WP5
Integration and testing of DSS for coastal flood and extreme weather early warning

Activity 5.2
Integration of coastal forecasting modules into early-warning

D5.2.1 Integration of coastal forecasting modules into early-warning

PROJECT AND ACTIVITY DETAILS

Project Acronym	AdriaMORE
Project title	Adriatic DSS exploitation for MOnitoring and Risk management of coastal Extreme weather and flooding
Funding Line	Priority Axis 2, Specific Objective 2.2
Project Partners	LP Abruzzo Region (Italy) P1 Dubrovnik and Neretva Region (Croatia) P2 Meteorological and hydrological service (Croatia) P3 National Research Council (Italy)
Starting date	January 1, 2018
Activity number	5.2
Activity Title	Integration of coastal forecasting modules into early-warning
Work Package	WP5: Integration and testing of DSS for coastal flood and extreme weather early warning
Activity Summary	Activity 5.2, within Work Package 5, is devoted to the integration into myDEWETRA platform of data flow coming from the optimized CHyM hydrological model and Wave Forecast model. It was realize the personalized updating of the myDEWETRA Adriatic-Ionian system, with the new data mentioned with their visualization, integration, publication of sensors data and models generated by AdriaMORE project.
Deliverable number	5.2.1
Deliverable Summary	This deliverable is aimed at describing the myDEWETRA platform as improved by integration of the new dataset provided by the project for the integration of coastal forecasting modules into early-warning system. The main data integrate are hydro-meteorological information such as Hydrological model CHyM and Wave forecast model maps.
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1. INTRODUCTION

This is the second report produced by CIMA Foundation under the AdriaMORE project. The report consist on the implementation of activities specified on the Worked package 5 "Integration of coastal forecasting modules into early-warning DSS", on behalf of the project.

Particularly, this report describes the integration of models forecast data developed under WP4.
In this framework it was completed the personalized updating of the myDEWETRA Adriatic-Ionian system with the new data associated to the costal forecasting modules generated by different partners, for their visualization, integration, transmission and distribution.

In the report activity 5.1 is explain in details the myDEWETRA Adriaic – Ionian platform and all the development chain, form different previous project financed by the EU under the IPA Adriatic Programme.
The myDEWETRA Adriatic-Ionian platform as an web platform is accessible in the link below:
http://adriatic-ionian.mydewetra.org/,
with specific user and password for all the contribution partners.

Figure 1. myDEWETRA Adriatic-Ionian interface.

2. SOFTWARE DESCRIPTION

The report activity 5.1 “Integration of coastal remote sensing data into early-warning DSS” of the same work package describes in details the main components of the myDEWETRA Platform, including the system architecture, design, server parameters, Dewetra Data Server Workflow, Business model, final maps, integration and visualization of data.

Thus in this report we just recall that myDEWETRA system is web platform for environmental monitoring; this means that it is a real-time integrated system of risk forecasting, monitoring and prevention at regional level. The system is technically and operationally certified.
The platform was developed during the two main IPA projects, AdriaRadNet and CapRadNet as a regional system for forecasting and observation of natural risks and also for building real-time risk scenarios in the Adriatic and Ionian sea for civil protection purpose. In the figure in the following are explain the IT architecture.

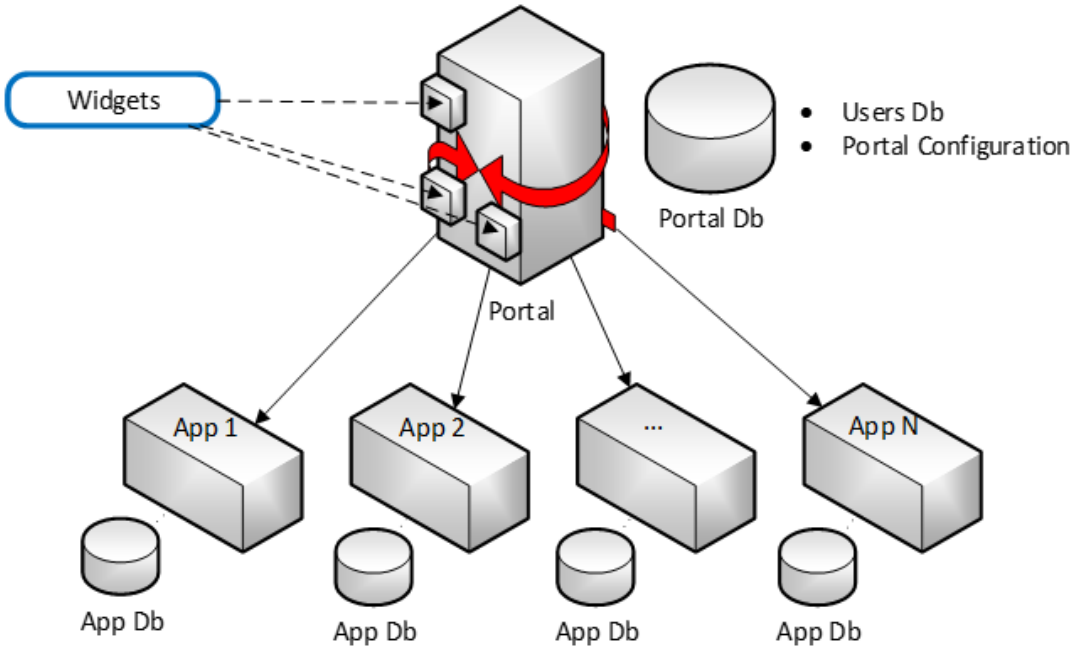

Figure 2. IT architecture of MyDewetra Adriatic-Ionian.

