Horizon 2020

Innovation Action

ICT programme

Project: 780118 FANFAR

Full project title:
Reinforced cooperation to provide operational flood forecasting and alerts in West Africa

Deliverable: D2.3
Report on technical verification results

FINAL VERSION

Due date of deliverable: 28/02/2019
Date accepted for publication/submission to EU: 11/03/2019
Actual submission date: 11/03/2019

Title	Report on technical verification results
Creator	Bernard Minoungou
Editor	Emilie Breviere, Jafet Andersson
Brief Description	The aim of this document is to test the forecasting and alert systems and provide feedback and suggestions of improvements to the consortium.
Publisher	FANFAR Consortium
Contributors	Abdou Ali, Hamatan Mohamed
Type (Deliverable/Milestone)	Deliverable
Format	Report
Creation date	13/02/2019
Version number	1
Version date	26/02/2019
Last modified by	Emilie Breviere
Rights	Copyright “FANFAR Consortium”. During the drafting process, access is generally limited to the FANFAR Partners.
Audience	☐internal x public ☐restricted, access granted to: EU Commission
Action requested	☐ to be revised by Partners involved in the preparation of the deliverable ☐for approval of the WP Manager ☐for approval of the Internal Reviewer (if required) ☐for approval of the Project Co-ordinator
Deadline for approval	28/02/2019

Version	Date	Modified by	Comments

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Executive summary

One of the objectives of the FANFAR project is to set up, adapt, integrate and operate the operational hydrological forecasting and alert (OHFA) system on the Hydrology-TEP (Hydrology Thematic Exploitation Platform) operational production cloud platform based on prioritized user needs. To ensure the reliability of the system, it is necessary to test all the features and to propose solutions for its improvement.
This deliverable reports testing results of the Hydrology-TEP platform and the FANFAR forecast visualization portal. Additionally, it provides feedback to the FANFAR consortium and includes suggestions for improvement.
The following sections compose the deliverable:

- A technical verification of the Hydrology-TEP;
- A technical verification of the FANFAR forecast visualization portal;
- Some suggestions for the improvement of the forecasting and early warning systems.

This deliverable reports the verification results of the current system. Similar verifications will be carried out at later stages as the system evolves.

1. Introduction

The FANFAR project aims are to produce forecasts and early warnings on floods, to provide useful information for the management of water resources and to support the design of hydraulic infrastructures. For this purpose, FANFAR is focused on providing an Operational Hydrological Forecasting and Alert (OHFA) system tailored for the West African region. Among the components of the system, there are the Hydrology-TEP platform and an interactive web portal to visualize the forecasts. This report provides an overview of the assessment of the functionalities of the forecast production system and the visualization portal of the outputs. It should be noted that all components are under development and updated regularly.

2. Technical verification of the Hydrology-TEP

The Hydrology-TEP is an initiative by the European Space Agency to facilitate the use of satellite earth observation (EO) data in hydrology and water resources management (https://hydrology-tep.eu/). EO satellites are capable of providing a diverse set of data relevant for freshwater applications, for example monitoring and mapping of floods, water bodies, water level, and water quality. FANFAR is using the Hydrology-TEP as a component of its operational production system.

2.1 Accessibility of the Hydrology-TEP

Like most scientific platforms, access to the Hydrology-TEP requires that the user is registered. To register, basic information and a password must be provided. The organization of the platform by thematic groups (Water Levels, Hydrological modelling, Water quality, etc.) and by communities (West Africa, River Niger, etc.) allows an easy access to the proposed services.

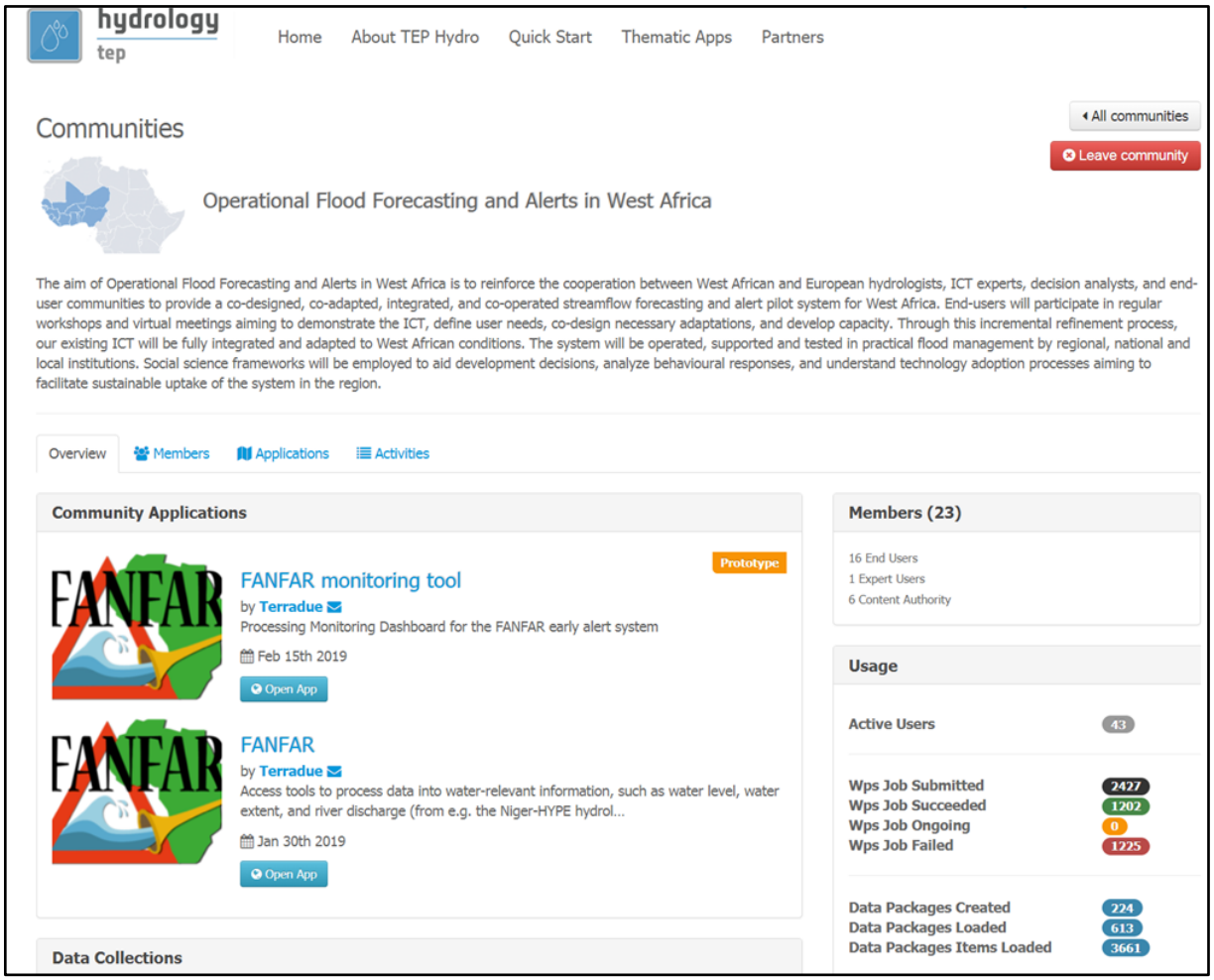

Figure 1 The FANFAR community page on the Hydrology-TEP platform (https://hydrology-tep.eu)

2.2 Verification of the platform functionalities

The platform has many functionalities. The verification presented below has been limited to the Hydrology-TEP Processing Services related to the use of the hydrological model HYPE. The tests include the execution of the different tasks (forecast, historical simulation, return period analysis) and visualization of the outputs.

