

Relevance of using ensemble forecasts of flash-flood impacts for an emergency service: an evaluation for the october 2018 flood event in the Aude River basin, France

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new experimental short range ensemble rainfall forecast products

New short-range
rainfall forecast
products

A first evaluation
based on discharge
threshold
anticipation

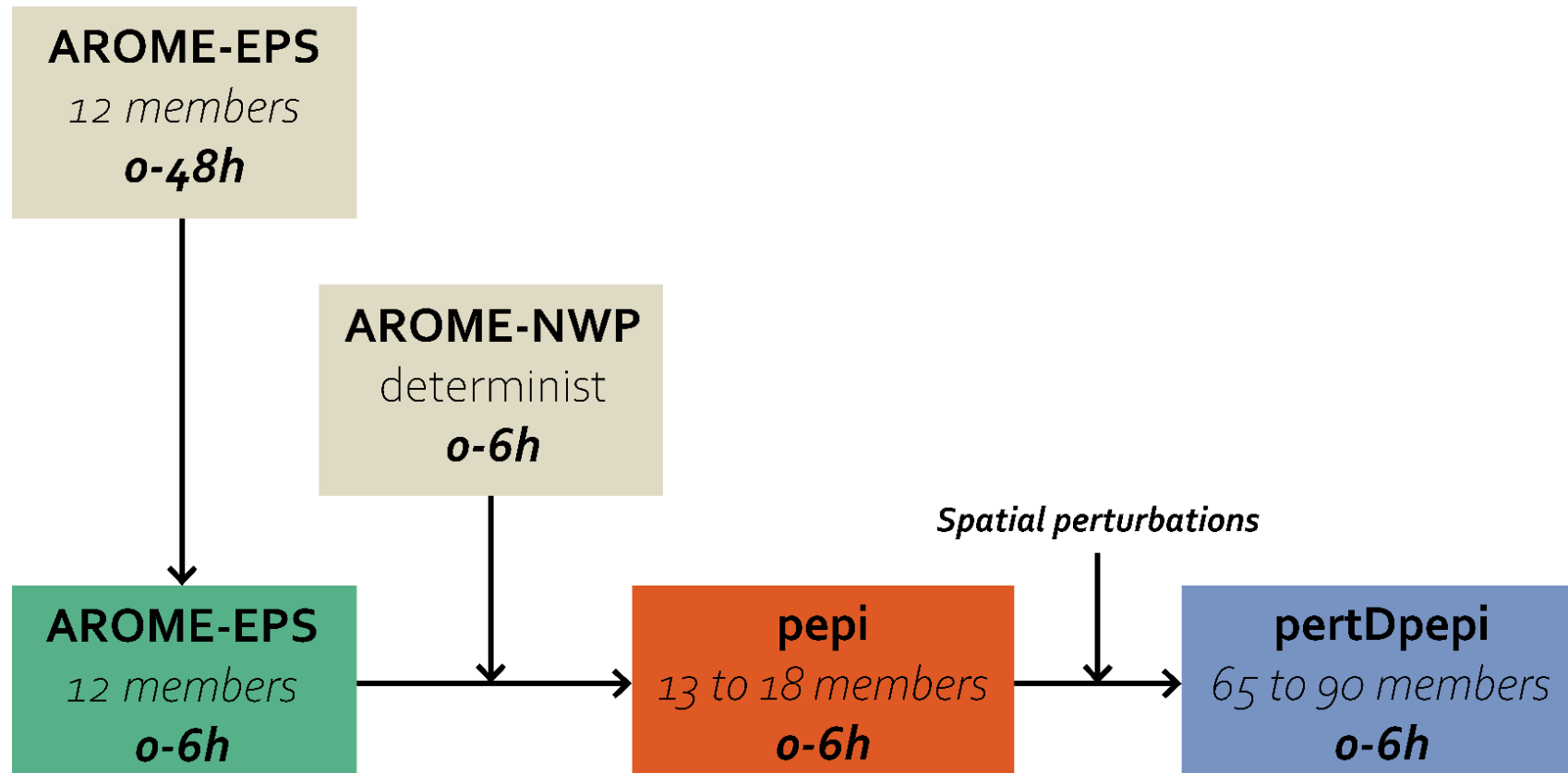
Objectives

Principles of the
multi-agent model

Results

Conclusions

Experimental ensemble rainfall products based on the convection permitting Arome EPS and Arome NWP model



A first evaluation based on the discharge thresholds anticipation

New short-range
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Anticipation capacity of T=10 years discharge threshold (Example of the Aude River basin: 1174 sub-basins)

