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A Study on the Influences of Rainfall on Agriculture Using the IDF Curve

Ajay Kumar[1], Shikha Bora[2], Netrapal Sharma[3] and Satpal Singh Bisht[4]
[1]Department of Zoology, Kumaun University, Nainital-263002, Uttarakhand, INDIA.
[2]Department of Zoology, Kumaun University, Nainital-263002, Uttarakhand, INDIA.
[3]Department of Zoology, Kumaun University, Nainital-263002, Uttarakhand, INDIA.
[4]Department of Zoology, Kumaun University, Nainital-263002, Uttarakhand, INDIA.

[1]Corresponding Author: ajaykumaar.ls@gmail.com

ABSTRACT

India's Earth Sciences Ministry oversees IMD Predicting quakes. Antarctica, India. Chennai, Mumbai, Kolkata, Nagpur. Persian Gulf, Bengal Bay 1875: India Meteorological Department founded. IDF curves show minute-to-minute precipitation (mm/h) (years). Conventional IDF covers 5-to-24-hour rainfall with 2-to-100-year return durations. Stream flow, runoff channeling, and floods use high-rainfall infrastructure. Storm water engineering uses IDF curves Meteorology.

Keywords- Meteorology, IDF, Rainfall, Climate.

I. INTRODUCTION

The IDF curves illustrate the severe rainfall intensity in millimetres per hour over a range of minutes to days (years). The standard IDF curve covers rainfall lasting from 5 to 24 hours and has return durations ranging from 2 to 100 years.[1] The majority of applications for managing streamflow, runoff routing, and floods make use of them to build high-rainfall infrastructure. IDF curves are used extensively in stormwater management and engineering nowadays. [2,3]

Both urban and rural hydrology may make use of IDF curves. The results are better in larger ponds that have longer concentration times. [4-5] In mountainous or cold regions, snowmelt and rain falling on snow can produce planned floods, which requires hydrological modelling and predictions regarding the frequency of floods. The most important method for flood design, known as IDF curves, is discussed in this article.[6,7,8,9]

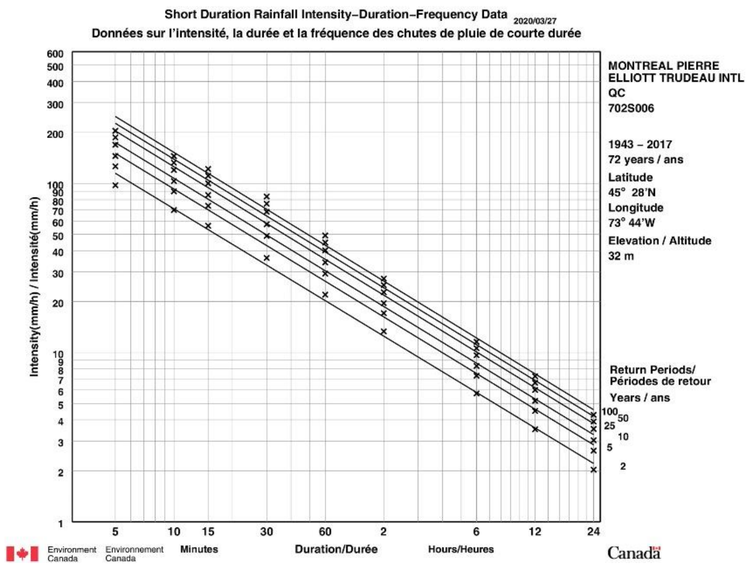

Fig. 1: Montreal's Pierre-Elliott Trudeau Airport's IDF curves from ECCC. Both the lengths of the rain showers and their intensities were log-transformed. Xs exhibit a log-transformed linear best fit according to the 2- to 100-year Gumbel quantiles[10]

These curves are generated by applying a fitting algorithm to historical maximum rainfall data, and then applying that algorithm to a local extreme value distribution. The majority of the government's IDF curves were created using NOAA Atlas [14]. ECCC IDF shown in figure 1.

Rainfall is both temporal and geographical, and the low-frequency internal climatic variability influences

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both temperature and rainfall.[15] The IDF curves presume that the weather will remain steady. The heavy rain is caused by GHGs.[16,17] The amount of rain that falls everyday has been increasing, and climate projections indicate that this trend will continue to worsen in the future. The possibility of flooding is elevated when precipitation occurs on a daily basis.[19,20] Increased precipitation intensity has a negative impact on water security because it reduces the amount of water that reaches reservoirs, which in turn stresses plants and makes farming more difficult.[21,22,23]

Existing IDF curves do not account for high rainfall nonstationarity, despite the fact that significant daily and subdaily rainfall intensification is both observable and expected for future climatic situations.[24,25] By the year 2100, the majority of engineering will be put to use. The assumption of a fixed climate might result in an underestimation of heavy rainfall of up to 60 percent, which would increase the danger of flooding and damage to infrastructure. The majority of stormwater infrastructure will require some form of adaptation. Changes to the environment and the infrastructure necessitate an update to the IDF curves. [27-30]

