

New cloud-based tool to Dynamically Manage Urban Resilience: the Fresnel Platform for Greater Paris

radx.enpc.fr



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INTRODUCTION

As cities are put under greater pressure from the threat of impacts of climate change, in particular the risk of heavier rainfall and flooding, there is a growing need to establish a hierarchical form of **resilience** in which critical infrastructures can become sustainable. The main difficulty is that geophysics and urban dynamics are strongly nonlinear with an associated, **extreme variability over a wide range of space-time scales**.

The polarimetric X-band radar at the ENPC's campus (East of Paris) introduced a paradigm change in the prospects of environmental monitoring in Ile-de France. The radar is operated since May 2015 and has several characteristics that makes it of central importance for the **environmental monitoring** of the region.

The platform is now focusing on displaying:

1

Live rainfall data

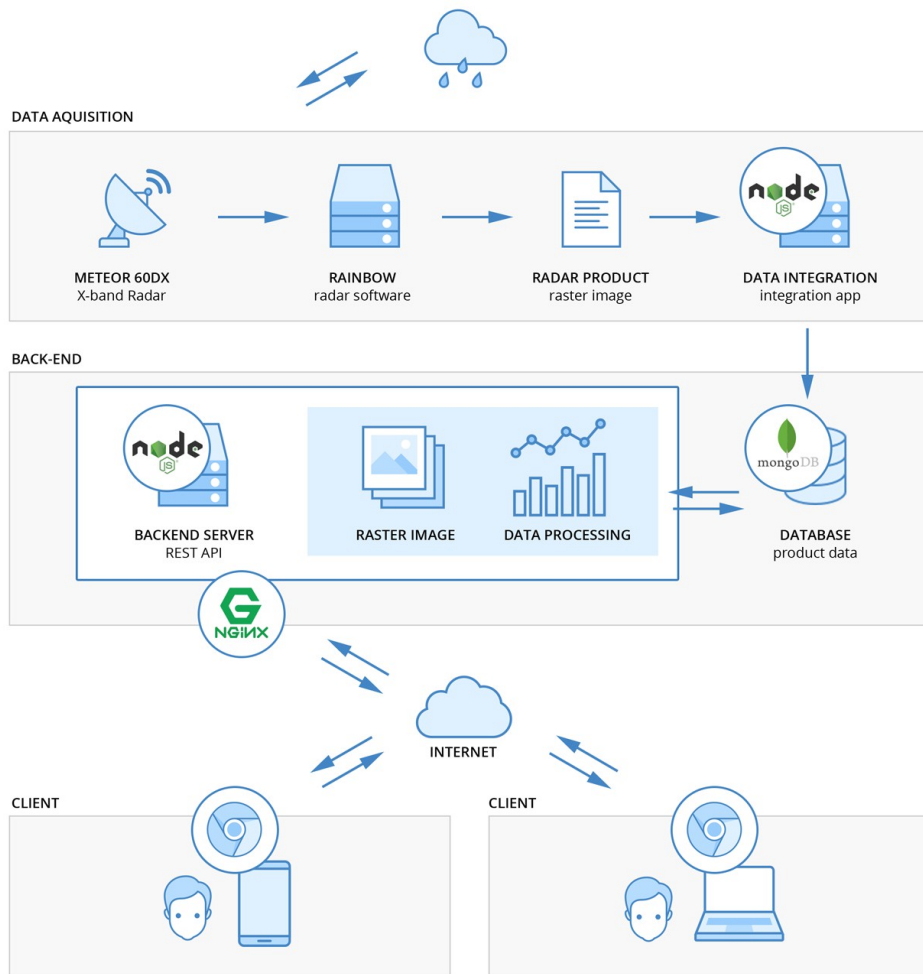
2

Historical rainfall data

3

At various spatial and
time scales

METHODS: DATA INTEGRATION



The Fresnel SaaS platform is rooted on an integrated suite of modular components based on an asynchronous event-driven **JavaScript** runtime environment (**Node.Js**), using open source librairies.

The data aquisition chain integrates radar data in a **MongoDB** instance and also generates statistical information for the final user. This allows for efficient responses on small (radar pixel) and large spatial requests such as catchment and subcatchment.

