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Application of Integrated Flood Analysis System (IFAS) for Flood Forecasting at Upstream of the Kabul River Basin

○Jamila Rajabi[1], Takahiro Sayama[2] and Kaoru Takara[2]

Introduction: Flooding events cause economical, social and environmental damages and loss of lives. They increases the negative potential of alluvial floods all over the world.

World Resource Institute (WRI) ranked 164 countries by the number of people affected by river flooding. They found that the top 15 countries account for nearly 80 percent of the total population affected every year. And over 50 % of the population exposed to river food risk worldwide lives in just 5 countries of South Asia, i.e. Afghanistan, Bangladesh, India, Myanmar and Pakistan.

Afghanistan is actually prone to flash floods because of its steep slopes in headwater zones. Flash floods occur mainly as a result of heavy rainfall combined with rapid snowmelt, mostly during the spring months; but during the summer of 2010 a rainfall of 274 mm was recorded in Peshawar (the Kabul River Basin) which was record-breaking rainfall at the location since 1961 (Pakistan Journal of Meteorology, 2014). These flash flooding killed more than 1700 people and affected 18 million people along the Indus River (United Nation, 2010). Therefore the use of hydrological models like IFAS in ungauged sites and in large geographical regions becomes important issue in hydrological study.

Objective:

1) Apply IFAS model for flood analysis in the upstream of Kabul Basin.

2) Assess the accuracy of the satellite rainfall data and accuracy of the flow simulation model.

3) Generation of the synthetic sequences of hydrological data for use in flood forecasting.

4) Forecast the peak travel time from the parameterized IFAS for the vulnerable downstream population.

Study area: The Kabul river basin has a catchment area of 92,605 km². The Kabul is a tributary river of the Indus river system (Fig.1). It drains the two countries, including Afghanistan and Pakistan and it enters Pakistan via northwestern areas flowing through the north in a southerly direction and joining the Indus River near the city of Attock and finally merges into the Arabian Sea near the port city, Karachi. The Kabul River Basin is divided in two parts upstream and downstream. The upstream has 52,000 km² area, surrounded by mountains with limited vegetation and an ungagged part.

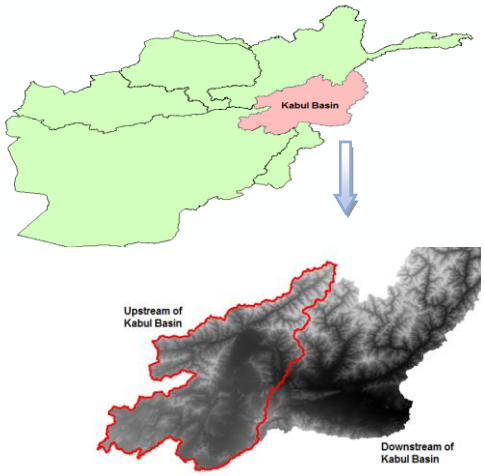

Fig. 1: The Kabul basin DEM

Method: To simulate the flood process, IFAS uses the theoretical of tank model and Manning's law, Darcy's law and kinematic wave method (Fig.2).

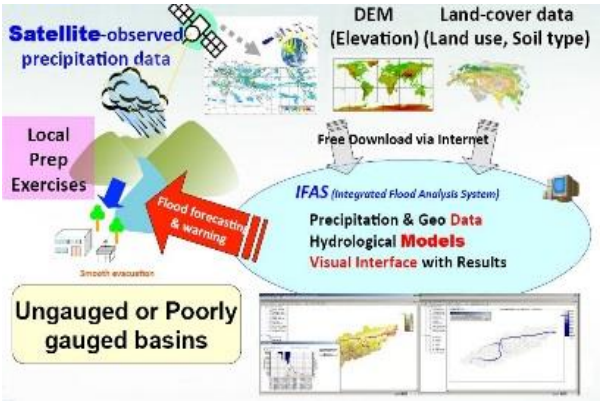

Fig.2: Integrated Flood Analysis System (IFAS)

The IFAS model could draw sub-basin, River course, Surface parameter and River course parameter by using land cover, land use and MEM data. (Fig.3).