2.2.1. Niger-HYPE historical simulation

This service is very important as it provides simulated historical data necessary to carry out a retrospective analysis on the past conditions of the water resources availability.

- Verification 1
  - Aim: The first verification was to test if the processing service produce expected results with default parameterization.
  - Method: In this test we simply navigated to the processing service, did not modify any parameters, clicked “Calculate Cost”, clicked “Run Job”. Then we waited until the job had finished and verified if the results were as expected. We verified with the documentation of processing service, that provides a list of the files that should be produced: http://hydrology-tep.github.io/documentation/apps/hm.html#results-from-the-niger-hype-historical-simulation-service

- Results: The service runs successfully (figure 2). The service produced also the expected files.

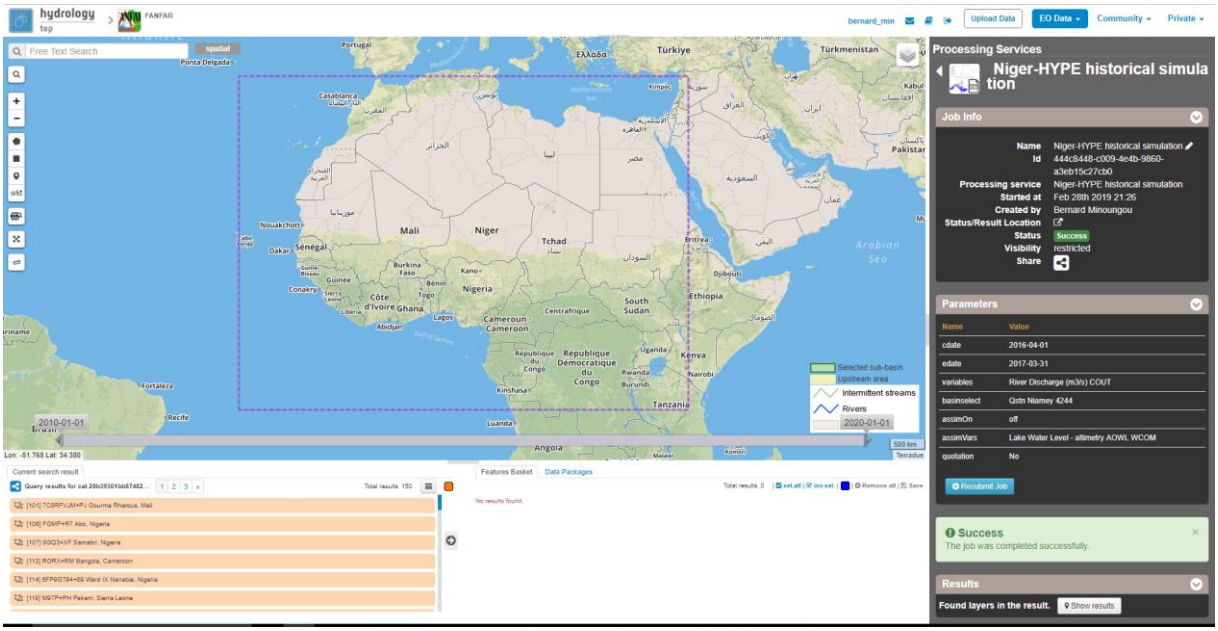

Figure 2 Screenshot indicating that the Niger-HYPE historical simulation service ran successfully

Below (figure 3) is the screenshot of the list of files produced by the service as defined in the documentation.

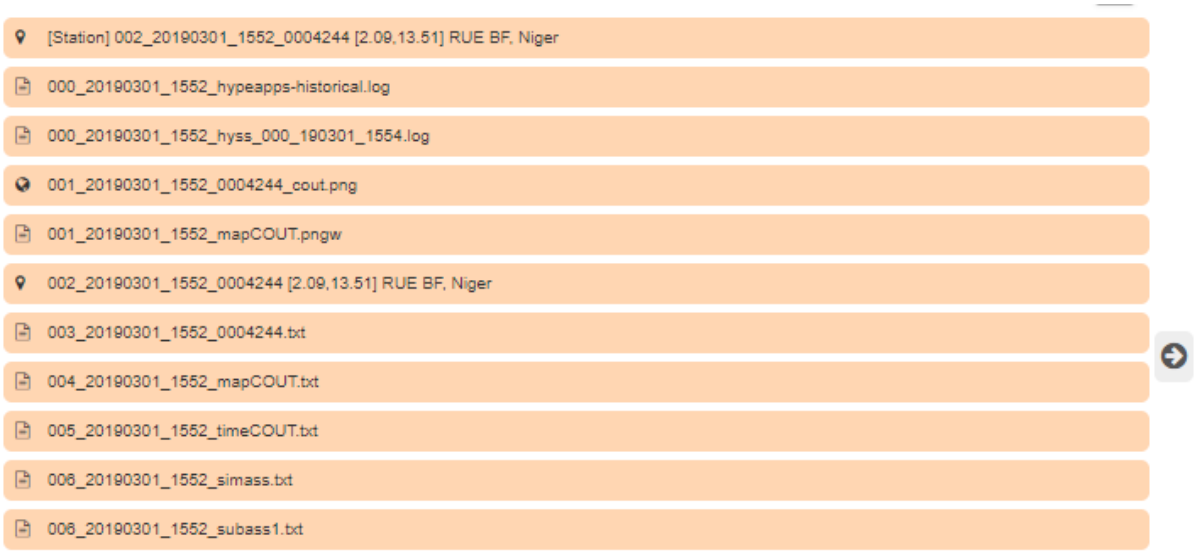

Figure 3Screenshot of the Niger-HYPE historical simulation produced files

We tested the "Time series Viewer" module that also works (figure 4).