The front-end communicates with the back-end via an dedicated API. An **nginx** server is configured as a reverse proxy to dispatch the **API requests**.



Framework



Display librairies

The front-end is build using the **React** library, it enables to create a User Interface (UI) that will render only the modified application component states when receiving new data from the API.

It is coupled with **Redux**, a state container. It allows for state and logic centralization, and also state persistance through the app.

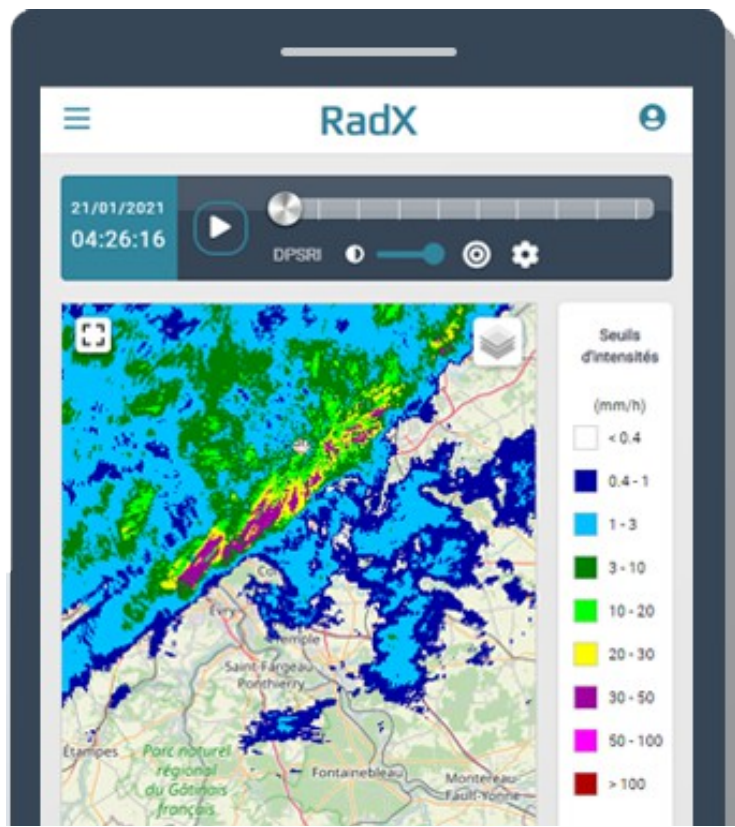
The display libraries used in the app are:

Leaflet a javascript library for interactive maps

D3, Data drive document, a library used to generate the SVG (Scalable Vector Graphics) directly in the UI. The use of SVG graph instead of bitmap graph allows for user interaction and render scalability (desktop to mobile display)

RESULTS: LIVE RAINFALL DATA

General public and professional can now freely access the **real-time** radar rainfall data from their web browser. Registered users can access the archive for deeper rainfall data analysis.