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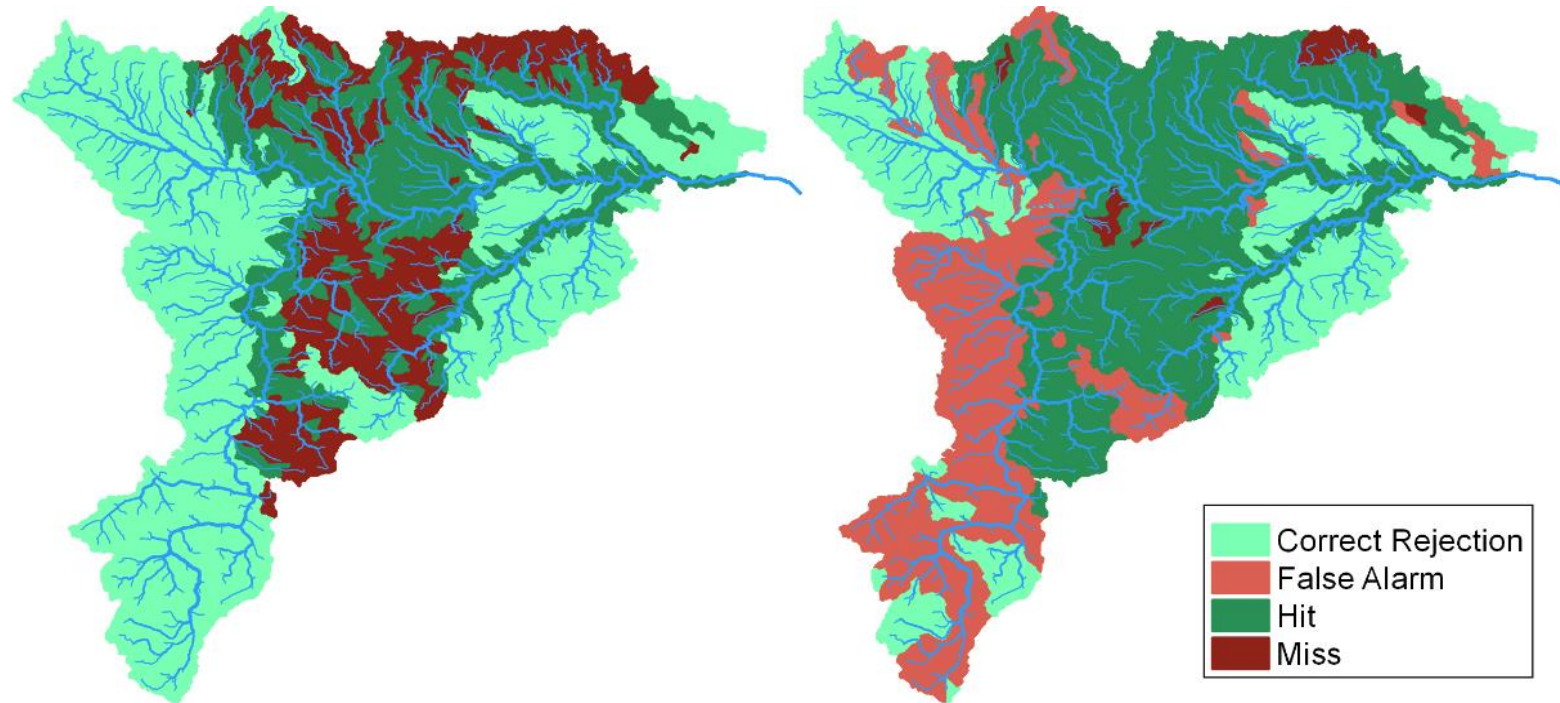
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Zero future rainfall

pepi ensemble product - 75% percentile



Charpentier-Noyer et al., 2022, NHESsd, <https://doi.org/10.5194/nhess-2022-182>

What is the best forecast for an user ?

Flash floods in the Aude River basin 14-16 October 2018

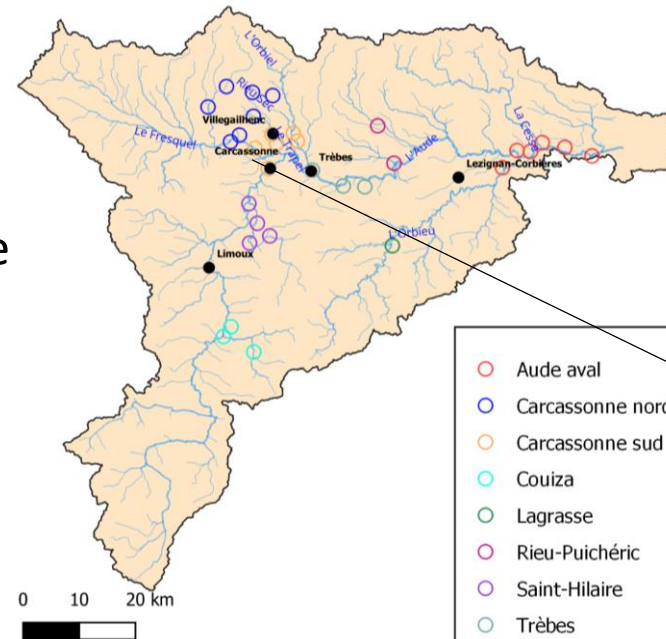
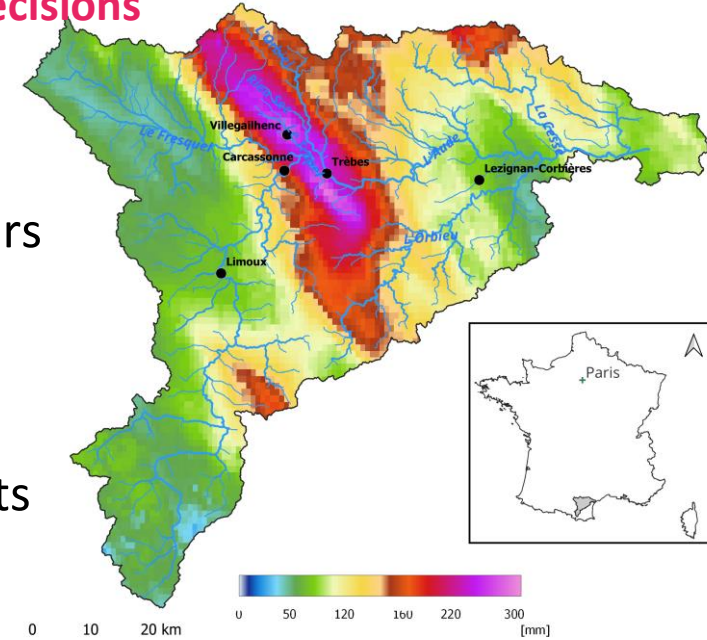
Objective: evaluate the forecasts based on the capacity to take efficient decisions

