Team 1 - HydroEurope

Uncertainties for runoff & discharge assessment on the Vésubie Catchment

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Overview

- Defining Uncertainty
- Introduction
  - Vésubie Catchment
  - Storm Alex
- Methodology
- Presentation of Results
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- Summary & Conclusions

Defining Uncertainty

"Uncertainty is a measure of the degree of confidence in the predictions of a hydrological model, and is a reflection of the incomplete knowledge of the real world system, and the inevitable errors in the input data, model structure and parameters." (Gupta et al., 2008)

- Data Uncertainty
  - Lack of Data - Difficulties in finding certain data e.g. observed flow Hydrograph
  - Data measurement errors from gauge undercatch and soil moisture recordings

- Structure of the Models used
  - HEC-HMS is a semi-distributed model and thus has limitations
  - Ability to model complexity of catchment versus computational demand

- Parameterization of the Models
  - Empirical hydrological parameters of the basin
  - Thiessen Polygon Method was used on the rainfall data to adopt a characteristic rainfall

Introduction - Vésubie Catchment

- Sub-catchment in the Eastern Region of the Var
- 390 km^2 in area
- Located 40 km north of Nice
- Soil composition mostly gypsum and granules
- Land use percentages of:
  - 96.0% Forest & Natural Environment
  - 2.5% Urban/Artificial areas
  - 0.8% Farmland
  - 0.7% Wetland

