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On method calculation design flood elevation of esturial city

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Recently due to repeatedly occurrence of flood, a lot of Chinese cities accept new design criteria for their protective project. Most of them calculated by a certain type of probability distribution. In order to meet the demand of development economy the return period of design criteria is changed more longer and longer even 1000years, but the data which the calculation dependent on is only about 30~40 years. So the stability and reliability of calculated results become a noanswered problem. Some design criteria is rather conservation, because it is obtained as superposition of extreme value astronomical tide and storm surge.

In this paper the design flood elevation is estimated by a multi-dimensional joint probabilistic distribution with non-Gaussian and non-independent courses for the bigest industrial and economical city of China-Shanghai.

1. Factors Influential on Flood.

1.1 Astronomical tide

Shanghai is located in fluvio-maritime section of downstream Yangtze River. By records of gaging station Wong Pu Gong Yun from 1913 to 1981 the historical highest tide and lowest tide is 5.22m and 0.24, Mean high tide and mean low tide is 3.12m and 1.29m, Mean amplitude of tide is 1.93, Maximum amplitude of tide is 3.55m. So it is obviously astronomical elevation (about 2.0-3.5m) has the most important effect on water level.

1.2 Storm surge

By records from 1884 to 1981 there were 188 typhoons hited Shanghai. In overage it was 2 times npo year. The most serious situation was 5-7times npo year. The storm surge is almost over than 1m. For example 1.42m on Aug. the 25th 1936, 1.07m on jul. the 25th 1949, 1.20m on Seb. the 4th 1981··· ect.

1.3 Elevated water level ny flood peak run-off

Every Summer when flood peak flow down from upstream Yangtze River, Wong pu river get into flood period and Shanghai was threated by sharply rised water elevation. For example the elevation purely called by flood flow at station Wu Soon on July 1954 was 22-27cm. Because of correlation coefficient of water level in flood period for station Wong Pu Gong Yun and Wu Soon is 0.9983, so the conclution is that at station Wong Pu Gong Yun the flood peak flow affect water level in a comparative smaller range.

1.4 Precipitation

By analysis 55 heaviest rainy procedures chosen from 1965-1988 correlation coefficient of water level between stations Wong Pu Gong Yun and Gao Qiao is 0.9987. But gao is on the Picific coast and located far from estuary, it is difficult to image that precipitation has

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influence on it's water level. So precipitation also has no influence on water level of Wong Pu Gong Yun because of it's correlation coefficient with Gao Qiao.

1.5 **Land sink**

The land sink of Shanghai have been stoped after some control works accepted since 1966. So in this paper only several date of water level has made correction.

As a result of above analysis the astronomical tide, storm surge and flood peak run-off as most important factors are considerable for joint probabilistic distribution.

2. Multi-Dimensional Probabilistic Distribution with Non-Gaussian and Non-Independent Courses.

The joint probability of getting together actions of astronomical tide, storm surge and flood peak run-off in all is to solve the following formula

$$P=\int\int\int f(X_1,X_2,X_3)dX_1dX_2dX_3 \tag{1}$$

where X_1 is yearly maximum of astronomical tide of Wong Pu Gong Yun by prediction, X_2 is yearly maximum value of simultaneous difference between predicted astronomical tide and measured water level in period typhoon at station Wong Pu Gong Yun, X_3 is yearly maximum elevated water level by flood peak flow at station Wong Pu Gong Yun. For series as X_1, X_2, X_3 mean value, variance, and matrix of coefficients correlation obtained as follows:

$$E(X_1)=424.67cm \qquad \sigma(X_1)=5.45cm$$

$$E(X_2)=30.57cm \qquad \sigma(X_2)=16.11cm$$

$$E(X_3)=19.62cm \qquad \sigma(X_3)=10.10cm$$

$$r_{X_1,X_2}=0.26 \qquad r_{X_1,X_3}=0.17 \qquad r_{X_2,X_3}=0.31$$

$$\varphi_{Af}=\begin{vmatrix} 1.0 & & \\ 0.17 & 1.0 & \\ 0.26 & 0.31 & 1.0 \end{vmatrix}$$

As mentioned above most in hydrologic phonomenona are accorded with non-Guassian and non-independent courses, so formula (1) can not be solved due to its abosolutely complexity. But simulation technique is efficient in this case. Simulation method is the method of representing certain procedure by computer with some characteristic parameter of it, such as mean value, variance, matrix of coefficients correlation and type probability analysis for failure probability.

In presented paper the method ISP(Importance Sampling Procedure) of simulation technique worked by liu. P. et al. , 1986 and schueller, G. I, et al. , 1986 is applyed.

3. Calculation and Result

After statistic check the series X_1, X_2 and X_3 are proved to obey distributions Gumbel, Weibull and Gumbel separately.

Taking mean value, variance, matrix of coefficient correlation and type distribution of

serieses X_1, X_2, X_3 as input data, using ISP method by equation

$$G = Max\ (G_1, G_2, G_3)$$
$$\begin{aligned} G_1 &= X(1) - X_3 \\ G_2 &= X(2) - X_3 \\ G_3 &= X(3) - X_3 \end{aligned} \qquad (2)$$

the design criteria of flood elevation for Shanghai is Obtained.

In order to compare calculated result with traditional method the following table is shown for example.

Design Criteria Flood Elevation of Shanghai

Return Period	1000y	500y	200y	100y	50y
Method ISP	6.11m	5.88m	5.81m	5.76m	5.66m
Gumbel distribution	5.93m	5.78m	5.58m	5.48m	5.28m

4. Conclusions

4.1 The method presented in this paper is a more objective and more comprehensive method that gives over all consideration t factors influential on water level.

4.2 Calculated design criteria by this method obiously improved on traditional method of combination most serious situations of factors.

4.3 Although the nowaday accepted design flood level for Shanghai 5.86m is calculated by Gumbel distribution with one thousand years return period, but by method ISP the same value only have four hundreds years return period. This situation will bring us a posibility to reduce instability and error which formed in calculation especially for long return period criteria.

4.4 Finally the advantage efficient and hight convergent method used in this paper could be widely applyed for estinate multi-dimensional joint probability.

Key Words : Design Criteria Flood Elevation Joint Probability Distribution