Case study: Aude October 2018 flood

15 fatalities € 200 M€ 213 mm in 6 hours

32 municipalities with rescue operations

Interventions triggered by reports of observed impacts



The agents of a fire service are rescuing team

Decisions based on impacts forecasts

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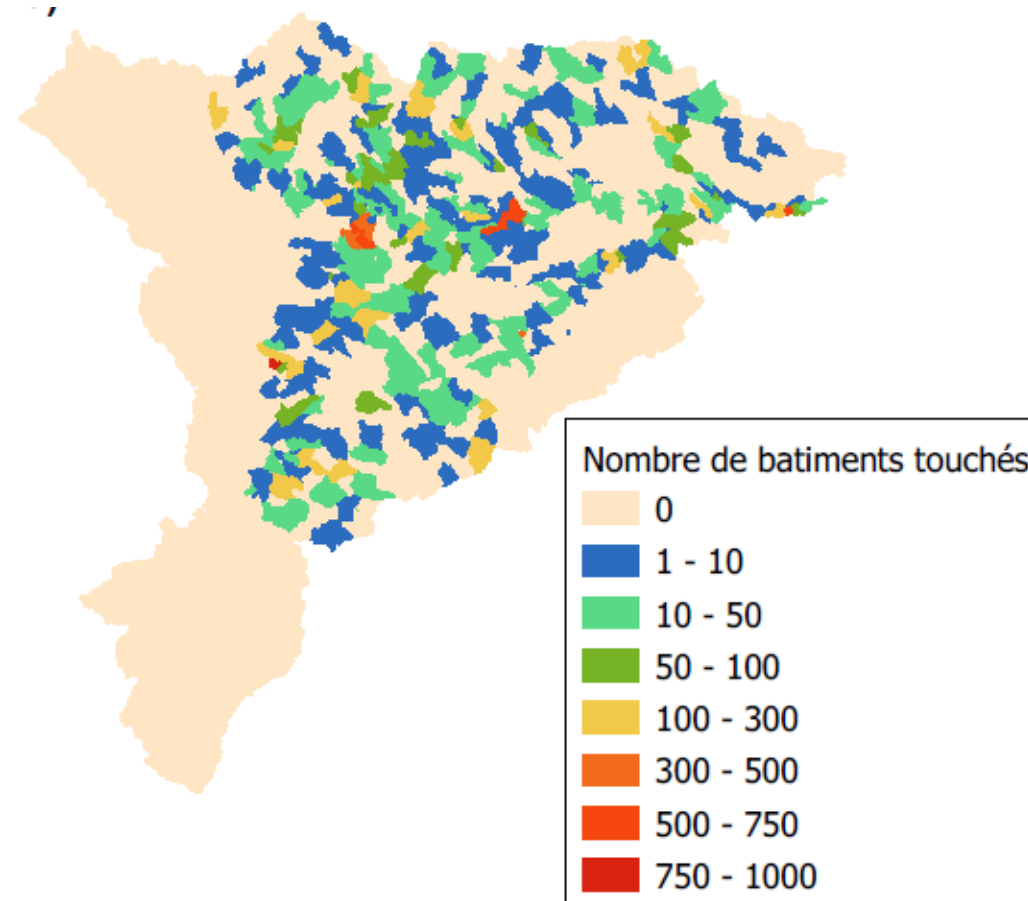
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Forecast of flooded buildings, at the river reach scale and 15 min time resolution

A decision threshold (number of inundated buildings) triggers the decision of sending a rescue team

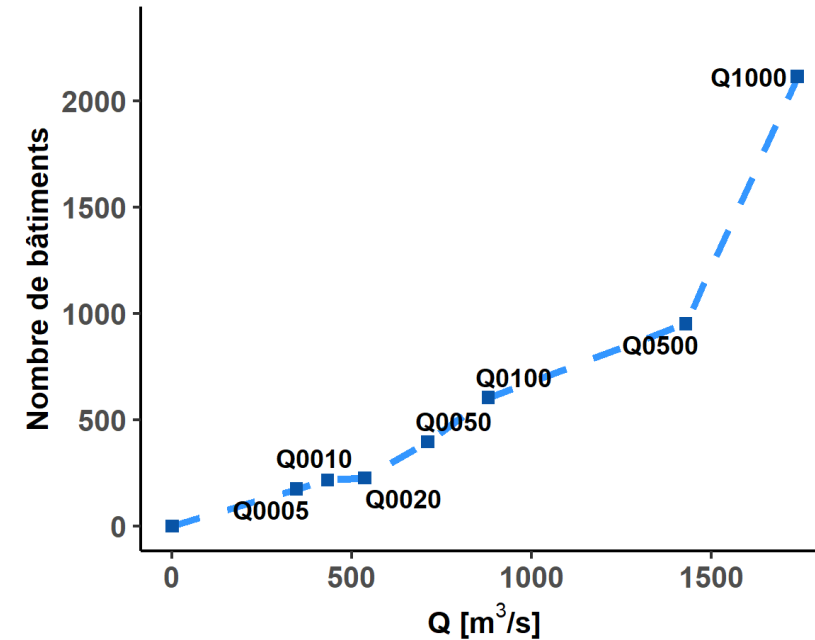
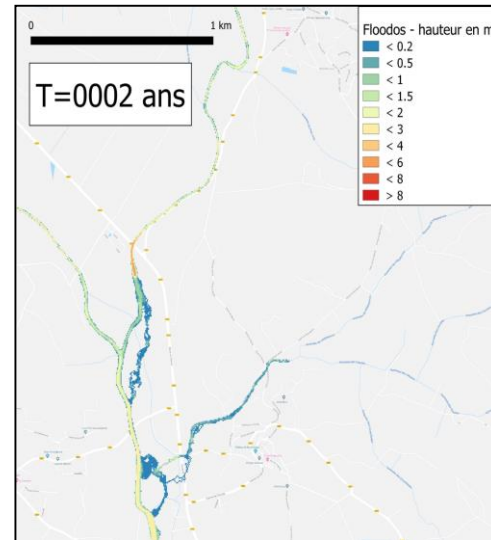


*Maximum number of
flooded buildings in oct.
2018*

Overall principles of the multi-agent model

Principle of the impact forecasts used to take decisions

- ✚ A discharge-impacts relation is built on each river reach (7 flood scenarios, T=5 to 1000 years)