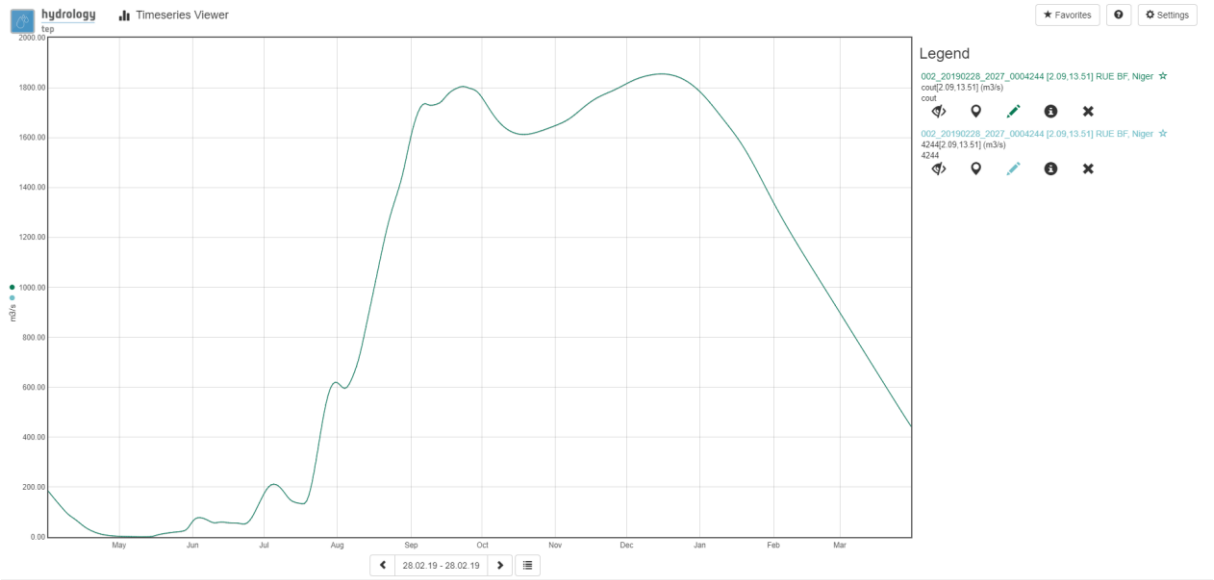

Figure 4 Time series plot from Time series Viewer module

- Verification 2
  - Aim: Test of simulation period limits.
  - Method: As verification 1, except we defined the simulation start as 1950-01-01 and simulation end as 2018-12-31.
  - Results: Failed. The following error message is obtained (figure 5).
  - Recommendation: There is no information that specifies the limit of the period (minimum and maximum dates) to be considered for the simulation, which may lead to crashes. Hence we recommend adding an indication that specifies the maximum limits of the simulation period.

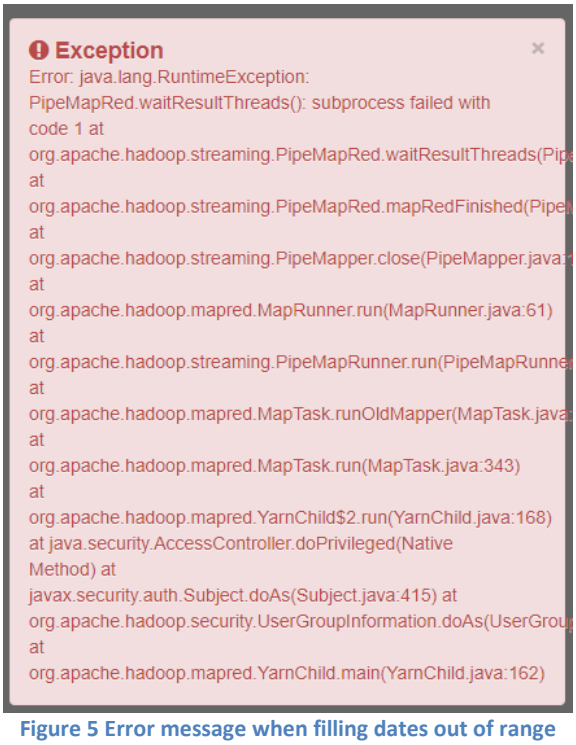

Figure 5 Error message when filling dates out of range

- Verification 3
  - Aim: assess clarity of the Processing Service interface and the parameter descriptions.
  - Method: Visual inspection of the processing service interface and parameter descriptions through the lens of a service user (rather than a service developer).
  - Results:
    - The clarity of the user interface needs to be improved. Today it is not sufficiently clear what the different parameters do and what impact they have. We suggest to provide a clearer link between the processing service and its documentation. This should both be (1) a link the Processing Service introduction to an the documentation overview (http://hydrology-tep.github.io/documentation/apps/hm.html#run-the-niger-hype-historical-simulation-processing-service), and (2) a button beside each parameter, with a direct link to a more lengthy description of each parameter (e.g. as an info button to the right of the parameter).
    - There are two boxes to enter output sub-basins. The first one is an option to select from existing gauging stations, while the second is an option to select any sub-basin. This is not intuitive. To distinguish existing stations and other sub-basins, we suggest modifying the tooltip text as in Figure 6.

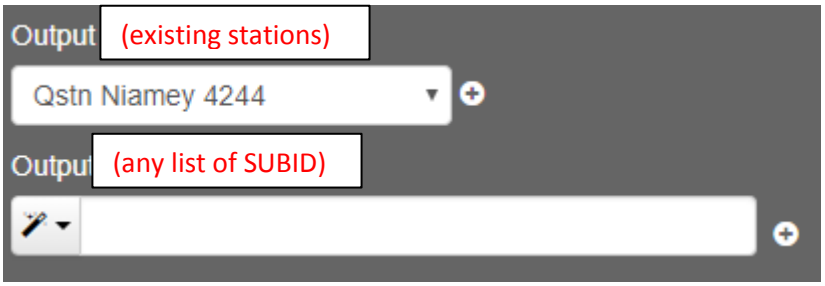

Figure 6 Suggested changes on field names

- Verification 4
  - Aim: Check clarity of format specifications
  - Method: Control if the description of the parameter, processing service or its documentation provides sufficient information to understand the formats required for input data.
  - Results
    - To assimilate “Lake Water Level” it is possible to use the field “Xobs file with EO and/or In-situ data”. The format is specified as “Xobs.txt” which is a HYPE-specific format. The format is described in the tooltip (Figure 7) and documented through a link to the HYPE wiki in the description of the Processing Service. This may or may not be sufficient. It can be improved as described in Verification 3.
    - No option is available to assimilate river discharge. In the future West African users may prioritize to include the possibility to compare simulated and observed river discharge. This would require an entry for a QObs.txt file and an associated tooltip to its format description.

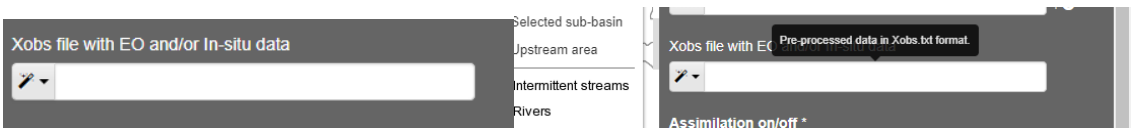

Figure 7 Current field tooltip for in situ data upload

2.2.2. Return period analysis

As the previous service, the return period analysis service meets our needs. This service allows users to estimate return period levels analysing timeoutput data from HYPE model simulations. The output of the service can be used to define warning levels in the Niger-HYPE forecast service.

Verification 1:

- Aim: The first verification was to test if the processing service produce expected results with default parameterization.
- Method: In this test we simply navigated to the processing service, did not modify any parameters, clicked “Calculate Cost”, clicked “Run Job”. Then we waited until the job had finished and verified if the results were as expected. We verified with the documentation of processing service, that provides a list of the files that should be produced: http://hydrology-tep.github.io/documentation/apps/hm.html#run-the-return-period-magnitude-analysis-processing-service
- Results: The service runs successfully (figure 8). The service produced also the expected files.