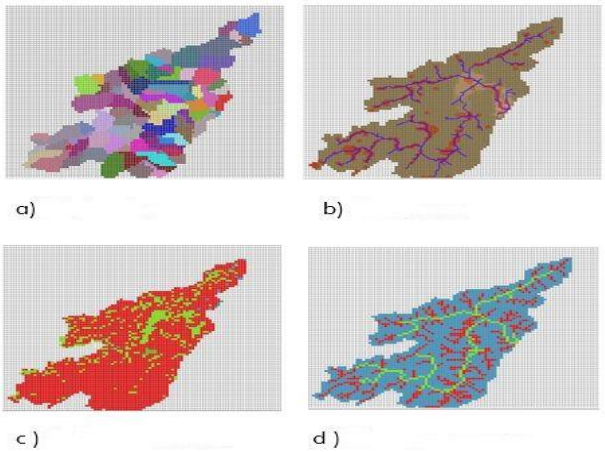

Fig. 3. a) Sub-basin, b) river Crouse, c) surface parameter, d) river course parameter of the Kabul Basin Upstream.

Result: Due to the 2010 flood, the result of calculating discharge (satellite data) for different places in the Kabul River shows well agrees with the observed one after data correction (Fig. 4(a)). The satellite data result before correction is 3 times bigger than the observed one. And satellite data could not show a good flood peak (Fig. 4(b)). The result of comparing rain gauge data and satellite data does not show much rainfall in the area except one station that show better result (Fig.5).

The model performance is strongly dependent on the availability and quality of measured discharge and rainfall data.

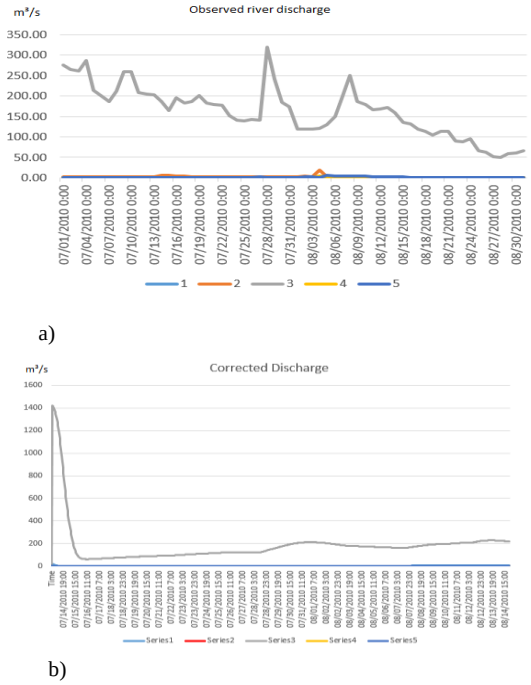

Fig.4: a) Rain gauge data, b) Satellite data after correction

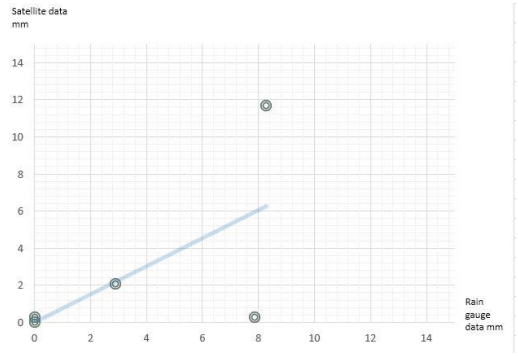

Fig. 5: Compeering satellite data and rain gauge data

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- ICIMOD, 2009: Mountain Development Resource Book for Afghanistan, International Centre for Integrated Mountain Development (ICIMOD), Nepal.
- United Nations, cited 2010: Pakistan Flood Emergency Response Plan. (Available online at http://ochaonline.un.org/humanitarianappeal/.)
- Aziz, A. 2014: Rainfall-Runoff Modeling of the Trans-Boundary Kabul River Basin Using Integrated Flood Analysis System (IFAS), Pakistan Journal of Meteorology, Vol. 10, Issue 20: Jan, 2014.