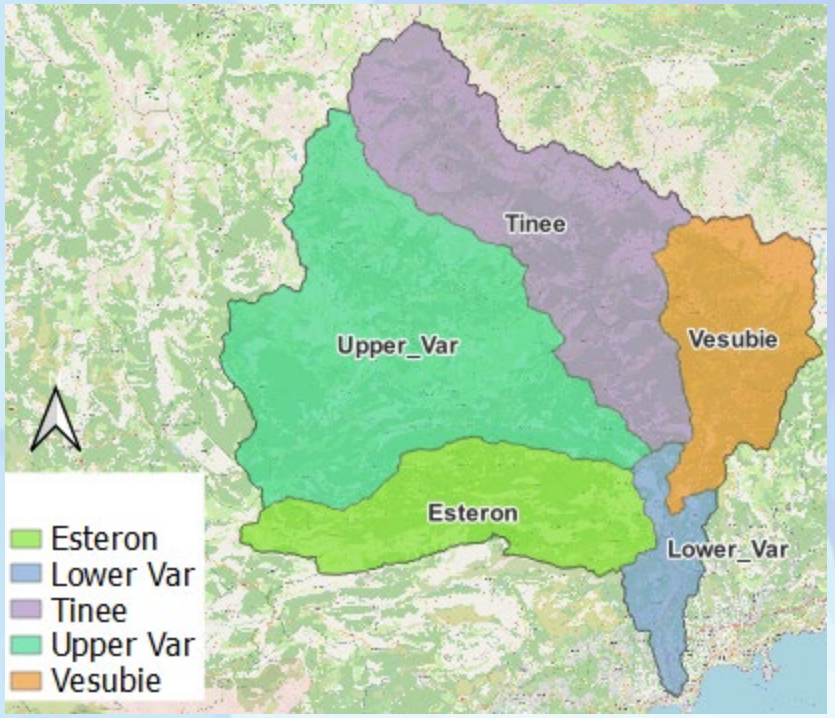


Figure 1: Vésubie Sub-catchment location in relation to the wider Var catchment

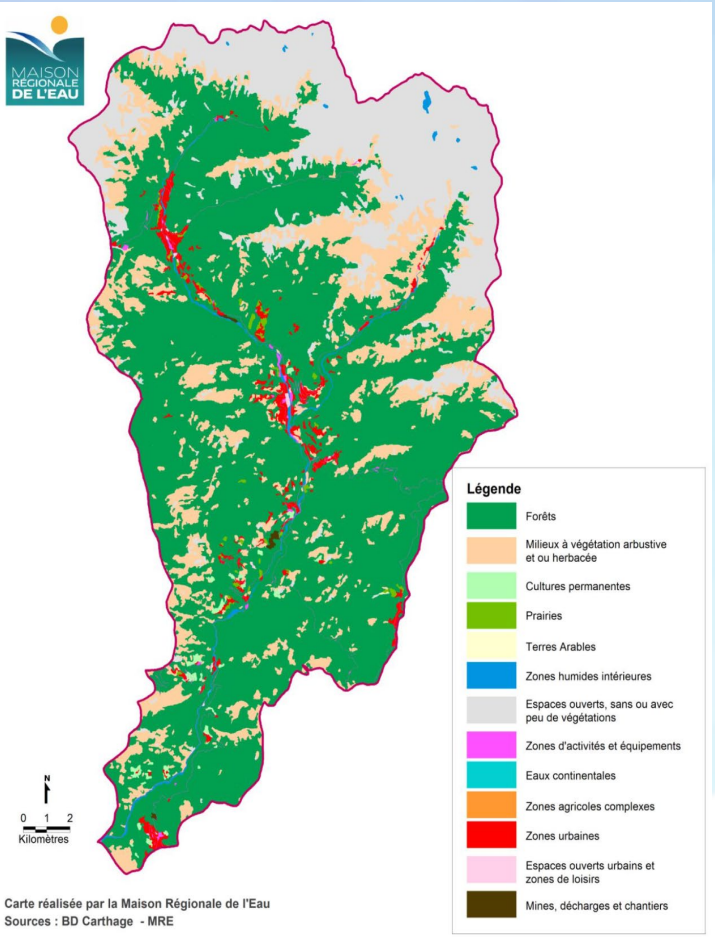
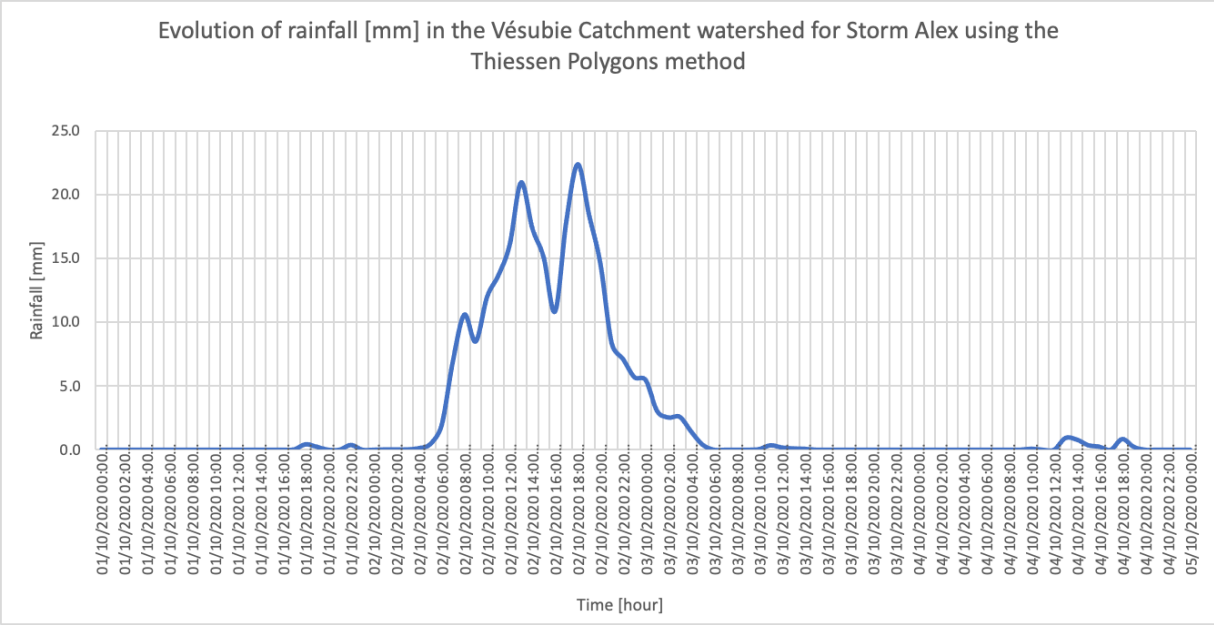


Figure 2: Vésubie Sub-catchment land use types (Maison Régionale de l'Eau)

Introduction - Storm Alex

- Formed over the North Atlantic Ocean from 30 September to 2 October 2020
- Caused a strong Mediterranean episode
- Destroyed Meteo-France Station at Saint-Martin-Vésubie



Graph 1: Vésubie Sub-catchment rainfall calculation for Storm Alex event using Thiessen Polygons method

Figure 3a (left): Aerial view of the Vesubie prior to Storm Alex in 2020 & Figure 4b (right): Aerial view shortly after the event - both figures show the recording station at point X

Methodology

- Identification of modelling uncertainties
- Discretization of HEC-HMS models
  - Lumped - 1 subcatchment
  - Semi-distributed - 3 subcatchments
- Digital Elevation Model resolution
  - 50 m, 75 m, 150 m
- Land use and soil conditions
  - Curve Number from 46 - 92
- Production of hydrographs
  - Comparison of peak discharge
  - Comparison of total mass balance
- Evaluation of models performance