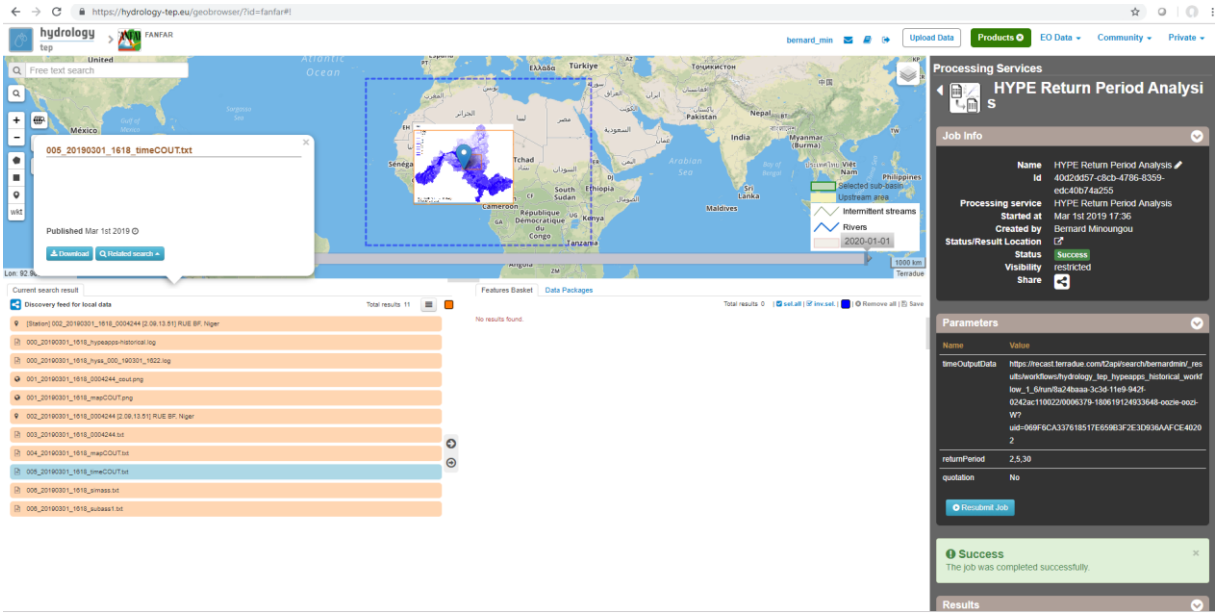

Figure 8 Screenshot indicating that the service ran successfully

Below (figure 9) is the screenshot of files produced by the service as defined in the documentation.

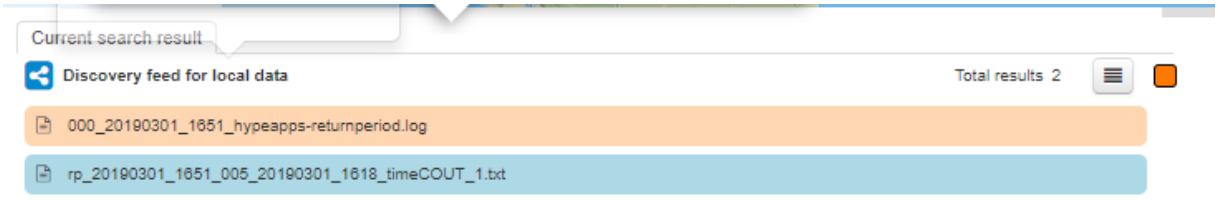

Figure 9 Screenshot of produced files

2.2.3. Niger-HYPE forecast

Verification 1

- Aim: Test if the Niger-HYPE processing service (hypeapps-forecast) produce expected results with default parameterisation, when using it interactively as a forecasting-on-demand service.
- Method: In this test we simply navigated to the processing service, did not modify any parameters, clicked “Calculate Cost”, clicked “Run Job”. Then we waited until the job had finished and verified if the results were as expected. We verified with the documentation of processing service, that provides a list of the files that should be produced: http://hydrology-tep.github.io/documentation/apps/hm.html#results-from-the-niger-hype-forecast-processing-service
- Results: The service runs successfully (figure 10). The service produced also the expected files.

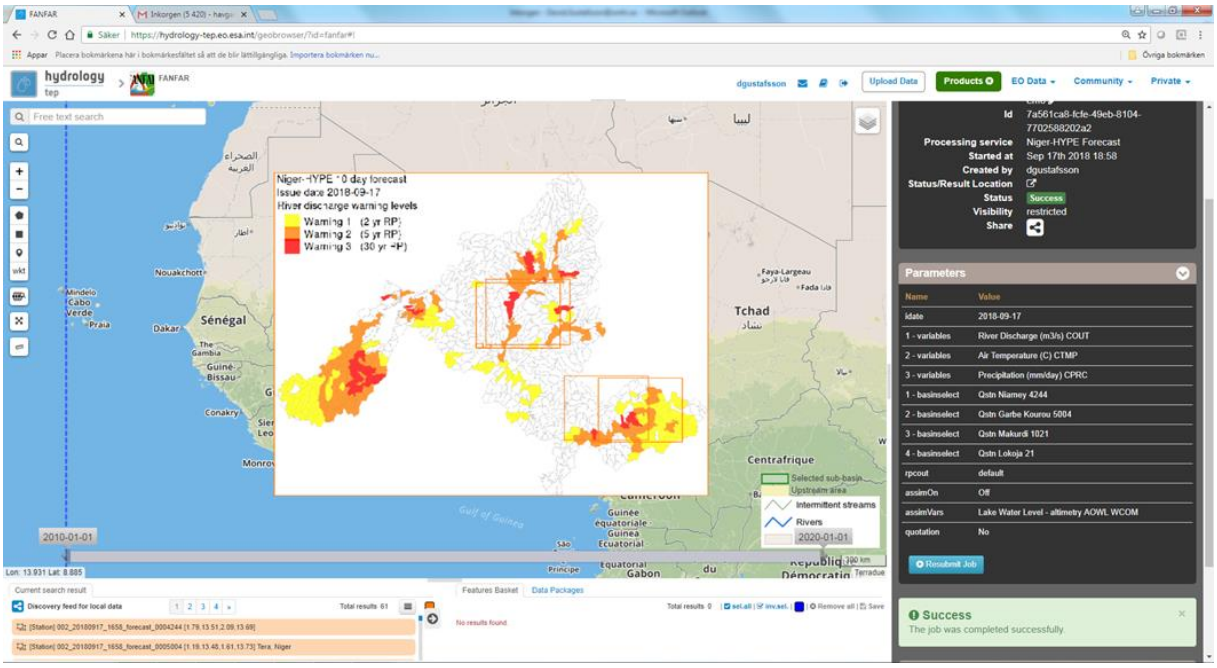

Figure 10 Screenshot indicating that the service ran successfully

This service allows producing a hydrological hindcast and forecast graph (figure 11) and a series of files (figure 12).

