian if $P\left[X(t_{n+1}) \leq X_{n+1} / X(t_n) = X_n , (t_{n-1}) = X_{n-1} \ldots X(t_0) \leq X_0\right] = P[X(t_{n+1}) \leq X_{n+1}/X(t_n) = X_n]$Where $t_0 \leq t_1 \leq t_2 \leq \cdots \leq t_n \leq t_{n+1}$.

Here $X_0, X_1, X_2, X_3, X_4, \ldots, X_n, X_{n+1}$ are called the states of the process. If the random process at time t_n is in the state X_n, the future state of the random process X_{n+1} at t_{n+1} depends only on the present state X_n and not on the past state $X_{n-1}, X_{n-2}, X_{n-3}, X_{n-4} \ldots, X_n$

C. Definition:

A Markov chain is a sequence of random variables $X_1, X_2, X_3, X_4 \ldots$ with the Markov property, namely that, given the present state, the future and past states are independent. Formally,

$$P(X_{n+1} = x / X_1 = x_1, X_2 = x_2, \ldots\ldots, X_n = x_n) = P(X_{n+1} = x / X_n = x_n)$$

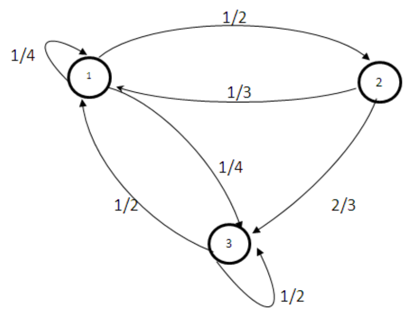
If both conditional probabilities are well defined, i.e. if $P(X_1 = x_1, \ldots\ldots, X_n = x_n) > 0$ the possible values of X_i form a countable set S called the state space of the chain.

III. A TRANSITION PROBABILITY MATRIX FOR A MARKOV CHAIN

A Markov chain is usually shown by a state transition diagram. Consider a Markov chain by three possible states 1, 2 and 3 and the following transition probability matrix is

$$P = \begin{bmatrix} \frac{1}{4} & \frac{1}{2} & \frac{1}{4} \\ \frac{2}{3} & 0 & \frac{1}{3} \\ \frac{1}{2} & 0 & \frac{1}{2} \end{bmatrix}$$

A State transition diagram for the above matrix (P)



1.1 state transition diagrams

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IV. IMPACT OF FLOODS

A. Environmental Impact Assessment of Flood Hazards:

The occurrence of a flood event usually elicits a response to alleviate losses and return society as quickly as possible to pre-disaster conditions. It is rare to find long-term strategic planning designed to mitigate the many facets of the flood hazard. Particularly, it appears that very little systematic environmental impact assessment has been carried out covering all environmental aspects of single flood events. Nevertheless, with the exception of water and sewage systems, environmental impacts of development are generally ignored. In part, of course, this is because floods are often low-probability events that do not rank highly amongst the many issues that people face on a day-to-day basis. In addition, many societies have implemented emergency action plans to facilitate the immediate relief of flood victims, which tends to work against the development of comprehensive disaster planning (White, 1975; Williams, 1986). Also, it should be noted that some events are relatively unpredictable, at least in time if not in space, thus compromising effective planning while promoting a simple response mode. However, despite these characteristics, the opportunities for evaluating probable impacts of a given event and for planning accordingly are considerable.[3][5]

Environmental impacts: Damage to habitats, food chains, species diversity and stability, rare to endangered species, natural recreational resources, scenic resources and archaeological and historical resources.

B. Chemical Hazards during the Flood Events:

There are many possible sources of chemical contamination during and after the flood. Some of them are: dumping ground, graveyards, chemical works (such as car batteries containing acid), pesticide and fertilizers in warehouses, oil spillage from petrol stations. Household and chemical hazardous waste from municipal and private lagoons, septic tank, septic fields and domestic fuel-oil heating tanks are some of the potential source. Chemical factories may induce more dangerous and severe consequence if they are damaged during the course of flooding and chemicals are spilled into the floodwater. Chemicals released into the environment may have a variety of adverse ecological effects. These effects may bring substantial economic, health and social losses. The adverse effects can be grouped as: 1.Short term effects (acute effects) and 2. Long term effects (chronic effects). Some case studies of chemical hazards caused by flooding events are presented below, to demonstrate the diverse chemical hazards associated with floods.

C. Surface and Ground Water Pollution:

Floodwater can be heavily contaminated with varieties of pollution starting from mud, sewage, decay of animal bodies, and pesticides to highly hazardous chemicals. Water treatment plant may go out of order or malfunction due to flood impacts and sewer discharge may directly enter the watercourse without purification.[2][6]

D. Flood Hazards for Nuclear/Thermal Power Plants:

Flood hazards for nuclear power plants can be divided in to two groups (Yen, 1988): internal and external flooding. Internal flooding are those caused by malfunction of the power plant internal facilities. External floods are those produced by heavy rain, river floods, failure of dams or levees, high wind induced waves, tsunamis and other external hydrologic events. Internal flood may also occur due to external flooding. It appears that in current practices in reactor safety considerations, a flood risk attracts far less attention than the risks of earthquake and fire. Flooding hazards for nuclear plants should not be ignored at either the design and construction stage or the operation stage. There are various external geophysical causes that could induce reactor incidents. Among rain related floods, hazards due to heavy rain at the plant site and due to flash floods should also be considered in additions to river floods.