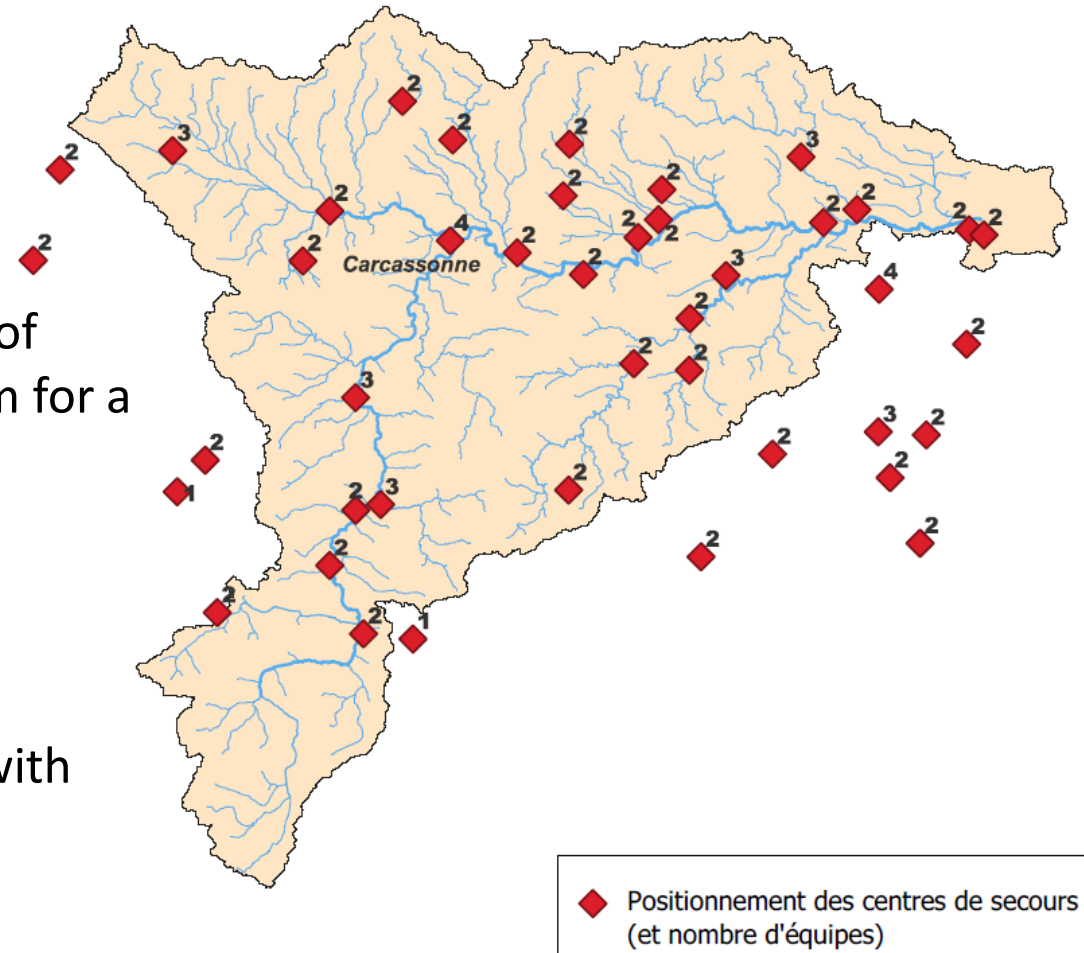


- ✚ Ensemble discharge forecasts can be directly translated in terms of impacts

Overall principles of the multi-agent model

Assumptions & parameters

- ↘ 92 rescue teams (42 firemen centers)
- ↘ Intervention threshold: minimum number of flooded buildings for sending a rescue team for a river section
- ↘ Intervention capacity: number of buildings treated by a rescue team
- ↘ Team displacement: displacement matrix with an average speed of 30 km/h



Examples of modelling results

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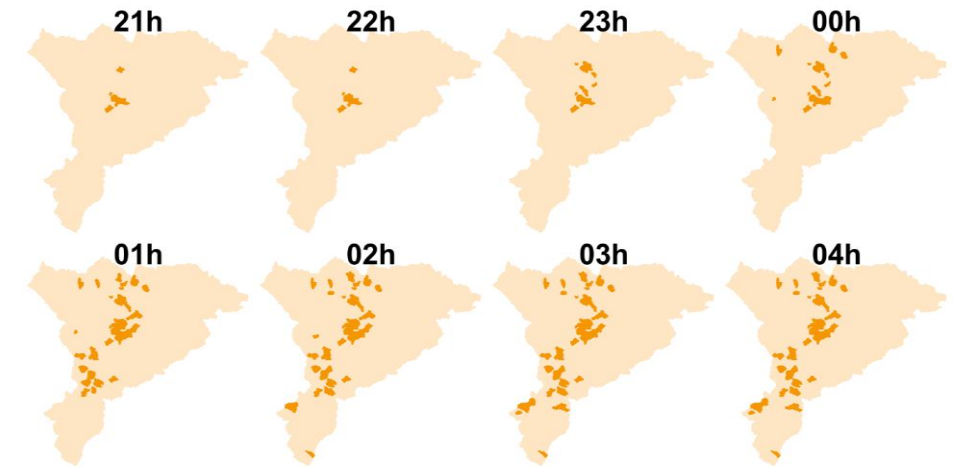
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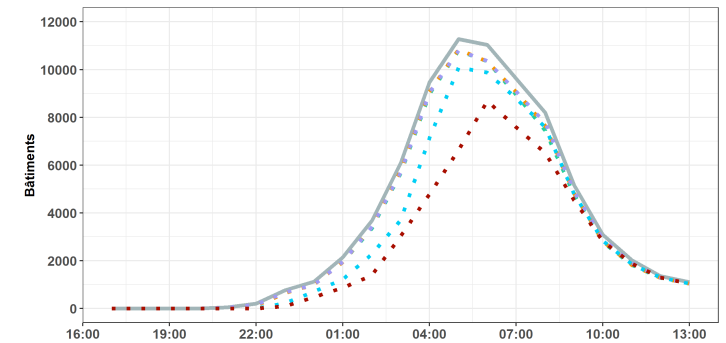
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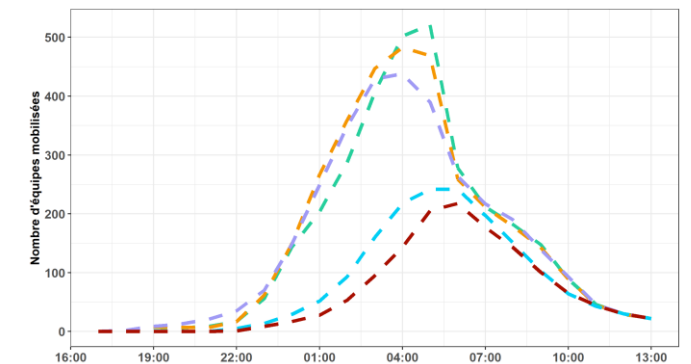
Location (and number) of rescue teams in operation