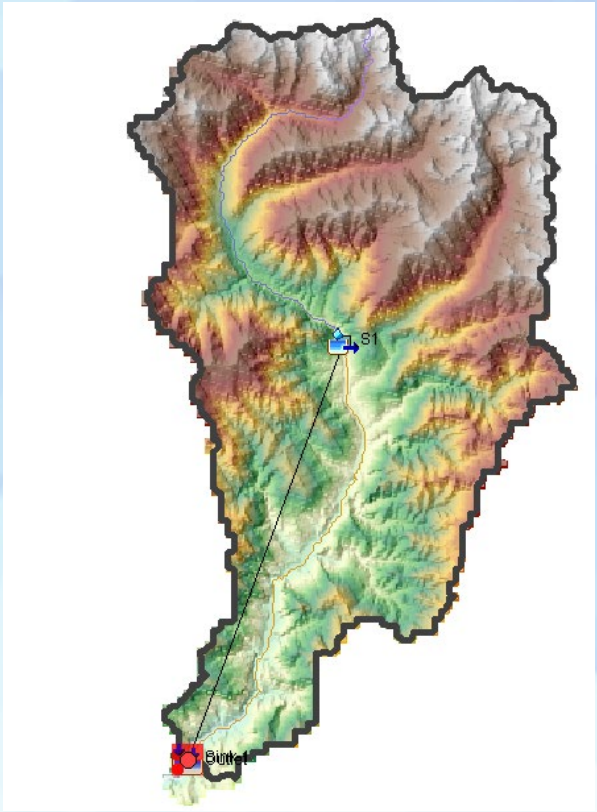


Figure 4: Lumped model - 1 Subbasin

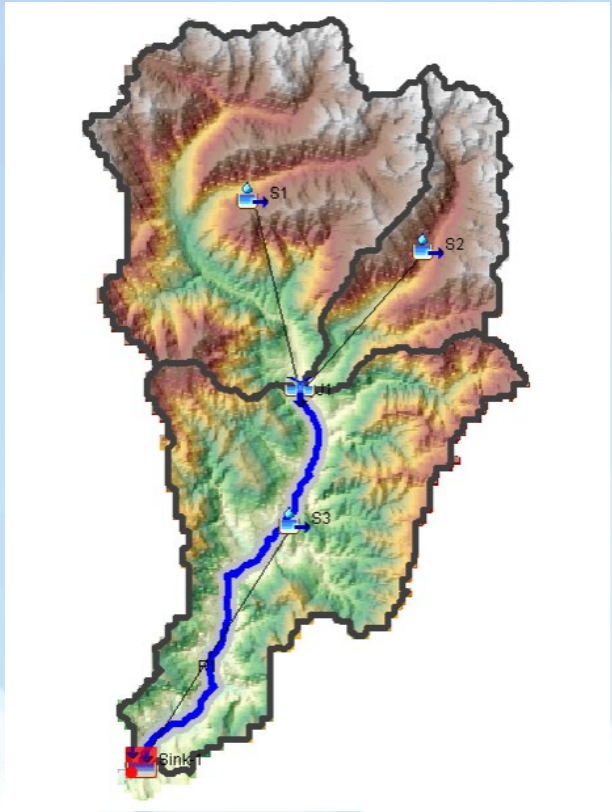
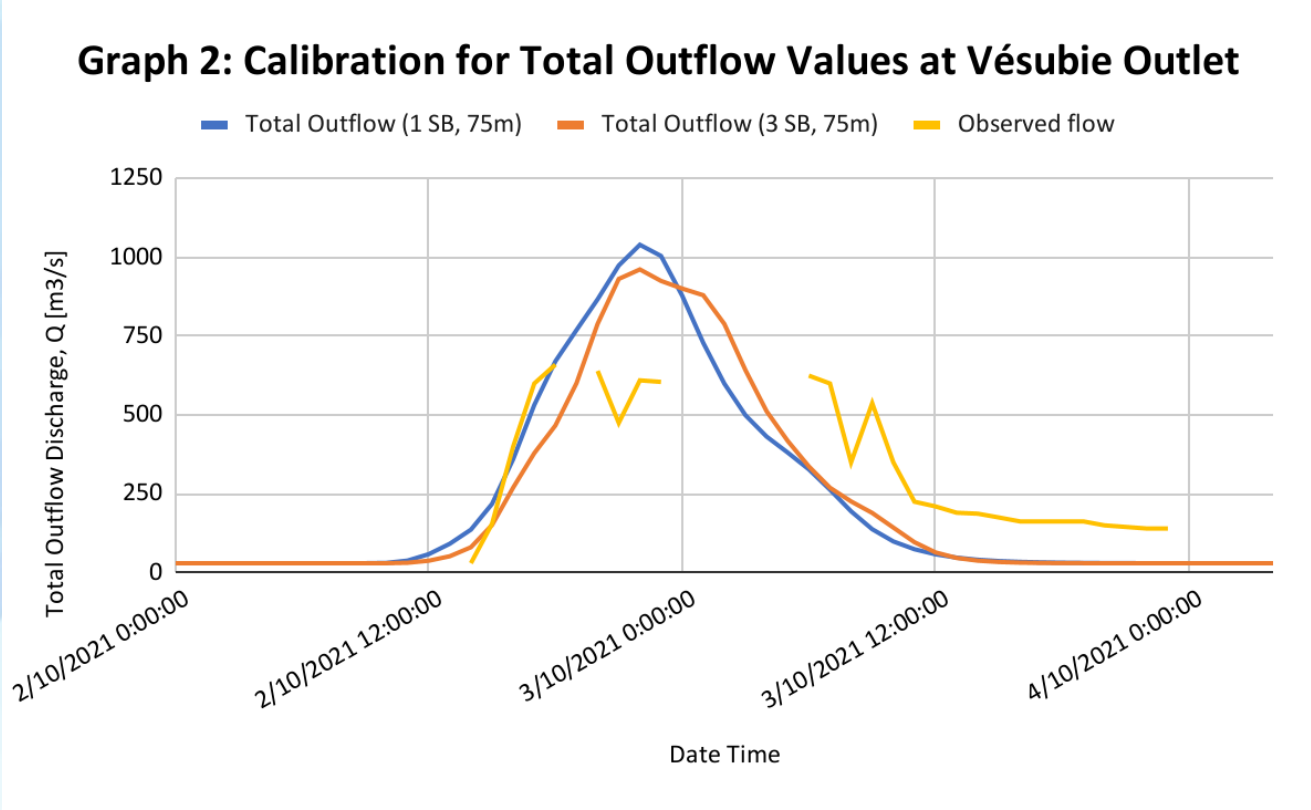