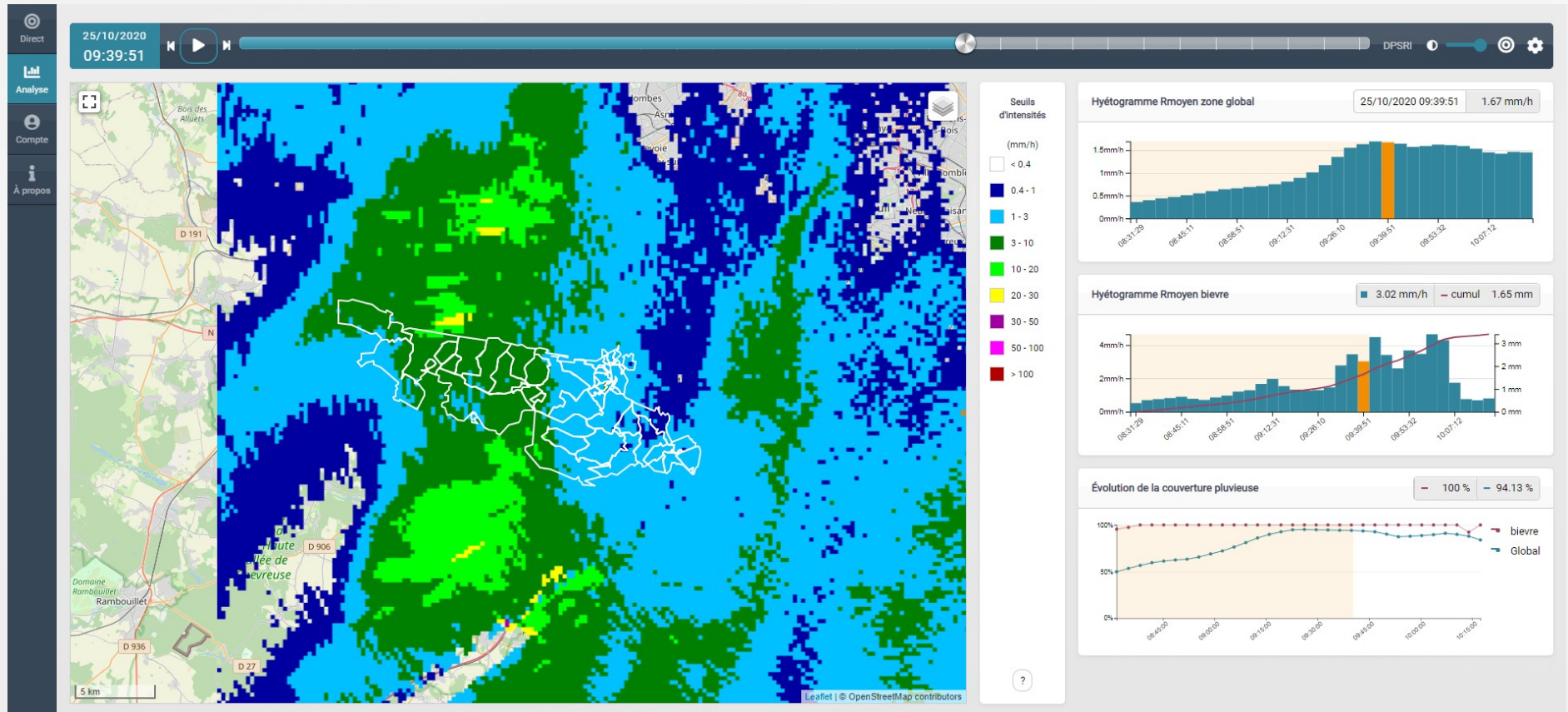


The application provides SRI (Surface Rainfall Intensity) and DPSRI (Dual Polarization Surface Rainfall Intensity) radar product with a spatial resolution of 250m (DPSRI) with a refresh time of 3min 20.

Rainfall image are generated and displayed on the map provided by the leaflet library. Hyetograms are dynamically generated and updated thanks to the D3 library.

For a better user experience, the application is fully responsive: it can be accessed from a desktop and mobile web browser.

RESULTS: HISTORICAL RAINFALL DATA



Analysis page: in the center the interactive map displaying the « Bievre » cathment in white. On the right, dynamically generated hyetograms displaying (from top to bottom) the rainfall average for the global area and catchment/subcatchment selected with cumulated rainfall, and finally the rainfall coverage evolution.