There are two types of hydrologic flood hazards prediction (Yen 1988): a) the probability of flooding for an expected service period and b) a real time forecasting of the probability of flooding for an incoming event. In both case randomness and uncertainties of all the factors such as spatial and temporal variability's of rainfall and watershed, measurement errors and model accuracy should be accounted for inclusively, not merely the frequency of occurrence of the flood events. In case of an accident in the nuclear station, the consequence would be very extensive, although no cases have been revealed of any such accident associated with any flood.

Nuclear power plants cannot be "switched off" like the engines of a motor car. The shutdown of a stream turbine, whether in a conventional or nuclear power plant, requires power for turning the shaft as it is cooling down; the nuclear section must similarly undergo a lengthy shutdown for which power and other services are required. In Tamil Nadu kalpakkam Koodankulam and Neyveli have nuclear and thermal power plant.

E. Human and Animal Health:

The human and animal health consequences of any one flood event will vary depending upon the nature and severity of the flood as well as the effects upon a given human or animal population. So far the researches have tried to establish the key aspects of flood characteristics, which suggest anticipated fundamental effects. Although the potential for disease outbreaks is always anticipated after a disaster, there are certain conditions that must be present for this potential to manifest in the form of epidemics. Human and animal health can be affected by flood directly or indirectly. Some of these effects can be summarized as presented in the table below:

Impacts of floods on human health:

The impact of floods on human health – Direct effects	
Causes	Health Implications
Stream flow velocity, topographic land features, absence of warning, rapid flood onset, deep floodwaters, landslides, risky behavior, fast- flowing waters carrying boulders and fallen trees Contact with water Contact with polluted waters Increase of physical and emotional stress Disruption of transport.	Drowning, injuries Respiratory diseases, shock, hypothermia, cardiac arrest Wound infections, dermatitis, conjunctivitis, gastrointestinal illnesses; ear nose and throat infections; possible serious water borne diseases Increase of susceptibility to psychosocial disturbances and cardiovascular disease. Food shortage, disruption of emergency response.
The impact of floods on human health – Indirect effects	
Damage to water supply systems, sewers and sewage disposal systems, insufficient supply water for drinking, cleaning and washing Underground pipe disruption, dislodgement of storage tanks, overflow of toxic-waste sites, release of chemicals, destruction of petrol storage tanks (may lead to fires) Standing waters, heavy rainfalls, expanded range of vector habitats Cleanup activities following the flood Destruction of primary food production Damage to health services, disruption of "normal" health services.	Possible serious water-borne infections (enter genic E-coli, hepatitis A, leptospirosis, giardiasis) dermatitis and conjunctivitis Potential acute of chronic effects of chemical Pollution , Vector-borne diseases Electrocutions, injuries, laceration, skin punctures Food shortage Decrease of "normal" health care services, Insufficient access to medical care.

F. Agriculture and Animal Farming:

Tamil Nadu Agricultural University has estimated that the recent flood has affected more than 20,000 hectare paddy in Cuddalore and a few other districts. But not all is lost say experts in the University. Most of the damage is in Parangipettai, Kurinjipadi and Mel Bhuvanagiri blocks where 400 mm rainfall was recorded in a few hours. This led to inundation of the paddy fields. But because the Navarai cultivation had only just begun and farmers had only recently transplanted paddy seedlings, there was an opportunity for a solution, says K. Ramasamy, Vice-Chancellor, who plans to visit the flood-affected areas in Cuddalore soon. [4]The University has 50 tonnes of paddy seeds. It can raise these seedlings and give it to the farmers to transplant into their fields through the Agriculture Department. It therefore proposes to talk to Agriculture Department to identify land in the area to raise the seedlings. This paddy will be of the short-term variety (80 – 90 days) so that farmers harvest early and earn money. Given the recent rains and its impact on ponds, tanks and ground water table, water for the paddy will not be a problem, he says. The University also plans to raise vegetable seedlings (Tomato, Brinjal, Gourds, Chilly and a few other vegetables) through the 'tray seedling' method, for distribution to farmers in the affected districts. The method will help farmers make up for lost time and help them harvest earlier and earn money in the shortest possible time, says Mr.Ramasamy. In Nagapattinam and Tiruvarur, the most affected areas, the University through its research station helped farmers by suggesting the right nutrient mix for the plants. G. Ravi, Director, Aduthurai Research Station, says that given the weather, the nutrient intake by plants will be poor. So they were asking farmers to spray zinc sulphate and urea as foliar nutrition (applying liquid fertilizer on leaves).In Kanchipuram and Tiruvallur districts, the University has devised the same strategy it has adopted for Cuddalore. [(31).]