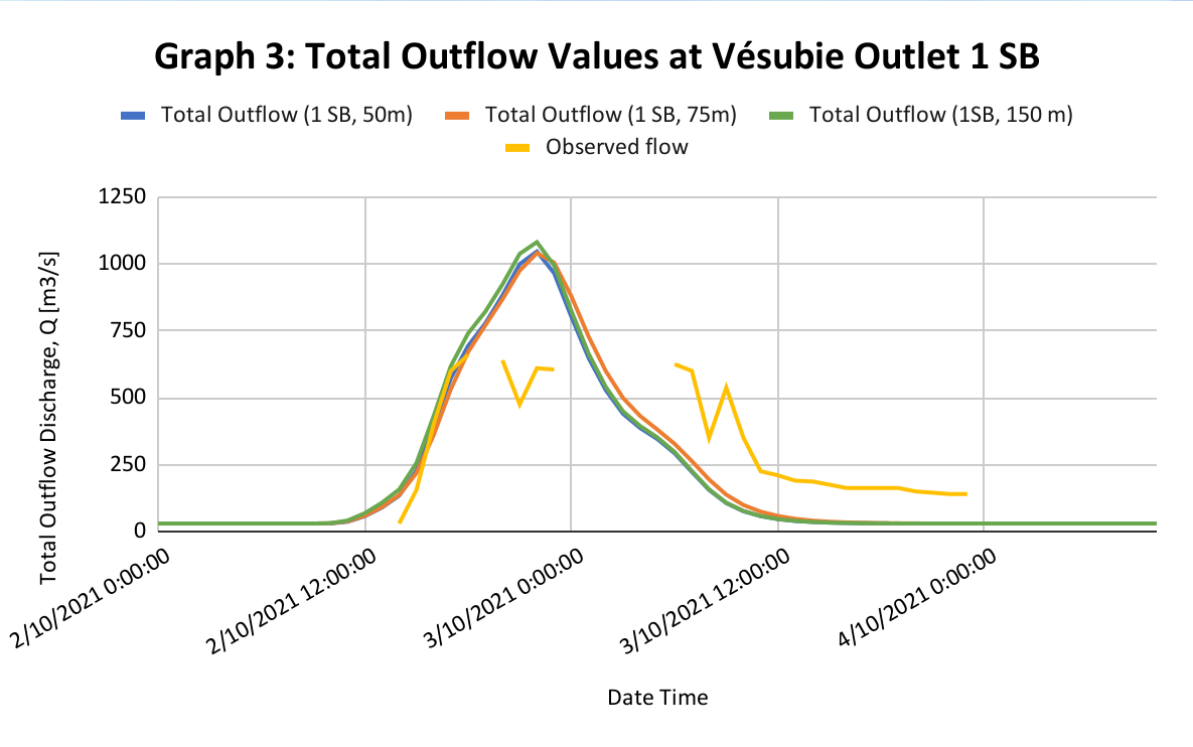
Figure 5: Semi-distributed model - 3 Subbasins