Evolution of the number of buildings really rescued



Evolution of the number of rescue teams mobilized



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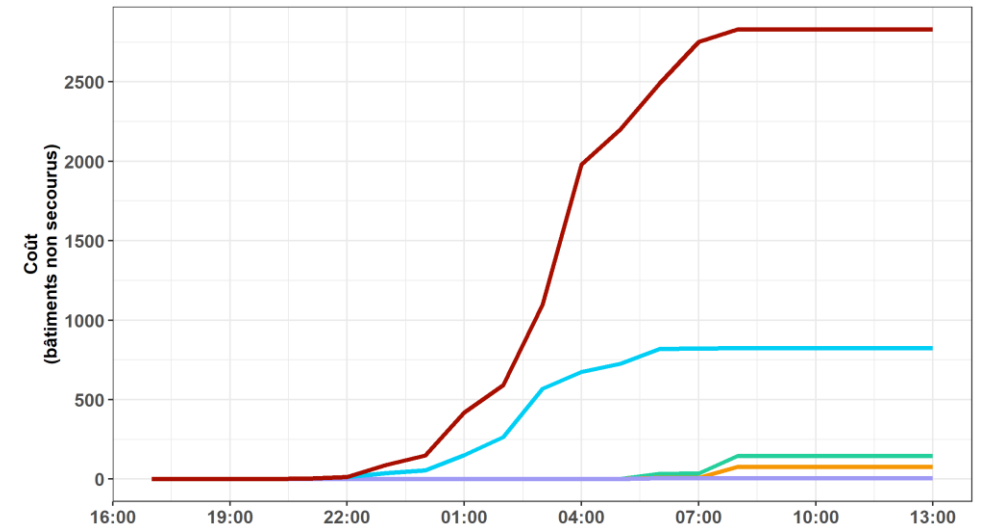
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Computation of a cost function



*Cumulative number of buildings for which
no rescue team was present during the
flood*



Before the beginning of the flood cost = **0** buildings



Less than 1h after the flood beginning cost = **10 %** flooded buildings



Between 1h and 3h after the beginning of the flood cost = **50 %** flooded buildings



More than 3h after the beginning of the flood cost = **100 %** flooded buildings

Comparison of the efficiency of forecasts

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Reference simulation based on observed rainfall: RS (used as reference, decisions based on field observations)

Forecasts based on zero future rainfall: RF0

Forecasts with the 3-ensemble rainfall forecast products (75% percentile):