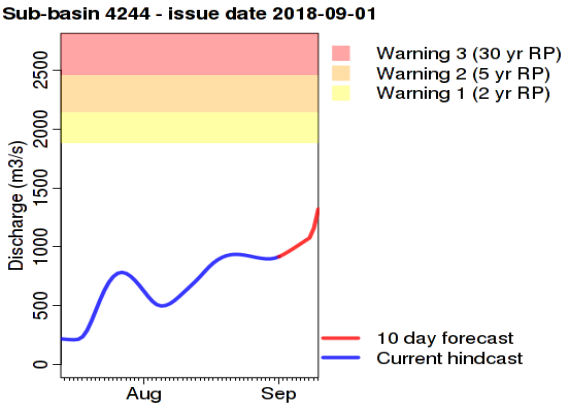

Figure 11 Graph obtained from the forecast service

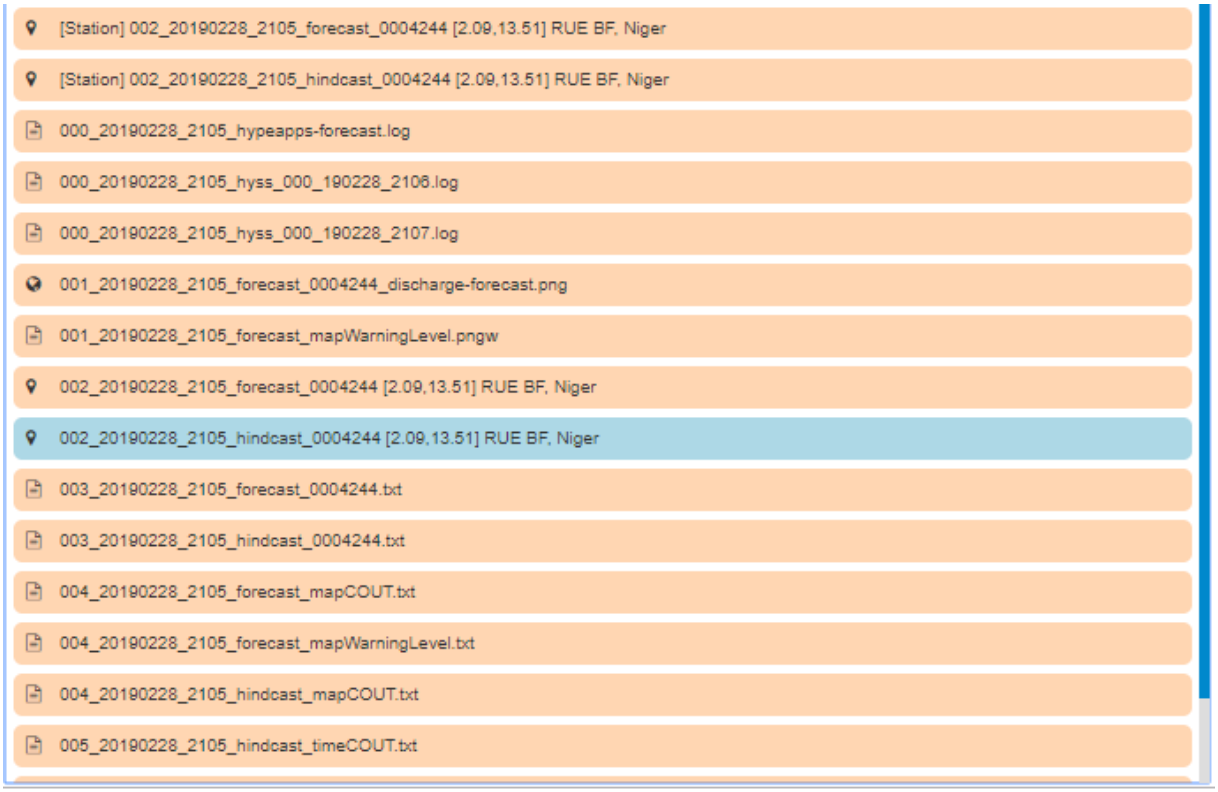

Figure 12 Screenshot of produced files

Verification 2

- Aim: Test if the automated execution of the processing service produce expected results for a number of forecasting issue dates.
- Method: We navigated to the FANFAR monitoring app providing the results of the automatic execution of the processing service (https://hydrology-tep.eu/geobrowser/?id=fanfar-monitoring). We clicked on the button: "Automatic Production" → "Forecasts" → "niger-hype+GFD1.3+ECOPER" to show the results of the automated execution of the Niger-HYPE forecasting service (hypeapps-forecast). We first checked the geobrowser (to see if it displayed a map of the current forecast). We then checked the "Current Search results" for issue dates 2019-03-01, 2019-02-27, 2019-02-26 (figure 13). We viewed the resulting output files for each date, and compared it with the output files obtained when running the service interactively/forecast-on-demand (Verification 1)(figure 14).
- Results:
    - We have tested this service and it works. However, this service produces hindcasts instead of forecasts. For example, as of March 1, 2019, the service only provided flow simulations from February 19, 2019 to March 1, 2019.
    - Issue date in the "Current search results" does not match with the one in the visualized map. The reason is likely a mismatch in the scheduling of the retrieval of input data to the forecasting service and the execution of the forecasting service. This should be addressed and implemented more robustly in future version of the system.