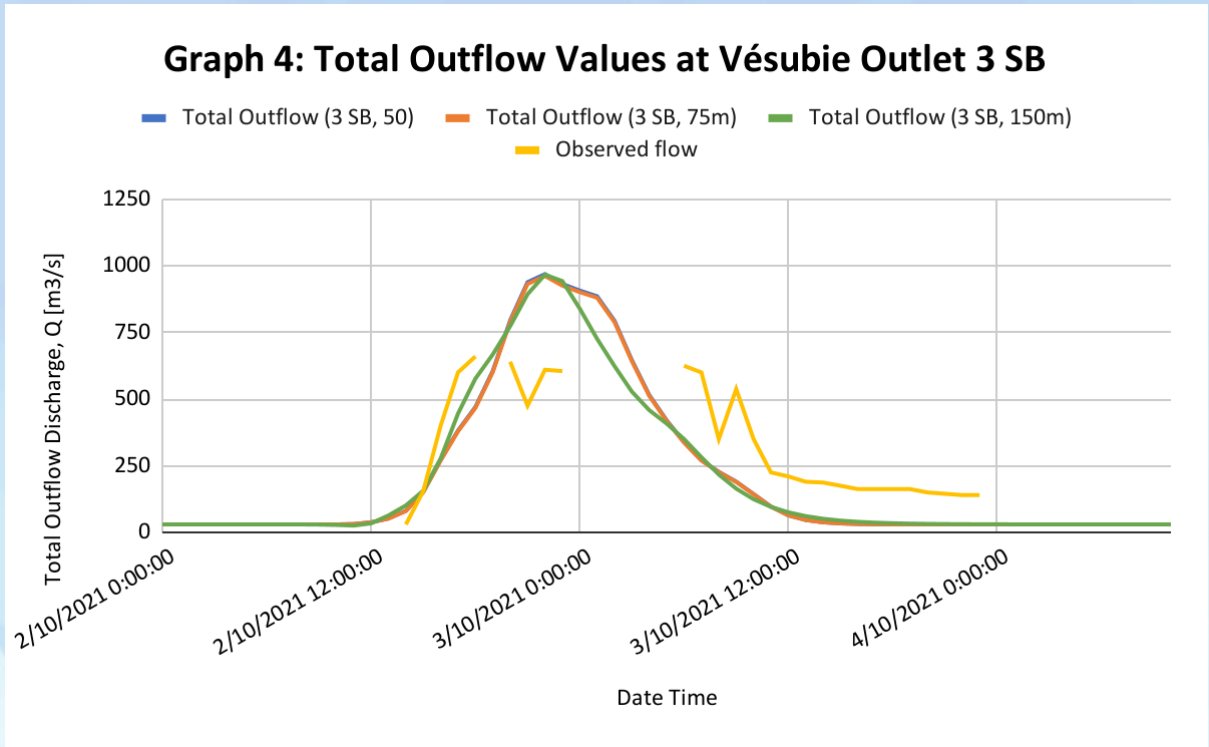
HEC-HMS: Calibration

- 75 m DEM
- Full Var catchment to calibrate - no data at outlet during 02.10.21 event
- Simulated Hydrograph for 1 subbasin (SB) and 3 sub basins models
- Comparison to modeled outlet discharge values of 650 - 1100 m^3/s (Payrastre et al, 2022) and AquaVar model