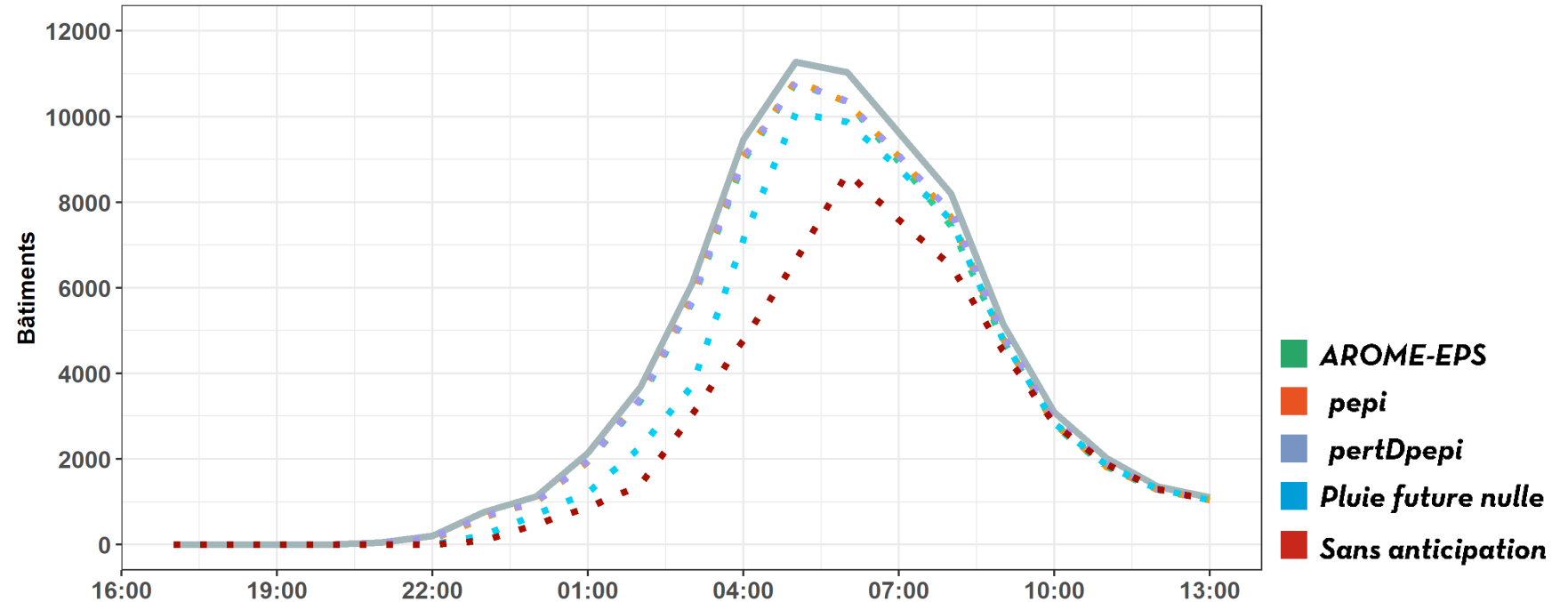
✚ *AROME-EPS*

✚ *pepi*

✚ *pertDpepi*

An ideal case with unlimited number of rescue teams

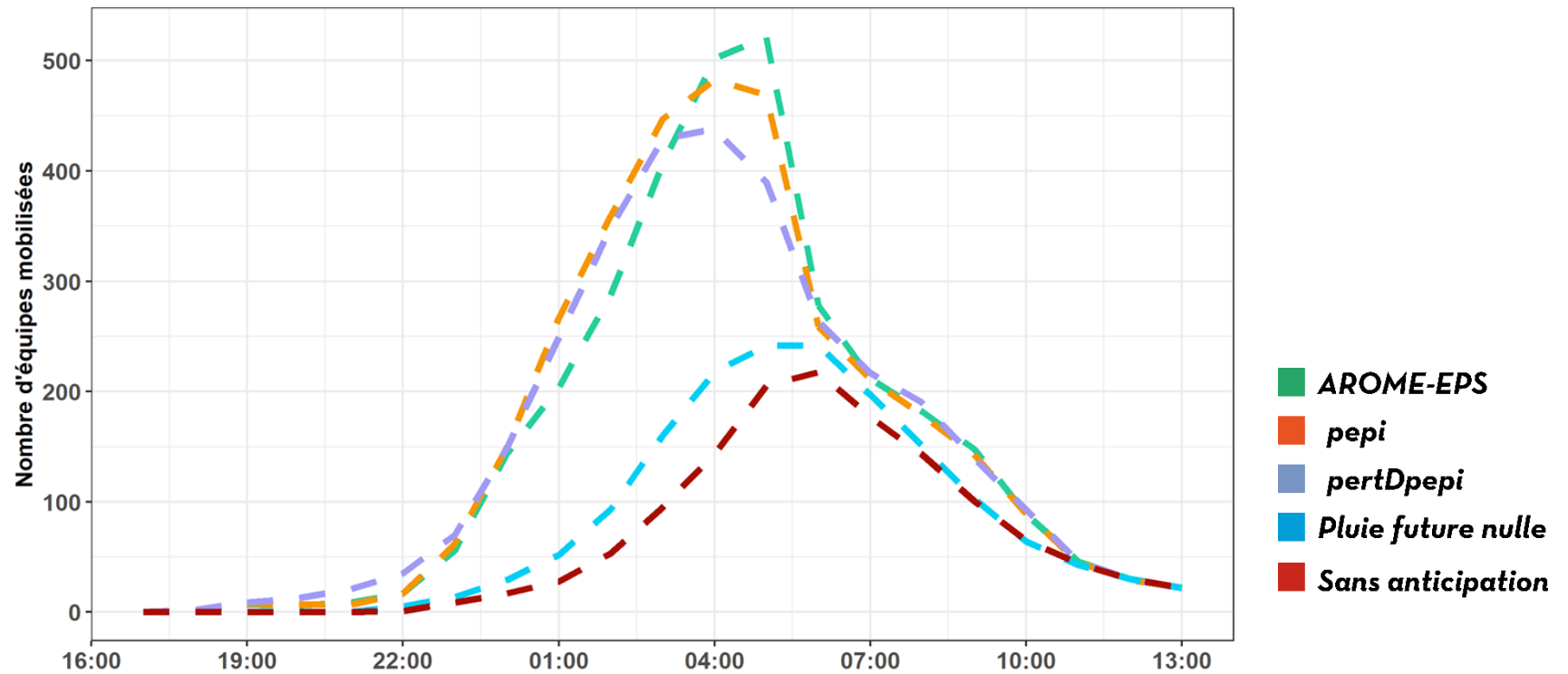
Number of buildings really rescued



- ↘ Intervention threshold: **10** buildings
- ↘ Team number: **unlimited**
- ↘ Intervention capacity: **100** buildings/team