The case study of this issue was analyzed and the following TPM was constructed. The stare of the people before they rejuvenated the protest after the Fukushima disaster in is taken as the X_{n-1} state of the Markovian process and the present status of the flood is taken as the X_n state of the Markovian process.

j_1= Environmental Impact Assessment of Flood Hazards

j_2= Chemical hazards during the flood events

j_3=Surface and ground water pollution

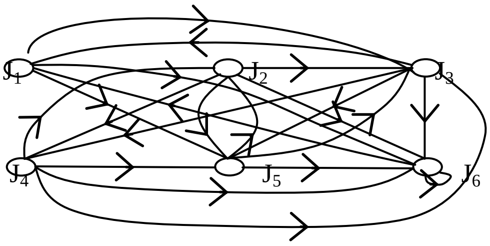
j_4=Flood Hazards for Nuclear/thermal Power Plants

j_5=Human and animal health

j_6=Agriculture and animal farming

The TPM is obtained by the above process is given by

$$P = \begin{array}{c} \\ j_1 \\ j_2 \\ j_3 \\ j_4 \\ j_5 \\ j_6 \end{array} \begin{array}{c} \begin{array}{cccccc} j_1 & j_2 & j_3 & j_4 & j_5 & j_6 \end{array} \\ \begin{bmatrix} 0 & 0 & \frac{1}{2} & 0 & \frac{1}{4} & \frac{1}{4} \\ 0 & 0 & \frac{1}{4} & \frac{1}{4} & \frac{1}{4} & \frac{1}{4} \\ \frac{1}{4} & 0 & 0 & \frac{1}{4} & \frac{1}{4} & \frac{1}{4} \\ 0 & \frac{1}{4} & \frac{1}{4} & 0 & \frac{1}{4} & \frac{1}{4} \\ 0 & \frac{1}{4} & \frac{1}{2} & 0 & 0 & \frac{1}{4} \\ \frac{1}{2} & 0 & \frac{1}{4} & 0 & 0 & \frac{1}{4} \end{bmatrix} \end{array}$$



1.2 state transition diagrams

Long run:

If $\pi = (\pi_1, \pi_2, \pi_3, ...\pi_n)$ be the stationary distribution of the Markov process , then by property of π. $\pi P = \pi$ .To analyze this problem we try to find out the impact of flood in the long run as

$$(j_1 \quad j_2 \quad j_3 \quad j_4 \quad j_5 \quad j_6) \begin{bmatrix} 0 & 0 & \frac{1}{2} & 0 & \frac{1}{4} & \frac{1}{4} \\ 0 & 0 & \frac{1}{4} & \frac{1}{4} & \frac{1}{4} & \frac{1}{4} \\ \frac{1}{4} & 0 & 0 & \frac{1}{4} & \frac{1}{4} & \frac{1}{4} \\ 0 & \frac{1}{4} & \frac{1}{4} & 0 & \frac{1}{4} & \frac{1}{4} \\ 0 & \frac{1}{4} & \frac{1}{2} & 0 & 0 & \frac{1}{4} \\ \frac{1}{2} & 0 & \frac{1}{4} & 0 & 0 & \frac{1}{4} \end{bmatrix} = (j_1 \quad j_2 \quad j_3 \quad j_4 \quad j_5 \quad j_6)$$

The above matrix can be written as

$$j_3 + 2j_6 = 4j_1 \quad ------(1)$$
$$j_4 + j_5 = 4j_2 \quad -------(2)$$
$$2j_1 + j_2 + j_4 + 2j_5 + j_6 = 4j_3 \quad ---(3)$$
$$j_2 + j_3 = 4j_4 \quad --------(4)$$
$$j_1 + j_2 + j_3 + j_4 = 4j_5 \quad ---(5)$$
$$j_1 + j_2 + j_3 + j_4 + j_5 + j_6 = 4j_6 \quad ---(6)$$
$$j_1 + j_2 + j_3 + j_4 + j_5 + j_6 = 1$$

Solving the simultaneous equations, we get the values as

$$j_1 = \frac{117}{220} \quad j_2 = \frac{9}{220} \quad j_3 = \frac{3}{220} \quad j_4 = \frac{3}{220} \quad j_5 = \frac{33}{220} \quad j_6 = \frac{55}{220}$$

$$j_1 = 53\% \quad j_2 = 4\% \quad j_3 = 1.5\% \quad j_4 = 1.5\% \quad j_5 = 15\% \quad j_6 = 25\%$$

V. CONCLUSIONS

The output from the application of Markovian process on some of these factors of impact of floods has yield the following result 53% of Environmental is affected, 25% of Agriculture and animal farming is affected, 15% of Human and animal health is affected, 4% of Chemical hazards during the flood events and 1.5% Surface and ground water pollution and Nuclear/thermal Power Plants is affected.

VI. RECOMMENDATIONS

There is a need for establishing a precious environmental impact assessment methodology for any flood events. Investigating past flood environmental assessment should be regulated by national environmental policies. For Chennai, need proper drainage system and clear all the unnecessary occupied places and properly maintain the entire Rivers in Tamil Nadu.

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