Experiences in using INCA-CH precipitation nowcasting for Urban Flood Nowcasting

Frédéric Jordan, Matteo Buzzi, Lorenza Gianoni, Raphaël Mutzner

Hydrique
ch. du Rionzi 54
CH- 1052 Le Mont-sur-Lausanne
Switzerland

www.hydrique.ch
info@hydrique.ch
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OBJECTIVES OF THE RESEARCH
What is the current performance of nowcasting in small river catchments?

Is the Inca-nowcasting product able to improve the forecasting skill of the system?

How to convert the new information into added-value for our customers?
INCA-CH PRODUCT
Geostatistical technique

- Spatio-temporal co-kriging with external drift
- Correlations are computed using semivariograms.
- Convection control capabilities
- Use of semivariograms of past states (Sideris et al., 2014)

- **Hourly aggregation.**
  - Produced every 10 minutes: 144 images per day.
  - Processing takes 3-5 minutes.
  - Equipped with a quality flag (0-9).

Disaggregation

- From 60 minutes accumulation to **5 minutes** accumulations using radar (12 pieces)
- Solution to zero accumulation problem (Barton et al., 2018)
  - Dilation by means of low-pass filtering
  - Use of spatio-temporally correlated noise
**INCA-CH precipitation nowcasting**

**Nowcasting window**

- **0h**
  - RADAR: 10min acc.
  - Raingauges: 10min acc.
  - **analysis CombiPrecip**
  - Movement: radar, U V COSMO-1, 10 min
  - **extrapolation**
    - Image comparison (3 images, 30min)
    - Per pixel linear motion vectors
    - Vectors corrected with COSMO-1 wind
  - **total rain**

- **1h**
  - **10% COSMO-1**
  - Movement: radar, U V COSMO-1, 10 min
  - **blending Extrapolation+COSMO-1**
    - **linear**
  - **total rain**

- **2.5h**
  - **50-50% COSMO-1**
  - Movement: radar, U V COSMO-1, 10 min
  - **total rain**

- **4h**
  - **100% COSMO-1**
  - Movement: radar, U V COSMO-1, 10 min
  - **total rain**

- **6h**
  - **total rain**

**Very rapid update frequency:**

- **10 minutes**
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HYDROLOGICAL FORECASTING SYSTEM
Hydrological Model: Routing System

- Semi-distributed model
- Elevation bands (typically 300m)
- SOCONT-MODEL

Processes modeled:
- Runoff
- Snow / glacier melt
- Evapotranspiration
- Soil moisture
- Flow routing
- Intake, lakes
- Pumps, turbines
- Reservoir management

(Schäfli et al., 2005; Jordan, 2007)
HYDROMETEOROLOGICAL CHAIN

- **Meteo gauging stations**
- **Routing System**
- **Simulated flow**
- **Data assimilation**
- **Forecasting model initial conditions**
- **Routing System**
- **NWPs: IFS, COSMO, ICON-EU, AROME, ARPEGE**
- **Human expertise and forecast combination**
- **Best forecast estimate**
• **Forecast as a service, webgis application**

• **Forecast update with Inca**: 10min

• **Alerts (SMS, email)**: future precipitation, discharge, water level, runoff

• **Archives of forecasts available online**

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Example of the 3rd of January, 2018
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INCA-CH ASSESSMENT
INCA-CH ASSESSMENT

294 Stations
11 Regions
Analysis: 07.2018 to 11.2018

Geneva
Rhône-Alpes
Jura
Plateau
Préalpes
Valais
Tessin
Grisons
ARPA Piemonte
ARPA Lombardia
Exclues
HIT / FAR analysis : COSMO-1 vs INCA-CH

Average of all 294 stations
1h lead time total precipitation

- Better results for INCA
- Poor skills of COSMO-1: HIT<0.2 and FAR>0.6 for P>1mm/h
- Good skills of INCA-CH up to ~5mm/h
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APPLICATION TO SMALL RIVER CATCHMENTS
Laveggio in Riva san Vitale (Ticino, Switzerland)

32.4 km² (catchment area)
4.5 km² (impervious area)

- Stabio rainfall gauge
- Riva discharge gauge

Response time: 40’ to 1h
Stabio meteo station
Event of 7.8.2018 00h

APPLICATION TO SMALL CATCHMENTS

inca

cosmo1
APPLICATION TO SMALL CATCHMENTS

Laveggio river
Event of 7.8.2018 00h

Technique
- Forecast update: 10min
- Lead time: 6 hours
Summary for forecasts in the Laveggio catchment:

<table>
<thead>
<tr>
<th>No</th>
<th>Date</th>
<th>Inca</th>
<th>cosmo1</th>
<th>comment</th>
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<tr>
<td>1</td>
<td>20.07.2018</td>
<td>90</td>
<td>no</td>
<td>Peak 30min too late</td>
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<td>2</td>
<td>25.07.2018</td>
<td>no</td>
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<td>90</td>
<td>no</td>
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<td>13.08.2018</td>
<td>30</td>
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<td>Poor quality of cosmo1 forecast during event</td>
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<td>Poor quality of cosmo1 forecast during event</td>
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<tr>
<td>6</td>
<td>27.10.2018</td>
<td>no</td>
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<td></td>
</tr>
<tr>
<td>7</td>
<td>06.11.2018</td>
<td>180</td>
<td>180</td>
<td>Model too low, but good reaction from forecasts</td>
</tr>
</tbody>
</table>

7 storm events analyzed

cosmo1 – 1 event “predicted”

inca – 5 events “predicted” 30-90 min ahead
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DISCUSSION
What is the current performance of nowcasting in small river catchments?

Some events can be «predicted», up to 1.5 times the response time of the catchment.

Is the Inca-nowcasting product able to improve the forecasting skill of the system?

Yes, especially when the numerical weather model doesn’t predict any rainfall.

How to convert the new information into added-value for our customers?

Most important feature: update the precipitation information as fast as possible (5-10 min)
THANK YOU FOR YOUR ATTENTION

Hydrique Ingénieurs
ch. du Rionzi 54
CH – 1052 Le Mont-sur-Lausanne

info@hydrique.ch
www.hydrique.ch

MeteoSvizzera
Via ai Monti 146
CH – 6605 Locarno-Monti

www.meteoswiss.ch
HIT / FAR analysis
Average of all 294 stations
10 min volumes

Example: 10 mm/h during 10 min
- HIT drops from 0.4 to 0.08
- FAR goes from 0.5 to 0.9

Lead time
- Skill until 20-30 minutes ahead