An ideal case with unlimited number of rescue teams

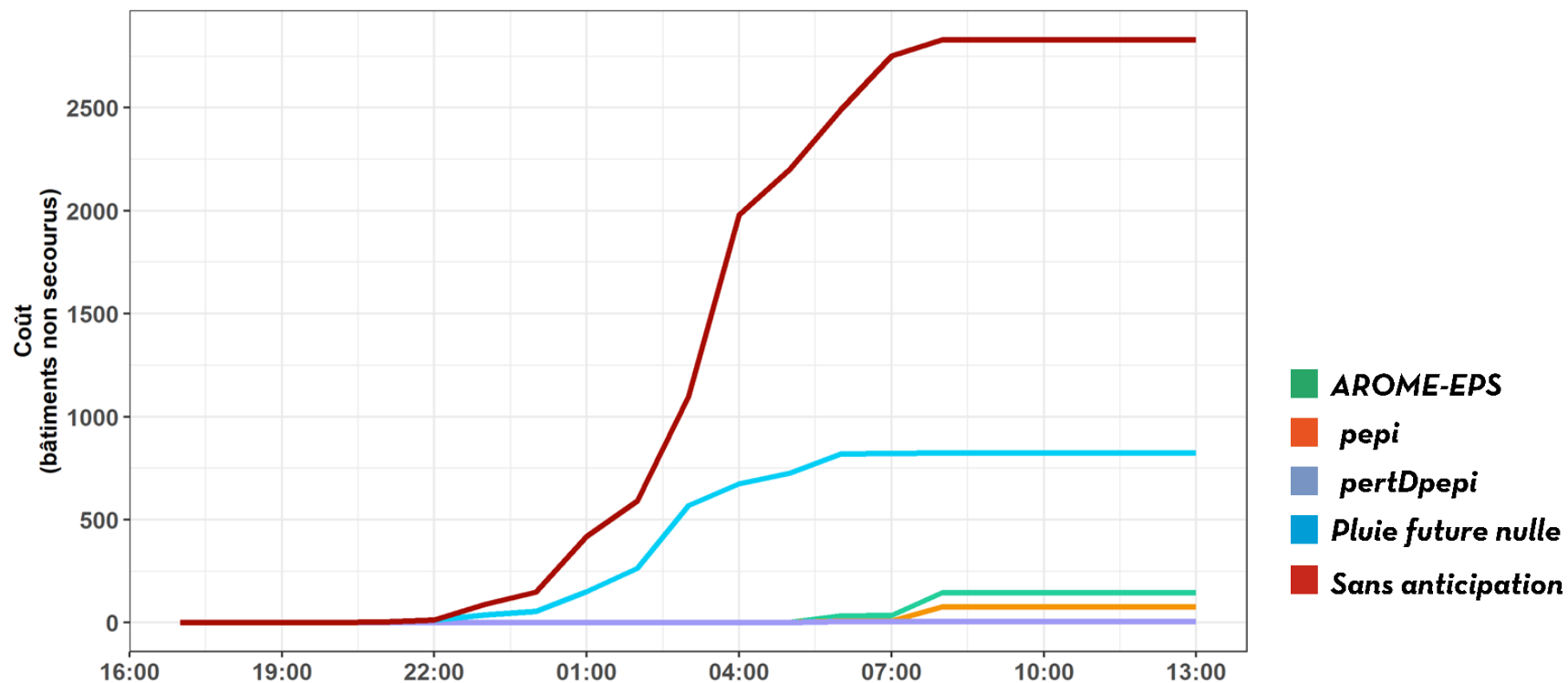
Number of rescue teams mobilized



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An ideal case with unlimited number of rescue teams

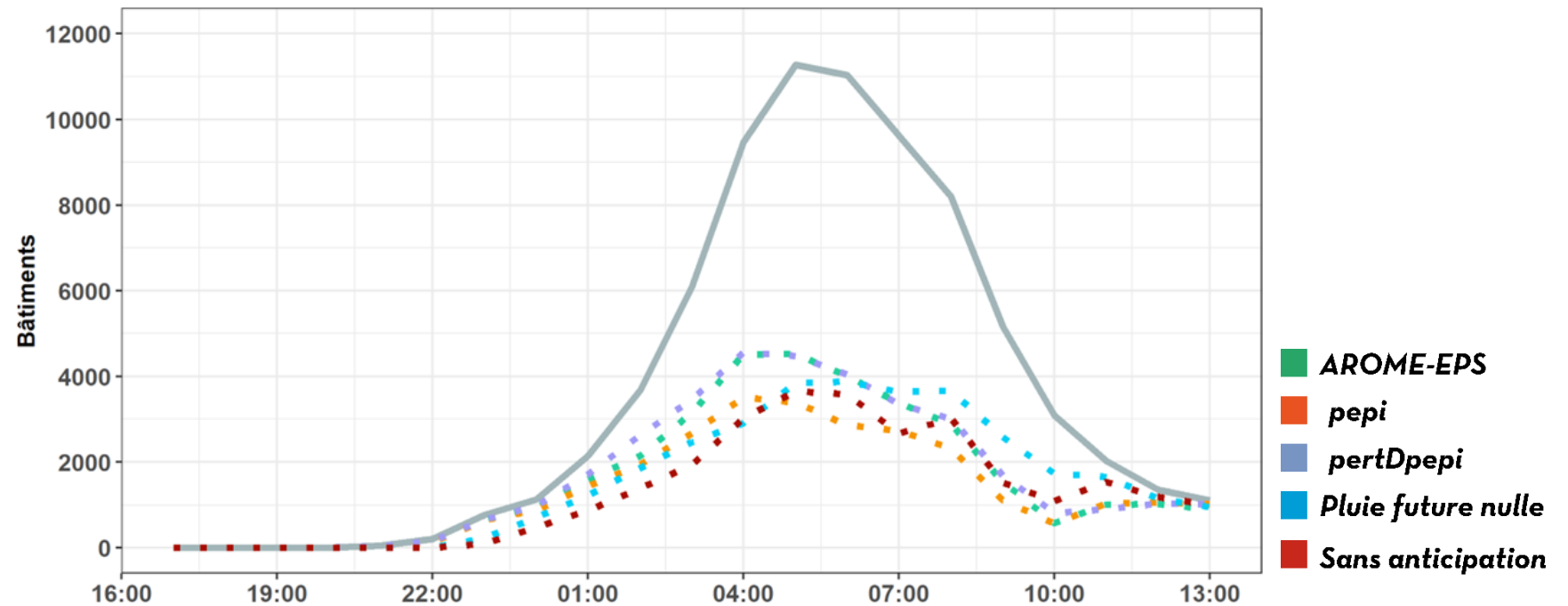
Cost function: buildings not rescued



- ↘ Intervention threshold: **10** buildings
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A more realistic case with 92 rescue teams