RESULTS: SPATIAL AND TIME ANALYSIS

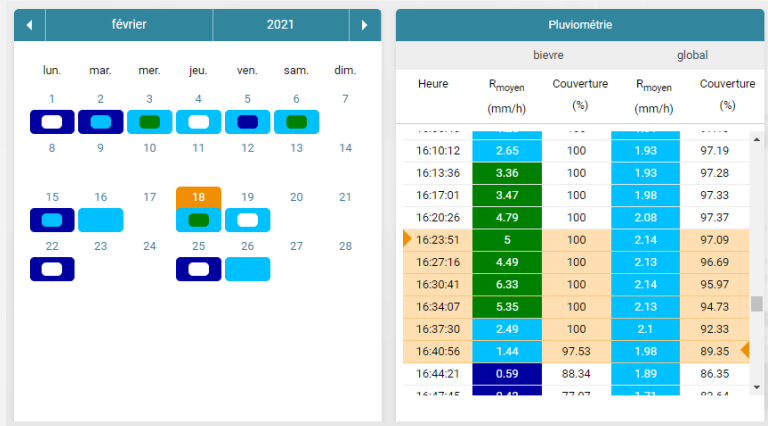


fig1

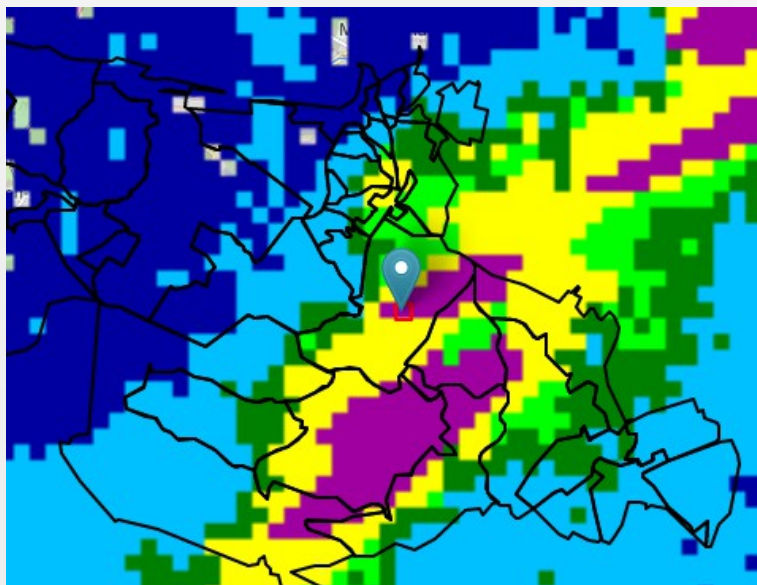


fig2

Analysis dates can be selected from a calendar displaying rainfall intensity on the global map and on the catchments and subcatchments defined by **user shapefiles**. (fig1)

By interacting with the map, users can inspect radar pixel data to study rainfall at a radar product **pixel spatial scale**. (fig2)
A hyetogram corresponding to the selected dates and location will be automatically generated in the UI. (fig3)

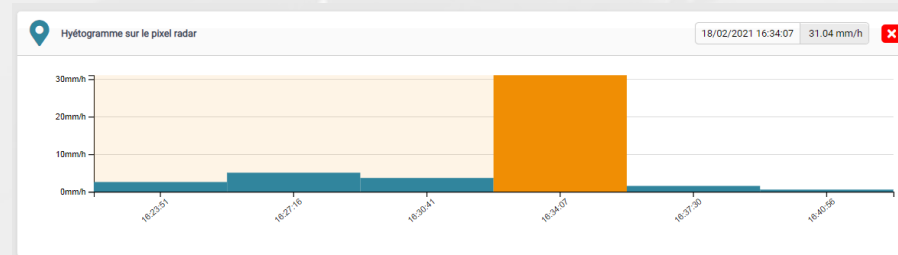


fig3

CONCLUSION AND PERSPECTIVE

Radx was developed using generated rainfall data from a polarimetric X-Band radar at Ecole des Ponts ParisTech, **open source** libraries, participative co-creation, and in **scientific collaboration** with the world leader industrial in water management.

General and professionals can have access to **real-time rainfall** radar data from their web browser.

Registered users can **analyse historical rainfall** event with precise spatial and time scales. The interface provides users the ability to easily save and replay rainfall events and export data.

Developments are still in progress, in constant request and feedback loops from the scientific and professional world. Future developments will focus on enhancing synergies between research and innovation.



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ACKNOWLEDGEMENTS AND REFERENCES

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Chodorow, K. MongoDB - The Definitive Guide 2e. O'Reilly (2013)

Ichiba, A., Tchiguirinskaia, I. & Schertzer, D. Plateforme RadX@HMCo, Manuel utilisateur v2.01. Rapport recherche contractuelle 2018 Chair Hydrology for Resilient Cities. 28p. Dec 2018.

Kleppmann, M. Designing Data-Intensive Applications. O'Reilly (2016)

Paz, I.; Willinger, B.; Gires, A.; Ichiba, A.; Monier, L.; Zobrist, C.; Tisserand, B.; Tchiguirinskaia, I. & Schertzer, D. Multifractal comparison of reflectivity and polarimetric rainfall data from C- and X-band radars and respective hydrological responses of a complex catchment model. Water (Switzerland), 2018, 10, 269. DOI: 10.3390/w10030269