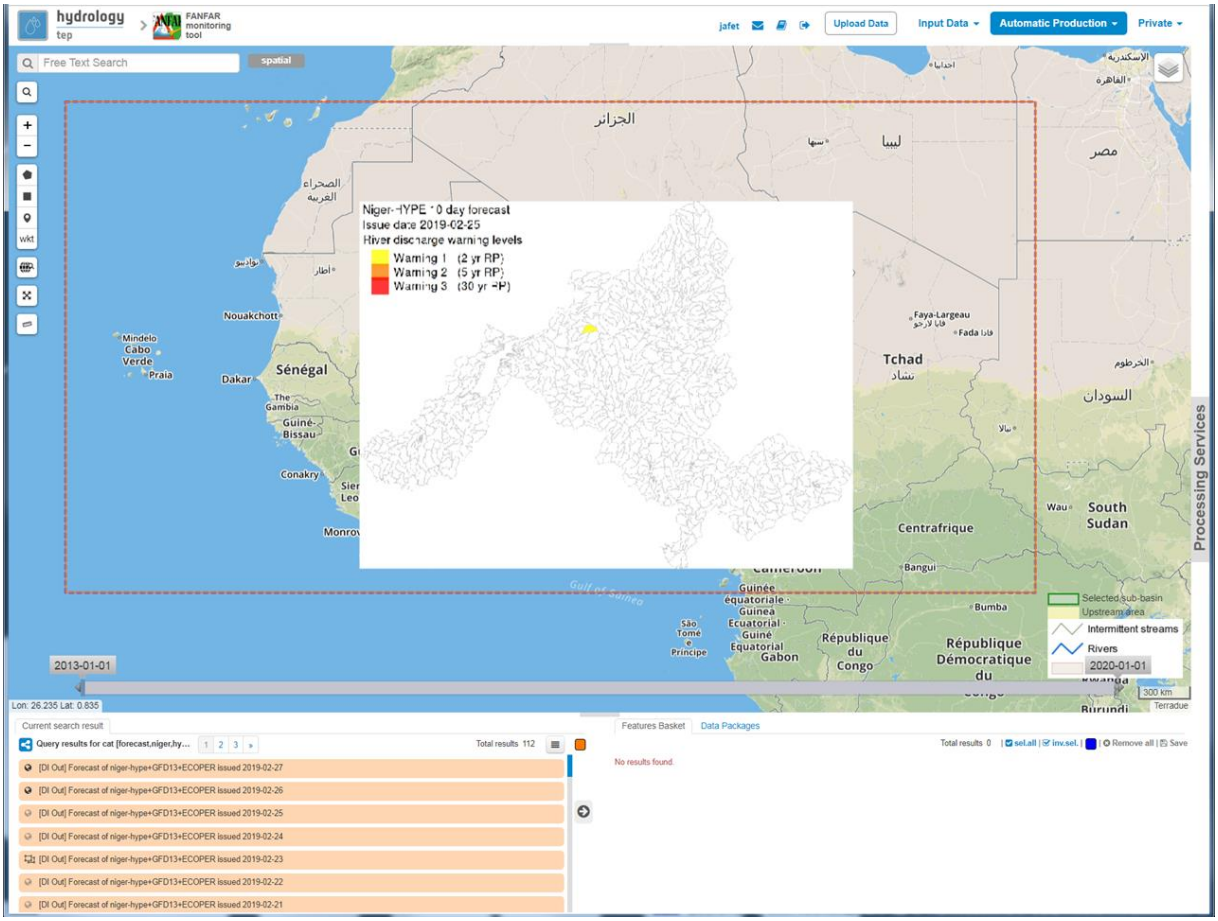

Figure 13 Screenshot of the FANFAR monitoring tool and the automated execution of the Niger-HYPE forecasting service (hypeapps-forecast) with default parameters.

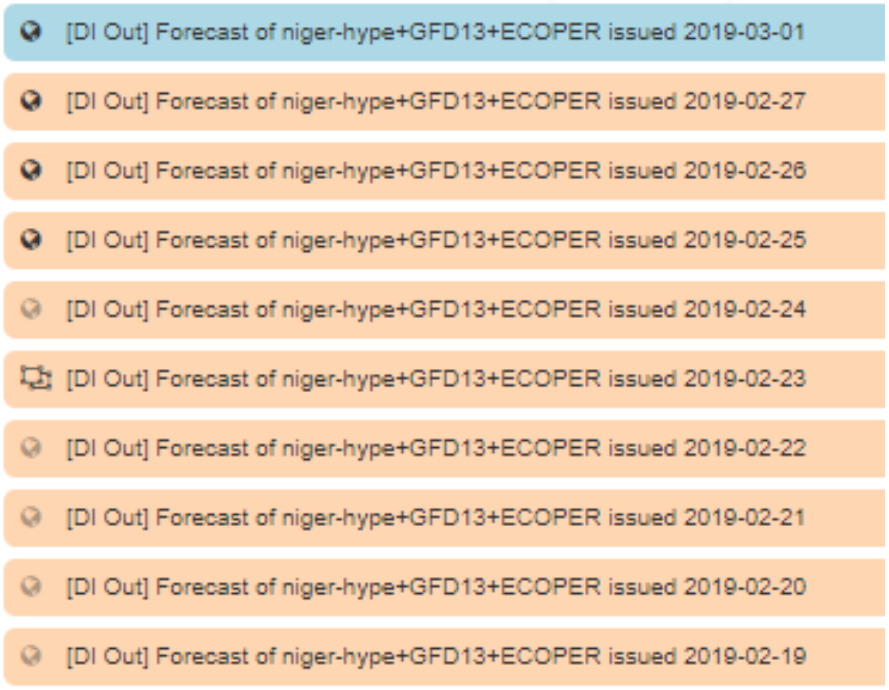

Figure 14 Screenshot of automated execution of the forecast processing service produced files

Verification 3

- Aim: Clarity of the interactive forecast-on-demand processing interface.
- Method: In this test we simply navigated to the processing service and check if the forecasting issue date defined by default by the platform corresponds to the date on which this service is executed.
- Results:
    - The default forecast issue date in the system is “2018-09-01” even if later dates can be forecasted (Figure 15). We suggest instead having as default the last date that a forecast can be made for.

Figure 15 Default forecast issue date

2.3 Technical verification of the support system

The documentation available at http://hydrology-tep.github.io/documentation/ to guide users willing to use the Hydrology-TEP is fairly comprehensive. The documentation includes the following main sections:

- Overview of the platform;
- Quick Start Manual;
- Community Portal User Guide;
- Community Portal Administrator Guide;
- Community Advanced User Guide;
- Thematic Applications including the Hydrological modeling services, which is assessed more specifically in this deliverable (http://hydrology-tep.github.io/documentation/apps/hm.html#hydrological-modelling).

Table 1 below summarizes the services tested.

Table 1 List of the tested features of the Hydrology-TEP

Features	Tested items	Results
The Hydrology-TEP accessibility	Is the platform easily accessible? Are the services of the platform well organized?	Yes. The information needed for accessibility is readily available Yes. The services are organized by communities and thematic groups.
Niger-HYPE historical	Is the processing service	Yes, the service runs

simulation	produce expected results with default parameterisation?	successfully and produced the expected files.
	Does this service show the simulation period limits?	There is no information that specifies the limit of the period (minimum and maximum dates) to be considered for the simulation, which may lead to crashes.
	Does the service describe the parameters of the interface?	The clarity of the user interface needs to be improved. Today it is not sufficiently clear what the different parameters do and what impact they have. We suggest to provide a clearer link between the processing service and its documentation
	Are input file formats (if required) specified?	The description of the input files is not sufficient. We propose to improve it
Return period analysis	Is the processing service produce expected results with default parameterisation?	Yes, the service runs successfully and produced the expected files.
Niger-HYPE forecast	Is the processing service produce expected results with default parameterization, when using it interactively as a forecasting-on-demand service?	Yes, the service runs successfully and produced the expected files.
	Does the automated execution of the processing service produce expected results for a number of forecasting issue dates?	This service runs but produces hindcasts instead of forecasts. It needs to be improved
	Is the interactive forecast-on-demand processing interface clear?	Yes, the interface is clear. But the default forecast issue date in the system is “2018-09-01” even if later dates can be forecasted. We suggest instead having as default the last date that a forecast can be made

		for.
Team Viewer module	Does the module allow you to plot graphs from time series from the platform?	Yes. This module allows to plot graphs
Platform output	Are the output files of the platform exportable?	The files generated by the platform are easily exportable in different formats (text, csv, etc.)

3. Technical verification of the forecast visualization portal

3.1 Accessibility of the portal

The interactive visualization portal is accessible from the FANFAR website menu bar and does not require an authorization or registration. The direct weblink is http://fanfar.eu/ivp/.

3.2 Verification of the visualization portal

Verification 1

- Aim: The portal accessibility
- Method: test the access by navigating to the portal through the menu system and test the direct link.
- Results: The visualization menu works (Figure 16). The direct link works fine.

Verification 2

- Aim: Test if the forecast visualization map produces expected results
- Method: We simply accessed the visualization portal site, then we clicked on the "Forecast visualization" menu and checked the different parts of the forecast visualization map.
- Results:
    - The forecast issue date is up to date. However, we notice that the process runs relatively late in the day.
    - The default time step is “maximum of 10-day forecast”. For example, on February 28, 2019, the situation is normal in most of the subbasins (figure 16).
    - The risk map is shown and the colors correspond to the legend. For example, on March 07, 2019, there are some sub-basins that have risk levels 1 or 2 (figure 17).
    - The time step can be changed to each forecasted date (figure 18 and figure 19)
    - The map can be clicked on to obtain a hydrograph/time series graph (figure 20).
    - It is not yet possible to assess if automatically visualized risk level map corresponds to the equivalent map generated by the forecast-on-demand service on Hydrology-TEP.