Impact of DEM/Model Resolution on Hydrographs



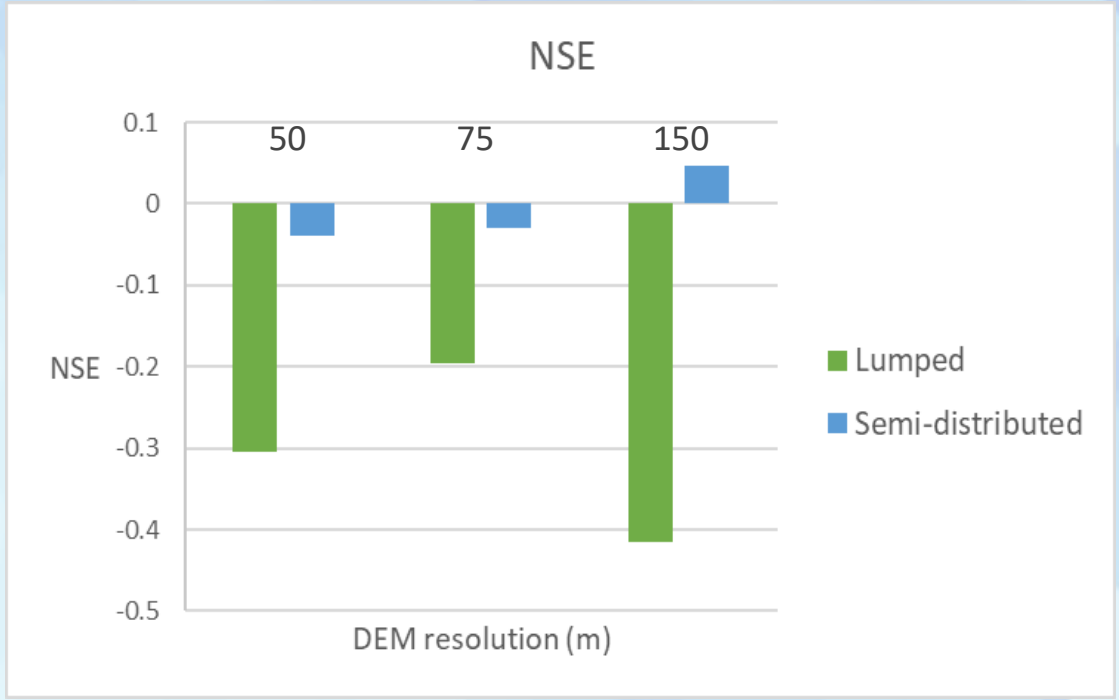


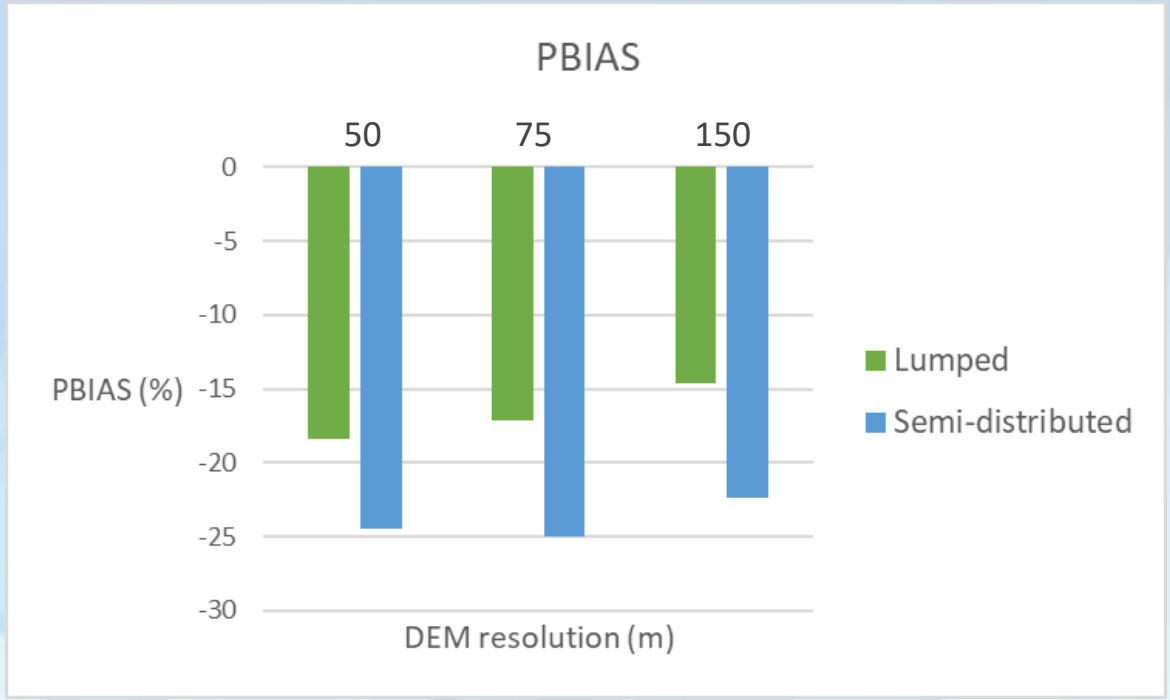
- Depression in peak discharge with increasing resolution
- Very similar output for 50 m and 75 m DEMs
- General decrease in total volume with increase in resolution

