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AUTOMATIC FREQUENCY-BASED FLOOD FORECAST FROM NUMERICAL WEATHER PREDICTION USING A SERVICE- ORIENTED ARCHITECTURE

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Destructive flash floods occurred more frequently in mountainous regions in China in recent years, causing enormous losses of lives and property. The existing flood forecast methods are generally based on the simulations of flood discharge, which are not applicable for regions with no observations; also, these methods are usually low-efficiency. And therefore, it is necessary to develop a high-efficiency, frequency-based flood forecast method to prevent people from suffering such flash floods.

The satellite-derived rainfall datasets (e.g., the CMORPH and the TRMM) and numerical weather prediction (noted as NWP hereafter) at global scale have been available. Moreover, service-oriented architecture (noted as SOA hereafter) has been applied in a wide variety of fields; however, the application of the SOA for flood forecast from the NWP cannot be found in literature yet. As a result, the method proposed in this paper, which takes advantages of state-of-the-art technologies, e.g., the high-accuracy NWP, the high-capacity cloud computing, and the interactive Web Service, has three main steps (Fig. 1):

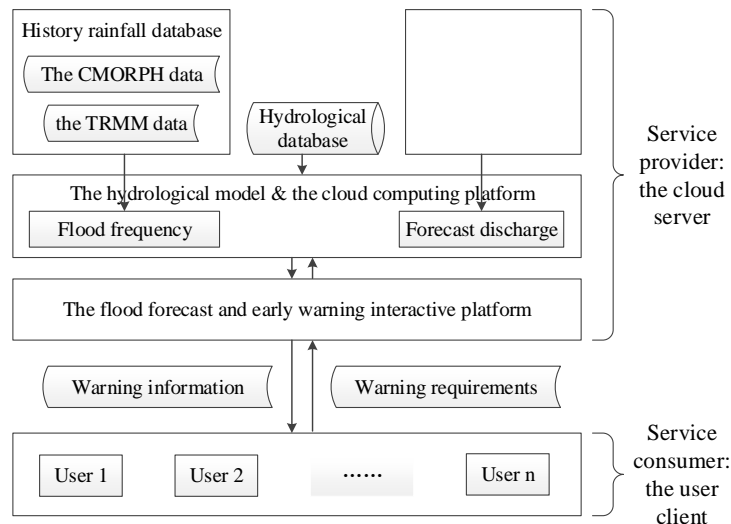


Figure 1. Framework of the frequency-based flood forecast from the NWP using the SOA

First, historical flood discharge is simulated with the satellite-derived rainfall data (e.g., the CMORPH and the TRMM) or the observed data recorded at rainfall stations by using a distributed hydrological model, and the relationship between flood frequency and simulated flood discharge (i.e., the frequency curve) is established. Figure 2 shows the frequency curve of the Linjiaping (LJP) hydrological station in the Qiushui (QS) River basin, which is located at the Loess Plateau.