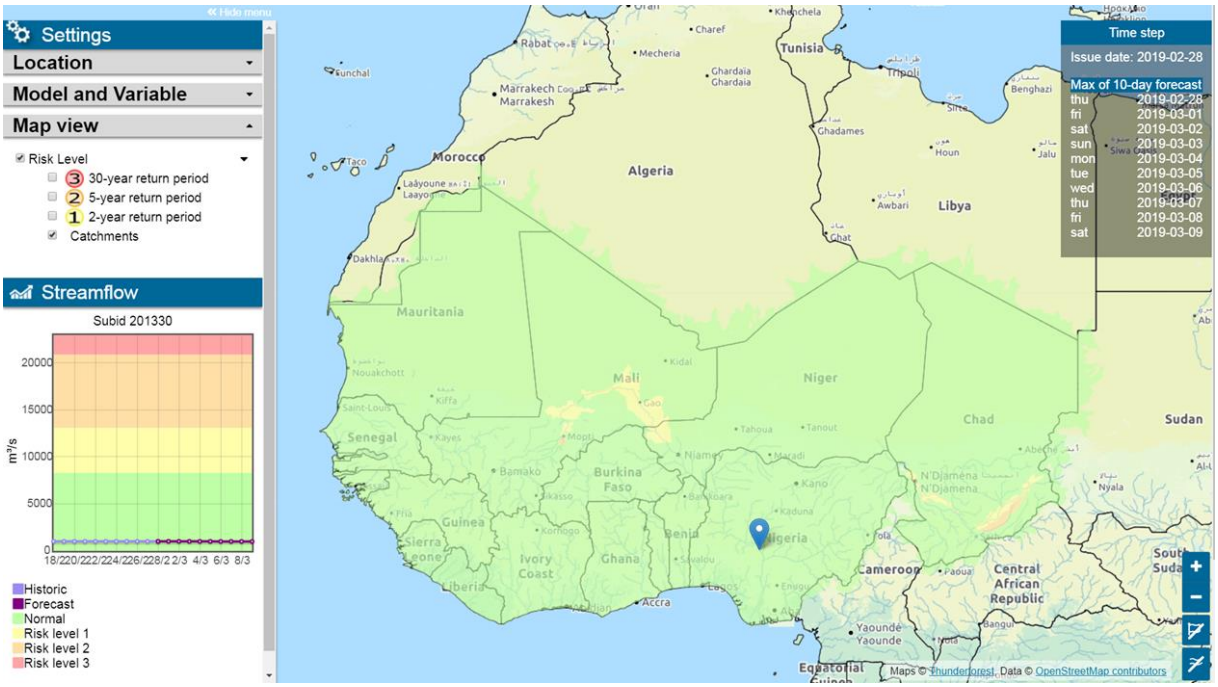

Figure 16 Forecast visualization

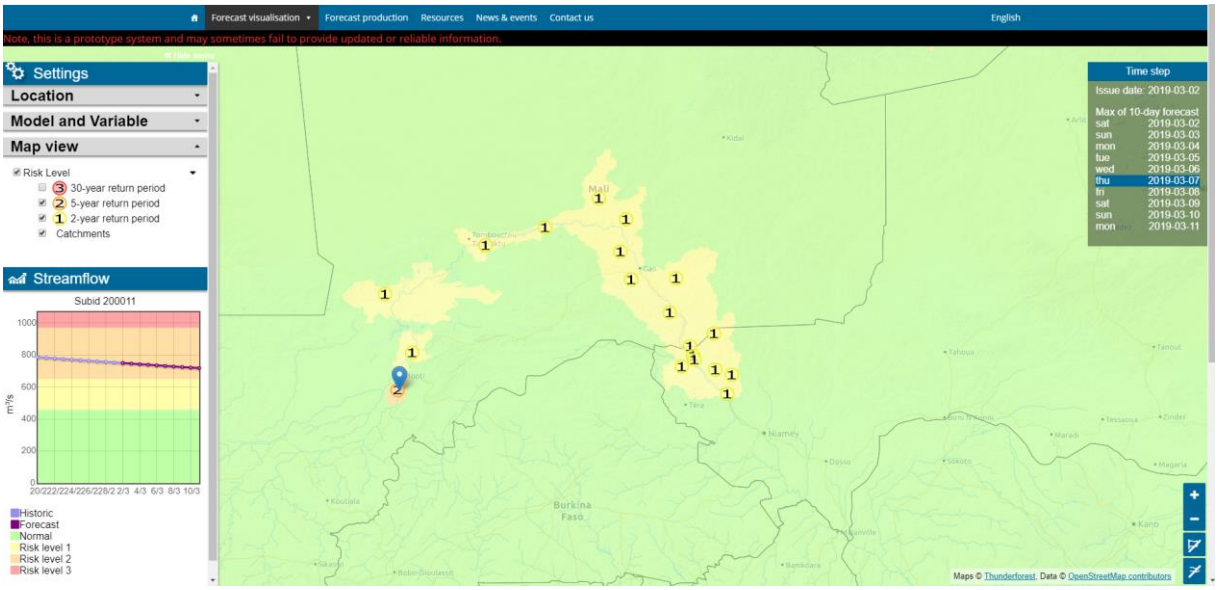

Figure 17 Risk map with corresponding colors

Figure 18 Risk map with corresponding colors on March, 02, 2019

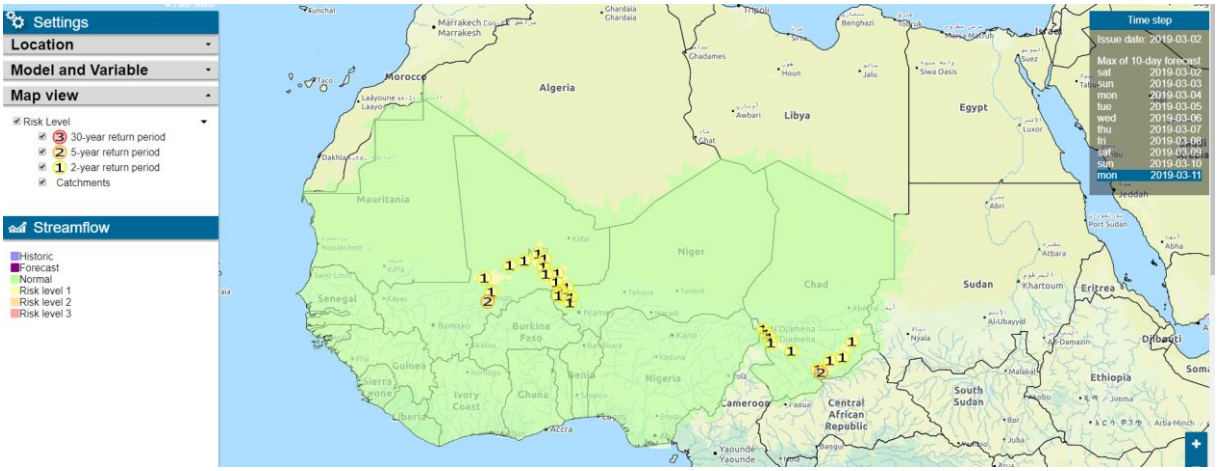

Figure 19 Risk map with corresponding colors on March, 11, 2019

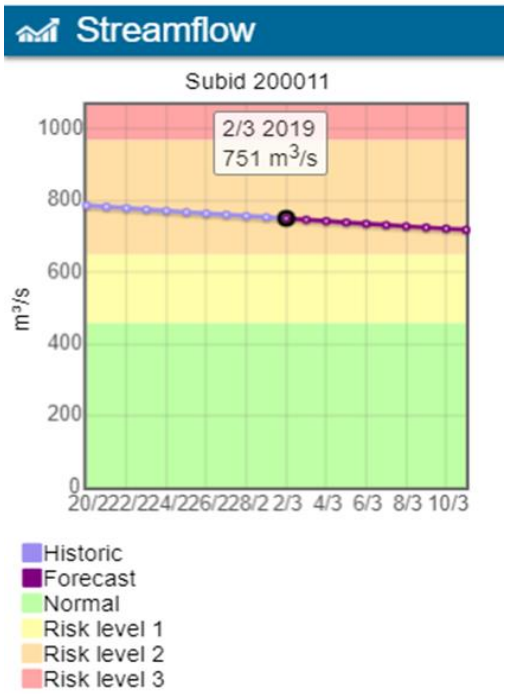

Figure 20 Hydrograph showing hindcast and forecast streamflow, hovering to see exact values and risk levels

Verification 3

- Aim: Test whether navigation through the visualization map is easy
- Method: We simply accessed the visualization portal site, then we clicked on the "Forecast visualization" menu and checked if the zoom, the superposition of the geographical layers, the map movement are possible.
- Results:
    - The zoom in and out works.
    - It's possible to add or hide countries and rivers layers in the map.
    - It is possible to move the map using the appropriate menu.

Verification 4

- Aim: Check if location options produce expected results
- Method: We simply accessed the visualization portal site, then we clicked on the "Forecast visualization" menu and checked if all the location options works.
- Results:
    - It's possible to select a location by various means (click on the map or fill in a city name or lat and long or a sub basin)
    - It's possible to select the option 'move view to position'. When the option is ticked the map is repositioning itself to have the location of interest centered on the screen.

Verification 5

- Aim: Check if the risk map can be presented according to the level of risk or if the situation for all sub-basins can be presented.
- Method: We simply accessed the visualization portal site, then we clicked on the "Forecast visualization" menu and according to the level of risk for which we want to present on the map, we clicked on 1 (2 year return period), 2 (5 year return period), 3 (30 year return period). If we want the situation for all sub-basins, we clicked on "catchments".
- Results:
    - It's possible to visualize the risk level as points (one click for each risk level);
    - It's possible to show the situation of all-sub basins in a same map.

Verification 6

- Aim: Check if it's possible to visualize hydrograph.
