Towards Probabilistic Flood Forecasting in France

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French flood forecasting network

- **1 national centre (SCHAPI, Tanguy et al., 2005)**
  - Publication of flood warning Map on vigicrues.gouv.fr

- 1-week ahead survey based on
  - EFAS (Thielen et al., 2009)
  - SIM-PE (Cousteau et al., 2013)
French flood forecasting network

- **19 regional Flood Forecasting Centres**
  - Monitored rivers: 22000 km, 3000 active gauges
  - Short-term deterministic flood forecasting
    - Limited number of meteorological scenarios
    - Hydrological, hydraulic, statistical models
French flood forecasting network

- **1-week ahead survey**
  - Based on **probabilistic** forecasting system
  - EFAS, SIM-PE

- **24-hr flood warning**
  - Regulatory framework focusing on gauged basins
  - Often with **deterministic** hydrological forecasts
  - Sometimes based on several hydrological scenarios

→ **Upgrading hydrological prediction system to explicit uncertainty** *(project Prévision2015)*

- **Ungauged basins**
  - Currently: only warning on intense precipitation

→ **Design of an integrated hydro-meteorological without human real-time expertise** *(project VigicruesFlash)*
Prévision2015

- Literally “Forecast2015”
- Explicit forecast uncertainty
- Display probabilistic forecasts on the VIGICRUES website

Prévision publiée le 03/01/2015 à 20h00
Assessing total predictive uncertainty

- Considering meteorological uncertainty
  - ensemble prediction systems (Météo France, ECWMF)
    - still experimental in French flood forecasting network
  - analog sorting approach (Marty et al., 2012)
    - only cover Alps and Loire catchments

Objective assessment of hydrological model uncertainty

⇒ OTAMIN

- Need to include human (subjective) expertise
  ⇒ EAO / EXPRESSO

- In order to provide proper uncertainty estimation
 Prévision 2015: OTAMIN

- **OTAMIN**
  - Developed by C. Furusho, J. Viatge and C. Perrin (IRSTEA)
    [http://webgr.irstea.fr/modeles/otamin](http://webgr.irstea.fr/modeles/otamin)
  - Tests and first applications by Loire-Cher-Indre Centre
  - Objective assessment of model predictive uncertainty
  - Based on the analysis of past forecasting errors

- **Calibration methods**
  - **QUOIQUE** (Bourgin et al., 2014)
    - Non-parametric
    - Preferably for streamflow and multiplicative errors
  - **Quantile Regression** (Weerts et al., 2011)
    - Parametric approach
    - Preferably for water level and additive errors

⇒ Past error quantiles for each (predictand value, lead-time)
 Prévision2015 : OTAMIN

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- **Real-Time post-processor**
  - Apply past error quantiles on current forecast
  - **Lower** (10%), **central** (50%) and **upper** (90%) trend

- **Limits**
  - No time correlation
  - Is calibration sample representative?
  - Performance in extrapolation?
ORTAMIN provides only a "first" guess

- All sources of uncertainty are **not** included:
  - Observation and forecast of precipitation, temperature
  - Observed water level and rating curve
  - Differences between models
 Prévision2015 : EAO / EXPRESSO

- **Computer-aided expert assessment**
  - Developed by L. Berthet, J. Barat and R. Marty
  - Interactive tool to help human forecasters to express
    - Their own expertise
    - The "final" assessment of total uncertainty

- **Graphical workspace**
  - Display forecasts, warning levels, state of rating curve
  - Handle quantiles curves (10%, 50% and 90%)
  - Release forecasts with its uncertainty to national server
 Prévision2015 : EAO / EXPRESSO
 Prévision2015 : Verification

- **Imperfect total uncertainty assessment**
  - Limits of models and tools
  - Under- or over-confidence of human forecasters

- **Unavoidable verification**
  - Systematic training for every forecaster
  - Regularly-scheduled forecast verification
  - Focus on reliability, accuracy and sharpness
  - Release our verification
Vigicrues Flash

- Integrated hydro-meteorological without human real-time expertise

Radar gauge QPE

Distributed hydro modelling
Determination of the basins concerned with threshold exceedance

Flash flood warning display

Flood warning maps available on the dedicated website

High threshold
Low threshold

1. débit (m³/s)
2. temps (h)
Vigicrues Flash

- **First version**
  - Implementation in **2016**
  - Only based on QPE by radar

- **Work in progress**
  - Extend lead time by using QPF
  - High-resolution nowcasts from AROME
  - Mean gain in effective lead time
    - 2-yr threshold: 2-5 hours
    - 5-yr threshold: 1-3 hours

**Estimated Return Period**

- < 2 years
- 2 ≤ < 10 years
- 10 ≤ < 50 years
- > 50 years
Technical and human challenge

- **Uncertainty assessment**
  - Meteorological uncertainty by meteorological ensembles?
  - Hydrological model uncertainty by multi-model approach?

- **Hydrological Prediction System for monitored basins**
  - Adapted to semi-distributed prediction chains?
  - Consistency at (sub-) basin scale?

- **Future flash flood warning system**
  - Need to include human expertise?
  - Link with warning emitted within the regulatory framework?

- **Human challenge**
  - Role of human forecasters?
  - How to deal with probability within the flood warning process and non-scientist end-user?
Thanks for your attention!