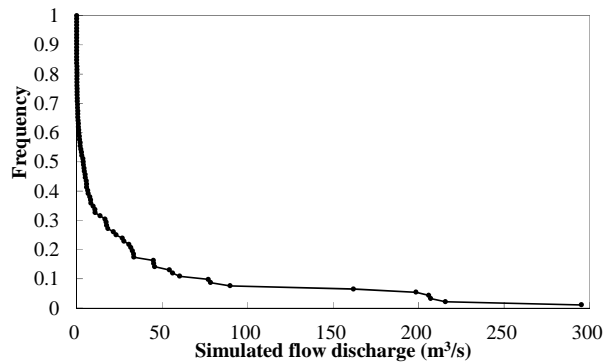
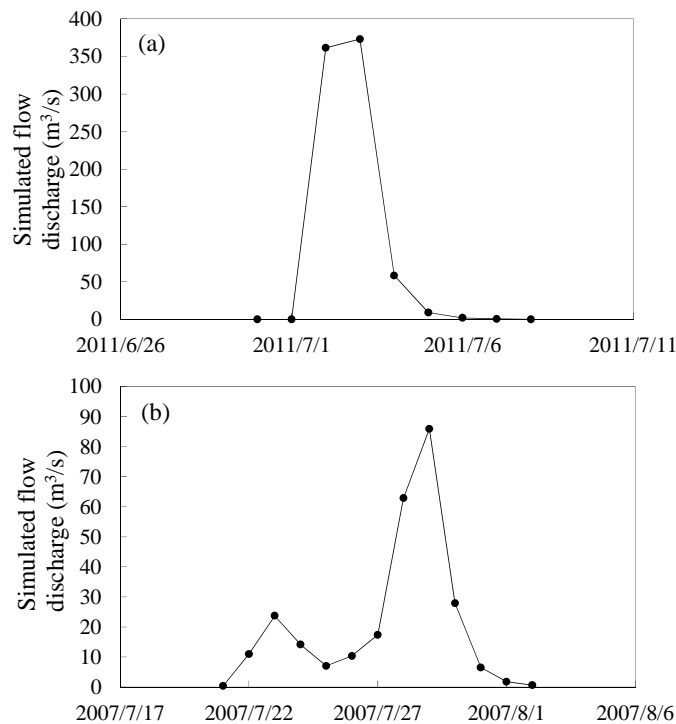


Figure 2. The frequency curve of the LJP hydrological station in the QS River basin

Second, through taking advantage of the highly automatic SOA technology, the predicted rainfall data from the NWP (e.g., the TIGGE) are downloaded and interpreted automatically in real time, which will drive the distributed hydrological model to run automatically on the cloud server to simulate and predict flow discharges. Figure 3 shows the simulated flow discharges of the LJP hydrological station in the QS River basin, and Table 1 lists several features of the simulated floods.



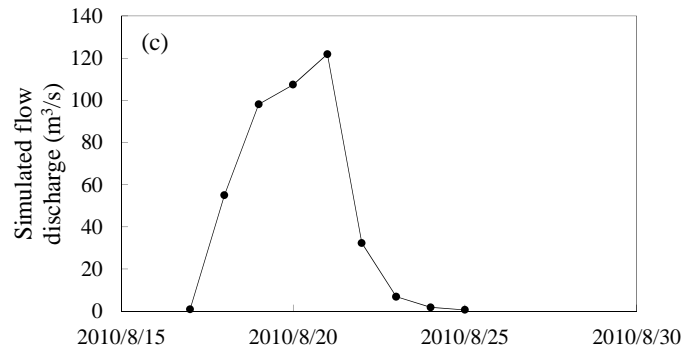


Figure 3. The simulated flow discharges of the LJP hydrological station in the QS River basin

Table 1. The features and the corresponding flood frequencies of the simulated floods

Time	Peak value (m ³ /s)	Total runoff (10 ⁶ m ³)	Frequency range
2011/7/1-2011/7/8	373.1	69.6	< 1.1%
2010/8/17-2010/8/25	121.9	36.7	(6.5%, 7.6%)
2007/7/22-2007/8/3	85.9	23.3	(7.6%, 8.7%)

Third, the corresponding flood frequency of the simulated flood can be obtained by looking up the simulated peak value in the frequency curve (Table 1). Based on the frequency range of the predicted flow, the recurrence period of this event is obtained and the risk assessment of the flood can be concluded. For example, the frequency of the first selected event is much smaller than those of the other two, but the risk of the event is higher. Based on the results and the flood control requirements offered by users, warning information of possible flash floods will be generated for potential sufferers and then sent to them as soon as possible if needed. Using Web service in a social network, users can also acquire such information on the clients by themselves at any time and make their decision whether to prepare for the possible flash floods.

Moreover, along with the updates of the satellite-derived rainfall datasets, the frequency curve will be continuously updated so that it will be more reliable. Also, along with the real-time updates of the NWP, the simulation results will be refreshed timely, and thus the latest warning information will always be available for users.

From a sample demonstration, it can be concluded that the frequency-based flood forecast from the NWP is highly useful to enhance user awareness of flood risk. The SOA and social network techniques are regarded as a feasible way for developing the automatic system.