- Method: We simply accessed the visualization portal site, then we clicked on the "Forecast visualization" menu and selected, in several ways, the sub-basin for which you want to see the hydrograph.
- Results:
    - The hydrograph could be visualized.
    - The graph has proper identifications (subbasin ID, units for X and Y axis).
    - The colors correspond to the legend.
    - Both hindcast and forecast data is shown.
    - It's possible to hover to see exact values.

- Risk Levels are visualized as well as streamflow (figure 21)

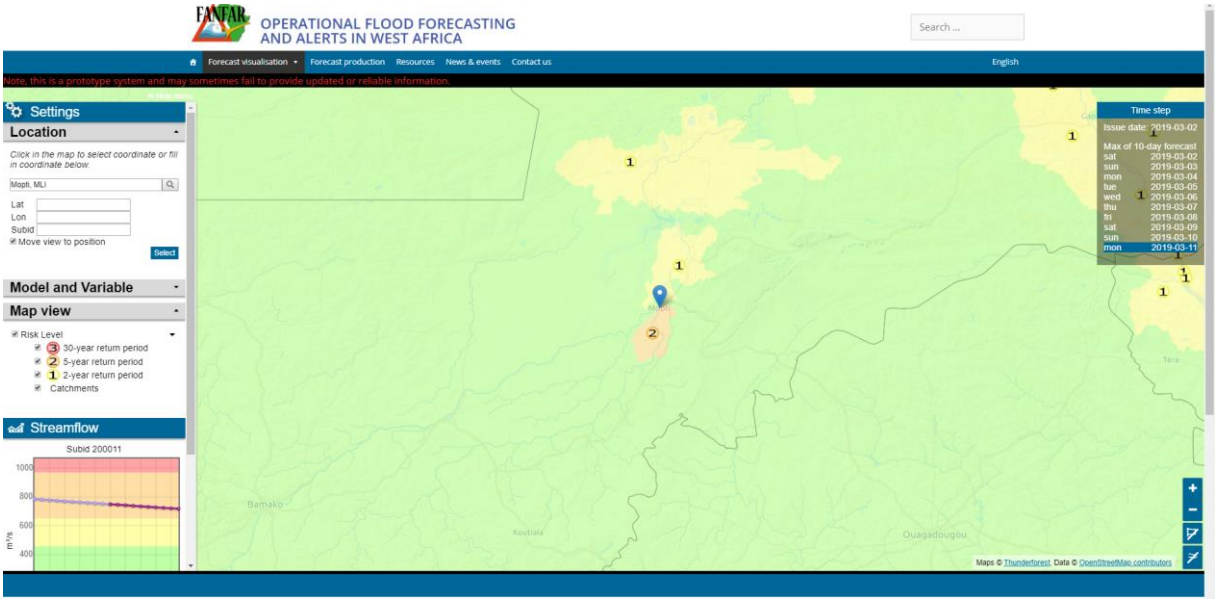

Figure 21 Getting the level of risk by filling in the name of a city (Example of the city of Mopti)

3.3 Summary of the tested features of the visualization portal

Below table 2 contains the list of all features which have been tested.

Table 2 List of the tested features of the visualization portal

Features	Description	Test result
Map window	Does the forecast visualization map produce expected results?	Yes, forecast visualization map produce expected results
Map window > navigation	Zoom in & out	Yes, this feature works
Map window > show/hide layers	Is it possible to show / hide layers of rivers or country boundaries?	Yes, this feature works
Settings box > Location	Do the different location options available work?	Yes, this feature works
Settings box > Map view	- Visualization of the risk level as catchments (default) - Visualization of the risk level as points (one click for each risk level)	These features work
Settings box > Hydrograph	Is it possible to visualize the hydrograph?	This feature works

4. Conclusion

In this report, a set of technical verifications were carried out on the current version of the FANFAR system in order to test if they work as intended. The conclusion is that Hydrology-TEP and the forecast visualization portal are both easily accessible, and that the functions work generally work as intended. The functions can generally be understood by the use of the documentation. For the improvement of the system, it is important to take into account the suggestions made in this report. In particular, the description of the Processing Services is quite brief and not always clear. We suggest to (a) expand the descriptions in the Hydrology-TEP documentation and the FANFAR knowledge base, (b) add more descriptive functionalities in the Processing Services interface, and (c) carry out more training sessions to convey the system components to its users.