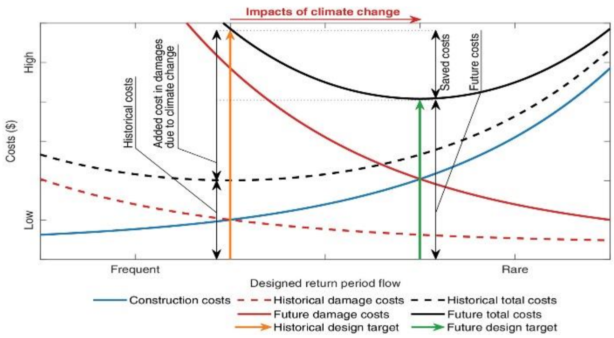
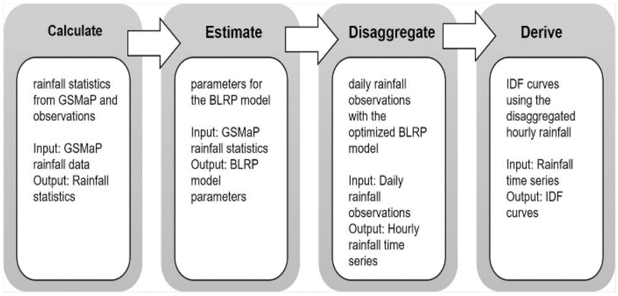


Fig. 2 Climate change effects on urban infrastructure design compromise

The investment-risk trade-off shown in Fig. 2 helps to minimise the expenses associated with stormwater drainage.[31-33] The planning of infrastructure strikes a compromise between constructing costs (the solid blue curve) and overflow damages (dashed red curve). The current flow over the return period is optimal in terms of overall cost (dashed black curve).[35,36] The possibility of exceeding the return period design flow may grow as a result of forecasted increases in intense rainfall, which will also boost the potential for property damage. [37] Figure 2 illustrates how the damage curve has an impact on the overall cost (green arrow). The height difference between the orange and green arrows is indicative of underdesigned infrastructure costs. Infrastructure that is more resistant to the effects of climate change might potentially lower long-term costs (black curve) (blue curve). It is difficult to accurately estimate the impact that variations in climate have had on red or IDF curve shifts. The cost-benefit analysis of climate change may be shown by enlarging a culvert in order to provide a passage. The initial cost is increased by oversizing (blue curve), but the cost of restoring a section of road that was washed away is higher.

II. IDF CURVES



Calculation:

The NCSC tracks the precipitation on a monthly basis. Due to the fact that yearly precipitation fluctuates, a monthly average requires ten years' worth of data. Rainfall on a monthly basis. Precipitation in the United States is measured in inches.

Calculate the annualised monthly average precipitation. 10-year rainfall: 3.08 inches each month adds up to 30.8 inches over the course of a decade.

Bartlett- Lewis Rectangular Pulse:

$$E\left[Y_i^{\Delta t}\right] = \frac{\lambda \Delta t \upsilon \mu_x \mu_c}{\alpha - 1} \quad (1)$$

$$\mathrm{var}\left[Y_i^{\Delta t}\right] = 2A_1\left\{(\alpha-3)\Delta t \upsilon^{2-\alpha} - \upsilon^{3-\alpha} + (\upsilon+\Delta t)^{3-\alpha}\right\} - \quad (2)$$

$$2A_2\left\{\phi(\alpha-3)\Delta t \upsilon^{2-\alpha} - \upsilon^{3-\alpha} + (\upsilon+\phi\Delta t)^{3-\alpha}\right\}$$

Rain was created by the usage of BLRP. This model was selected due to its flexibility to many climates, as well as its capacity to simulate rainfall on an hourly, daily, and even above scale. Cell arrivals come to a halt after a period of time that is exponentially distributed with the parameter, and each cell possesses a uniform intensity Xij with a specific distribution x. The storm and cell origins both follow a Poisson process rate.

III. DRIVE IDF CURVES

IDF curves are generated with the use of annual maxima, abbreviated as AMAX, of disaggregated hourly rainfall. The GEV distribution is utilised in the investigation. The IDF curves are used to characterise the intensity, duration, and return period of rainfall (or its inverse, probability of exceedance). The fields of hydrology, hydraulics, and water resources all make use of IDF curves.

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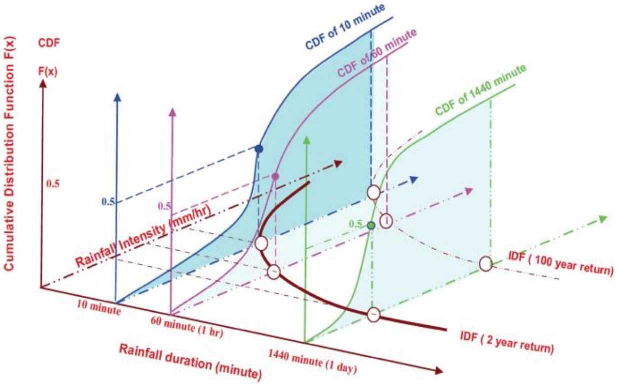