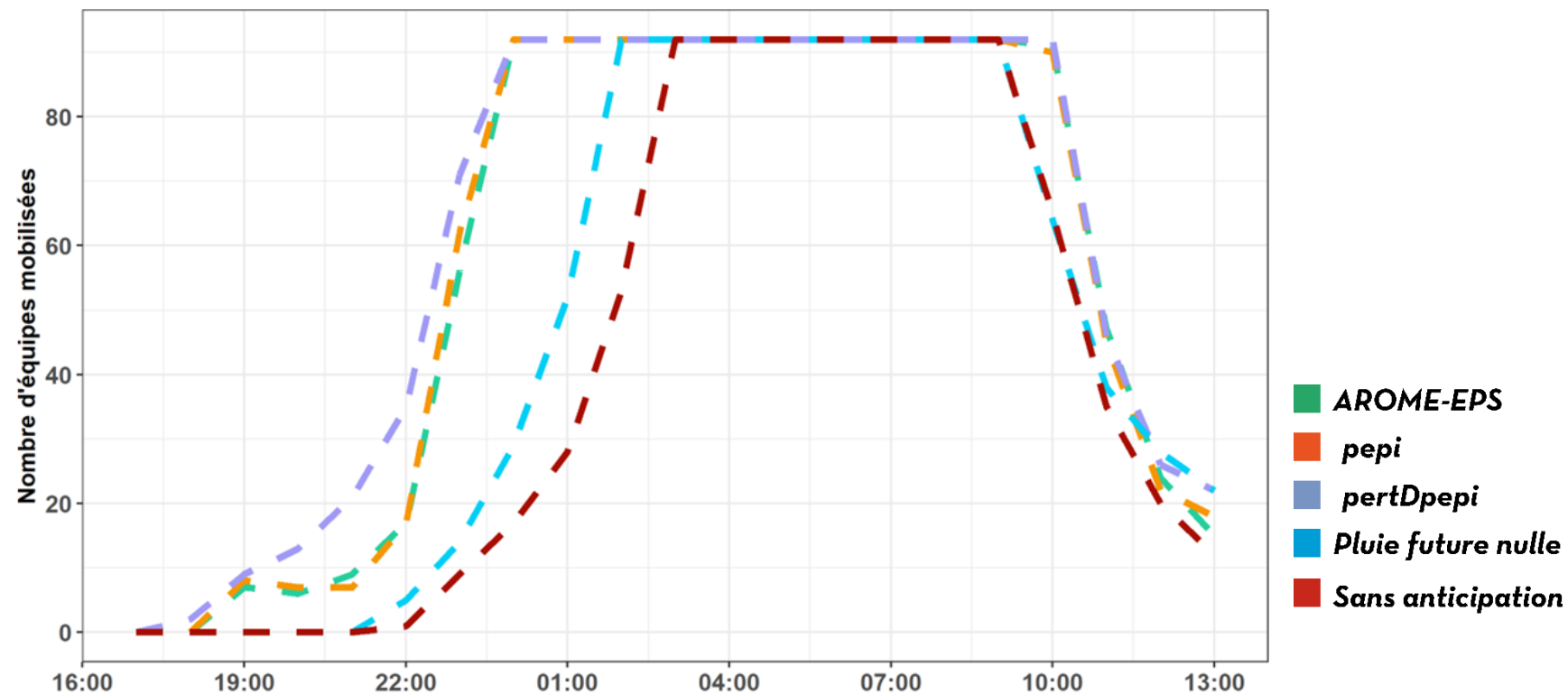
Number of buildings really rescued



- ↘ Intervention threshold: **10** buildings
- ↘ Team number: **92**
- ↘ Intervention capacity: **100** buildings/team

A more realistic case with 92 rescue teams

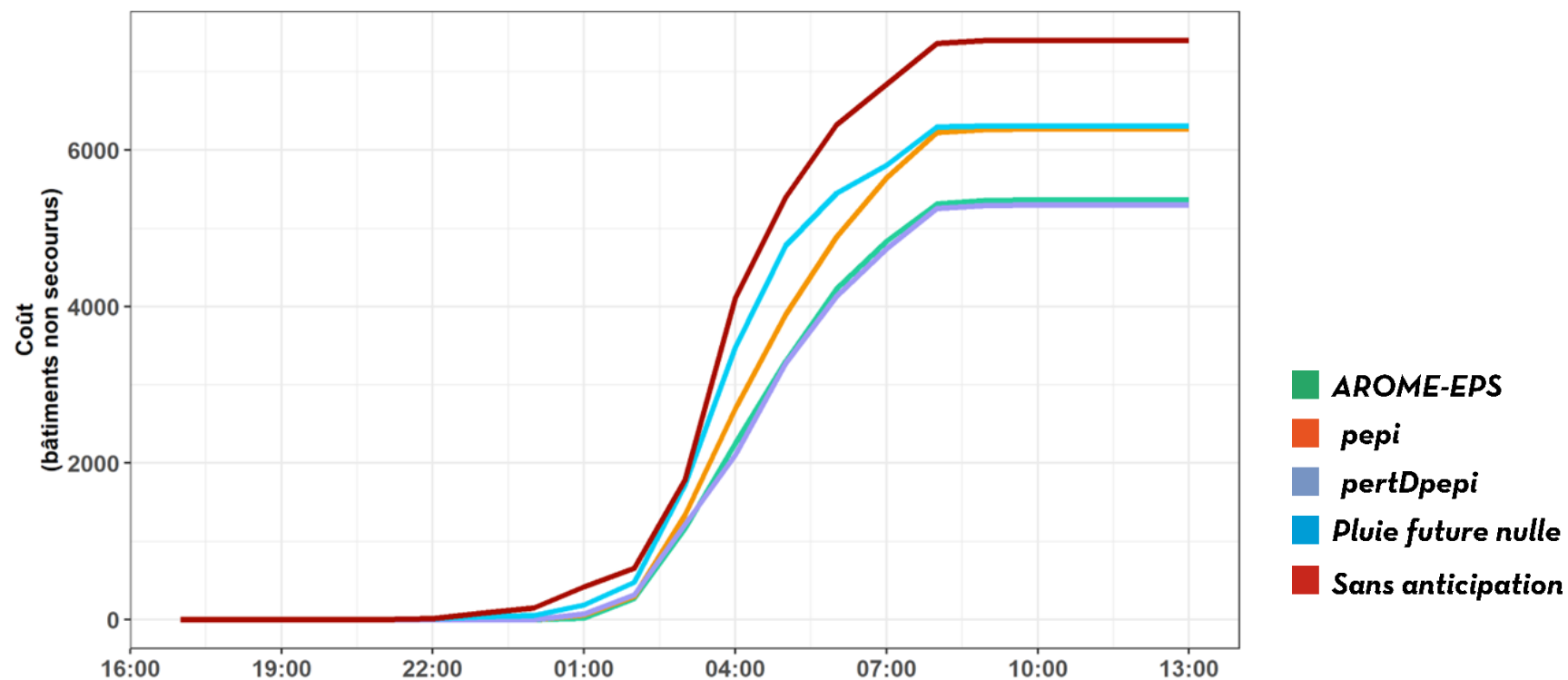
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Cost function: buildings not rescued



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Comparison of the efficiency of forecasts

Performance of the different tested rainfall forecasts

- ✚ The added value of forecasts can be identified, particularly in case if unlimited means
- ✚ Forecasts are largely affected by false alarms in case of limited means. Decisions based on zero future rainfall may be better in this case.
- ✚ Decisions based on forecasts never worse than decisions based on field observations

Realism of the agent-based model - improvements

- ✚ Impacts model based on affected population rather than buildings
- ✚ Travel times
- ✚ Cost function (case of late arrival of rescue)
- ✚ Duration of rescue operations and re-affectation of rescue teams

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