Linking flood peak, flood volume and inundation extent : a DEM-based approach

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1. Context

- 17 million people concerned by flood risk in France
- A cost of about 1.3 billion euros of damages for the last event of June 2016
- Growing interest in the field of rapid inundation modelling for public institutions and insurances
- Need for a simple method, working for any river with a minimum amount of data, and above all, easily available data

Photo : Le Monde (François Mori)

2. VIPER method

- Creation of a simple and fast inundation model inspired by recent ones such as HAND (Nobre *et al.*,2016) or EXZECO (Pons *et al.* 2010)
- Development of the VIPER method (*Volume d'Inondation Potentiel à l'Échelle Régionale,* i.e. Potential inundation volume at regional scale):

i. Semi-distributed daily hydrological simulation of an event with GR-SD (semi-distributed rainfall-runoff model; de Lavenne *et al.,* 2016)

ii. Spatial distribution of discharges following the drainage map: creation of one distributed map per day

iii. Determination of the overflowing volume $(Q - Q_b)\Delta t$ (approximation of bank-full flow Q_b as Q_2, 2-year return period discharge) for each river pixel

iv. Spreading of the volume from downstream to upstream, one river pixel and one day at a time

v. Creation of a set of inundation maps corresponding to each day of the flood event

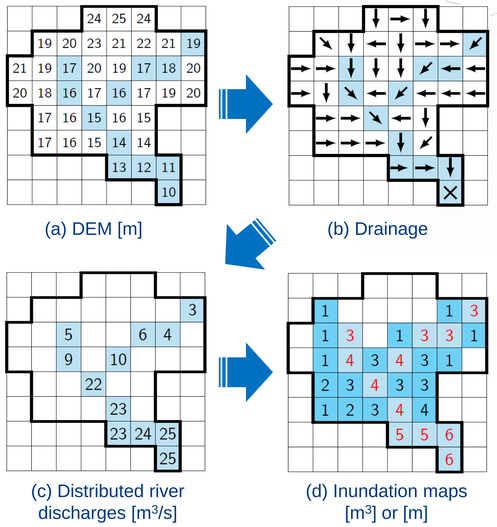
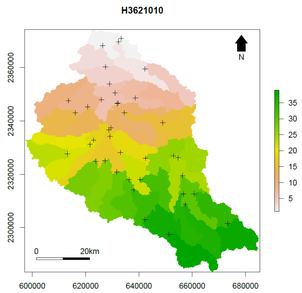


Fig.1: Summary of the VIPER method for determining inundation maps.

3. Results : example of the Loing River

- North central France faced a severe flooding event between 30th of May and 6th of June 2016
- Over 1300 municipalities affected by the flood
- On the Loing catchment :
- 130 mm of precipitation recorded
- The 2016 flood event ranked first over the period of record.
- Return period estimated to be over 1000 years

- Use of the VIPER method to replay the event :



Streamflow interpolation

$q = f(A)$

Fig.2: Sub-catchments derived from the GR-SD hydrological model for the watershed of the Loing River (France).

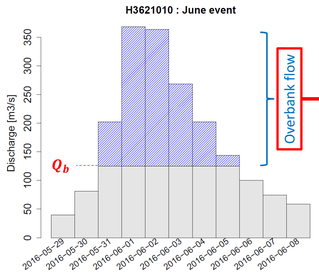


Fig.3: Hydrograph of the June flood event at the outlet of the Loing River (France).

VIPER

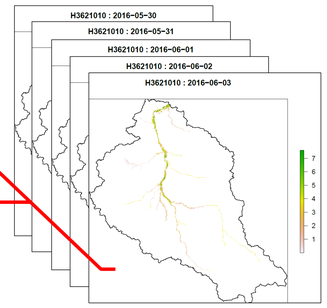


Fig.4: Set of maps produced by the VIPER method for the flood event of June 2016 on the Loing River (France).

- Meshing of the Loing basin into 39 sub-catchments, simulation of the event with GR-SD
- Calculation of an hydrograph for each and every pixel of the river system
- Generation of inundation and height maps for each day of the event.

4. Conclusions and outlooks

- The VIPER method allows to recreate rapidly flood inundation maps with few data.
- A better estimation of bank-full flow is still under ongoing research, notably in the field of hydraulic geometry.
- Our results will be validated against insurance damages and/or, when available, observed flood areas.
- Hydraulic models will be used to compare heights, inundation areas and computation time with our results.
- Depending on the results, the model might be adapted to an hourly time-step, and to take into account flood forecasts.
- The implication of the overflowing volume on the assessment of peak discharge is going to be investigated in further studies.

References

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