Table 1: Total volume [x10^3 m^3] calculated at the outlet for the different model runs

DEM Resolution	50 m	75 m	150 m
1 SB	43,065.75	44,785.73	44,835.84
3 SB	43,952.41	43,690.85	42,735.44

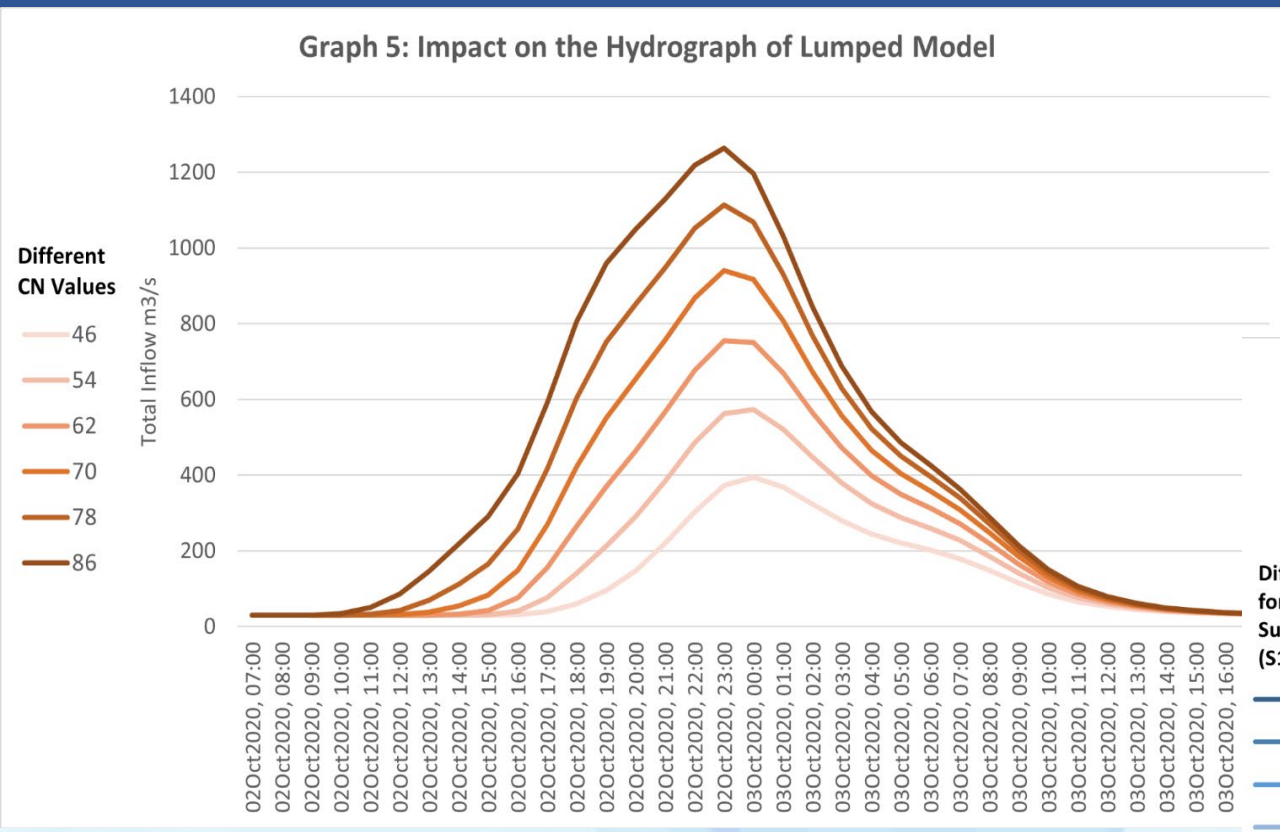
Performance Indicators

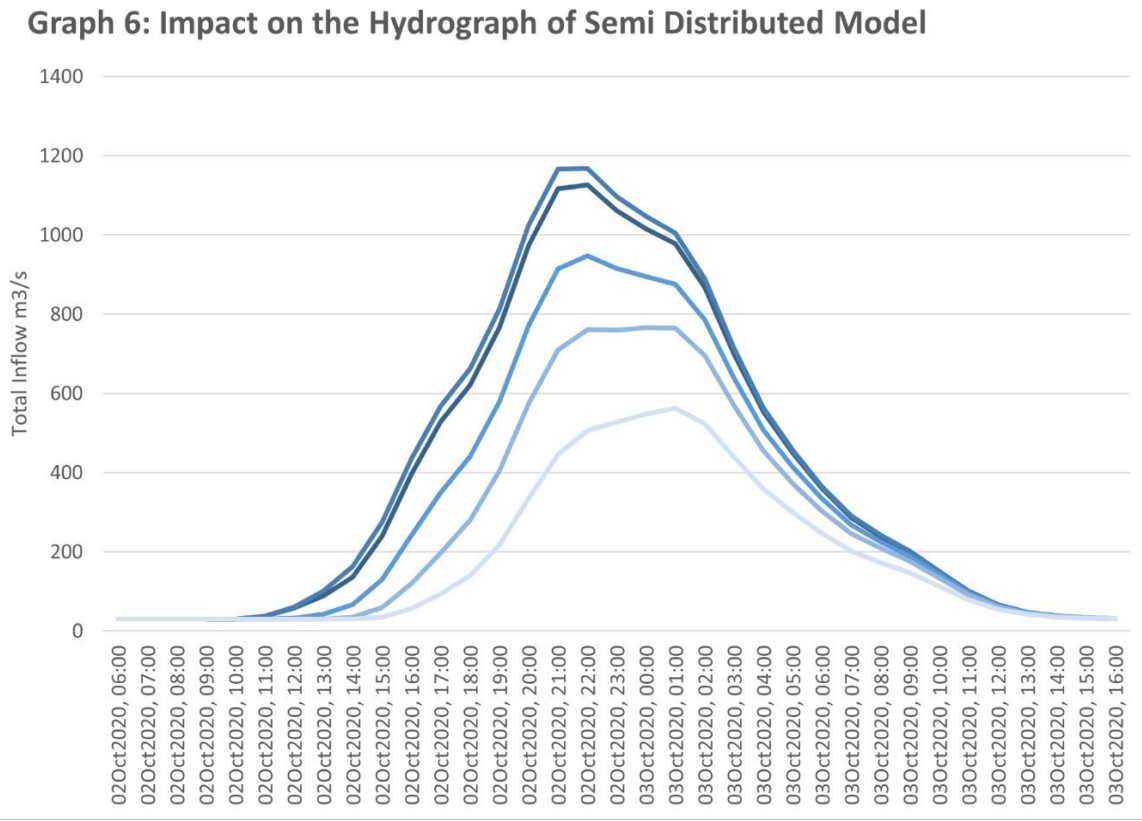




- Limited availability of observed discharge → Model performance evaluated on half of the simulation period
- DEM resolution
  - High sensitivity for the lumped model
  - Low sensitivity for the semi-distributed model
- Higher performance of the semi-distributed model

Impact of Land Use and Soil Conditions on Hydrographs





The most realistic curve number is 74 for the lumped model.

Summary & Conclusions

- Limited availability of discharge records
  - Hinder evaluation of the model performance
  - Importance of implementing remote monitoring
- Impact of higher DEM resolution
  - Lower total mass balance and peak discharge magnitude
- Impact of higher model resolution - Semi-distributed model
  - Transfer of discharge between the sub-catchments → Time shift in the hydrograph
  - Complex geometry → Flood transported faster downstream the basin
  - Able to reproduce the double-peak shape of the discharge
- Impact of land use and soil conditions - Curve number
  - Hydrograph shape - Flattening or steepening
  - High sensitivity of runoff and river discharge simulations to Curve Number
- Model calibration at low resolution does not guarantee a physical consistency of the hydrological parameters

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Thank you for your attention

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References

Liu, Y. & Gupta, H.V. (2007) Uncertainty in hydrologic modeling: Toward an integrated data assimilation framework - wiley online library. [Online] [online]. Available from: https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2006WR005756.

Payrastre, O., Nicolle, P., Bonnifait, L., Brigode, P., Astagneau, P., Baise, A., Belleville, A., Bouamara, N., Bourgin, F., Breil, P. and Brunet, P., (2022) Tempête Alex du 2 octobre 2020 dans les Alpes-Maritimes: une contribution de la communauté scientifique à l'estimation des débits de pointe des crues. LHB, p.2082891.

Gupta, H. V., Sorooshian, S., & Yapo, P. O. (2008). Toward improved calibration of hydrological models: Multiple and noncommensurable measures of information. Water Resources Research, 44(5), W05406. https://doi.org/10.1029/2007WR006716

https://alevelrivers.weebly.com/storm-hydrographs.html. (n.d.). Retrieved February 16, 2023, from https://alevelrivers.weebly.com/storm-hydrographs.html