Fig: 3 Systematic Diagram of IDF

Soil Conservation Service – Curve Number (SCS-CN) Method

The field of applied hydrology calculates the runoff from basins. Runoff is estimated using flood design models and water balance models. The SCS-CN method is straightforward and comes with extensive documentation. This method of analysing direct runoff in small agricultural watersheds was developed by the Soil Conservation Service, which is now known as the NRCS. Version from 2004 of the 1950s [1]. The tactic, which was straightforward and easily supported by evidence, was widely adopted. Its ease of use, the fact that its environmental inputs are extensively documented, and the fact that it incorporates a variety of runoff-forming elements into a single parameter known as the curve number (CN) [2]. SCS-CN has been implemented in a variety of environments, land uses, and climates, such as the calculation of runoff from river basins and daily hydrological models. Six decades' worth of analysis, alterations, and advancements. Innovative approach. Hydrological research with a narrow focus reveals obstacles, restrictions, and opportunities for improvement [3]. The most recent advancements in the SCS-CN methodology are presented in this issue. These advancements include novel applications, theoretical and conceptual research, and studies that expand the applicability of the method to a wider variety of geographical regions or scientific subjects. [3]

According to studies, the frequency of extreme rainfall events has increased over most of Asia, despite the fact that the number of rainy days and yearly precipitation have both declined. Flooding and landslides are both caused by rainfall. The yearly extreme rainfall that occurs in Kerala is decreasing overall, particularly in hilly areas. Rakhecha and Soman55 looked studied data from 316 Indian stations from 1901 to 1980 and found no statistically significant changes in the number of severe incidents lasting between one and three days. A 95 percent upward trend was seen in extreme rainfall series along the west coast of the peninsula, north of 12 degrees North, and at numerous stations east of the Western Ghats on the peninsula. Stations on the southern peninsula and the Ganga valley are seeing a decline.

IV. EXTREME VALUE THEORY

The pattern of severe rainfall has evolved as a result of climate change. In Kenya, heavy rains and flash floods have been responsible for the deaths of hundreds of people. For a resilient society and for the development of sustainable practises, accurate inference about periods of excessive rainfall is essential. This study predicted and anticipated the occurrence of extremely heavy rains. Estimating model parameters, fitting block maxima to the GEVD, and fitting Peak Over Threshold to the GPD were all done with the help of MLE (GPD). The Gumbel model performed the best in terms of GEVD, whereas the Exponential model performed the best beyond the threshold. It was determined that 10-, 20-, 50-, and 100-year return projections could be generated by using return level estimations and confidence level calculations. Returns rose in proportion to the period of the investment. Returns on 10- and 20-year GPD were greater than returns on GEVD. GEVD outperformed GPD during the course of 50 and 100 years. The probability, density, quantile, and return graphs all showed that the model fits the data quite well.

V. INDIAN METEOROLOGICAL DEPARTMENT

IMD falls under the purview of India's Earth Sciences Ministry. Forecasting earthquakes. India as well as the Antarctica. Chennai, Mumbai, Kolkata, Nagpur, and Guwahati. Bengal Bay, Arabian Sea, Persian Gulf. The India Meteorological Department was established in the year 1875. Forecasts of the weather The Ministry is in charge of the division. India as well as the Antarctica. Chennai, Mumbai, Kolkata, Nagpur, and Guwahati. Bengal Bay, Arabian Sea, Persian Gulf. Meteorological data are necessary for many industries, including agriculture, shipping, aviation, and drilling for oil offshore. Storms, dust, etc. Oil, water, commerce, and the establishment of new nations are all on the agenda.[40] Meteorology Agri-IMD. The weather has an effect on agricultural practises. Perishables. The weather is chaotic. Storms. The weather plays a significant role in agriculture. The planting, irrigating, fertilising, and harvesting processes are all easier for farmers when they have access to forecasts. The effects of climate change are felt by farmers. Unfortunate optimists, dryness has an impact on irrigation. The amount of water needed to cultivate crops is influenced by climate. Regular use of irrigation improves agricultural production.[41,42]

VI. CONCLUSION

This article presents a fresh method for deriving the rainfall IDF curve that makes use of stochastic downscaling and blends in-situ observations with data obtained from remote sensing (GSMaP). When

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calculating the IDF curves for Singapore, a downscaled or disaggregated version of the sub-daily rainfall is employed. The parameters of the BLRP model are optimised with the help of the statistics from the GSMaP. In order to generate hourly rainfall time series, the BLRP model that has been tuned is employed. In order to construct the IDF curves, the disaggregated hourly rainfall that takes into account both the hourly and daily statistics is used. The BLRP model makes use of proportional adjustment to keep track of hourly rainfall in order to maintain daily statistics in the same format as daily data. The disaggregated daily and coarser-scale (such as bi-daily) extremes of rainfall are comparable to the observed extremes of rainfall. This rescaling in BLRP fixes the problem that GSMaP has with incorrectly calculating rainfall. When sub-daily rainfall extremes are combined with daily and coarser-scale (such as bi-daily) rainfall extremes from observations, the resulting IDF derivation is more trustworthy, particularly for sub-daily durations.

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