3. NEW DATASETS IMPLEMENTED THROUGH ADRIAMORE PROJECT

AdriaMORE project goal is to improve an existing integrated hydro-meteorological risk management platform focusing on the Adriatic coastal areas of Italy and Croatia capitalizing the major achievements of ADRIARadNet and CapRadNet projects. The latter, successfully completed under the IPA Adriatic CBC Programme, were devoted to create a cross-border infrastructure of observing and forecasting systems for building real-time risk scenarios for helping civil protection authority in their mission.
Particularly, this report describes the integration of the forecast data developed under WP4.

The new dataset integrated into the myDEWETRA Adriatic-Ionian platform (http://adriatic-ionian.mydewetra.org) comes from the AdriaMORE project in the framework of the work packages 4, and intend the elaboration, visualization, transmission, and distribution of all the data from sensors and generated models of the project.
This report describes the integration of the generated models developed under WP4 actions 4.1, 4.2 and 4.3, the new dataset is composed by:

- **Hydrological forecast by CHyM model (act. 4.2 - indicatively 2 map each day)**
- **WAVE model forecast products (act. 4.3 - indicatively 96 maps each day)**

For each of the two new data the description of the integration in myDEWETRA from technical point of view as well as some example images will be provided in the chapter 4.

4. DATA INTEGRATION IN MYDEWETRA PLATFORM

4.1 Hydrological forecasting system (CHyM) in operative mode

The operational hydrological forecast is organized according to the operational flow scheme proposed in figure 3.

As a result of the many calibration tests carried out during the previous project activities, the CHyM return flow (see D4.2.1 for further description) and other parameters, operational settings are slightly different between the Pescara and Neretva basins.

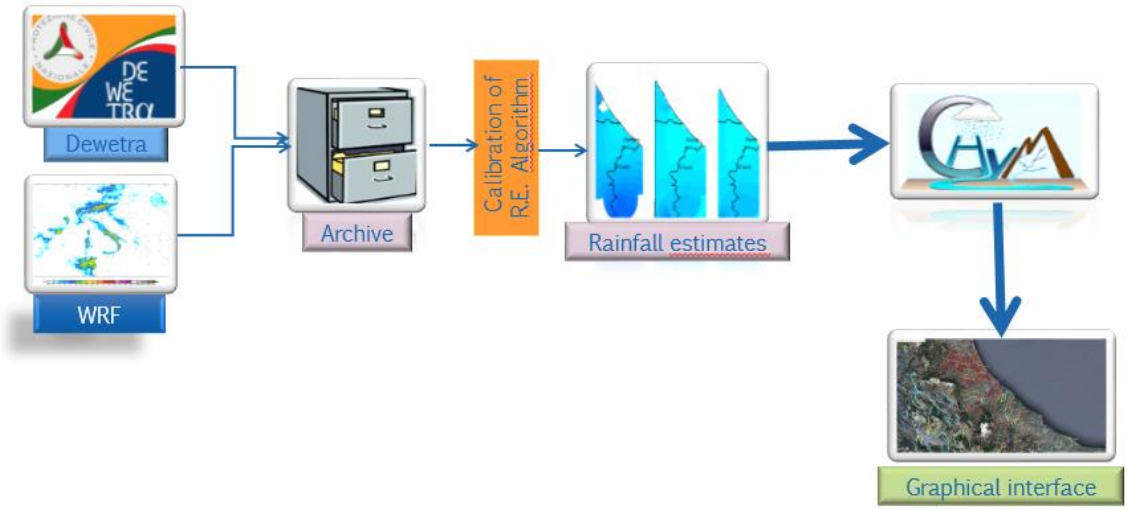

Figure 3. AdriaMORE forecasting scheme

4.1.1 Pescara basin operational forecast

The operational spatial domain includes the whole Aterno-Pescara catchment, rebuilt with a horizontal resolution of 270 m (see D4.2.1 for technical details about drainage network rebuilding techniques). The operational forecast is organized in four phases, each phase being called in a *c-shell* script:

1) Pre-processing of observed meteorological variables;
2) Pre-processing of forecasted meteorological variables;
3) Hydrological operational simulation;
4) Graphical representation of hydrological output.

The meteorological variables used as inputs for the spin-up time (5 days) are:

- Accumulated hourly precipitation by rain-gauges network;
- Hourly air temperature at 2 m from thermometer network;
- Hourly sea level at Pescara harbour station.

The meteorological variables used as inputs for the forecast time (3 days) are:

- Accumulated hourly precipitation simulated WRFAdria model;
- Hourly air temperature at 2 m simulated by WRFAdria model.

The hydrological forecast runs daily on a CETEMPS server with computing characteristics listed in table 1. The simulation generally start at 8 a.m. or, at least, when the meteorological forecast is ready. The model initializes the simulation with a spin-up time of 5 days before 0 UTC of the simulation day, where the observed meteorological variables are assimilated. For the following 72 hours, i.e. the forecast time, the meteorological input from WRF model is given. The timing operational setup is reported in figure 4.

Architecture	X86_64
Processor	23, Genuine Intel
CPU Model name	Intel® Xeon® CPU X5650 2.67GHz
CPU cores	6
RAM maximum capacity	288 GB

Table 1. Computing power of the AdriaMORE dedicated server for hydrological operational activities

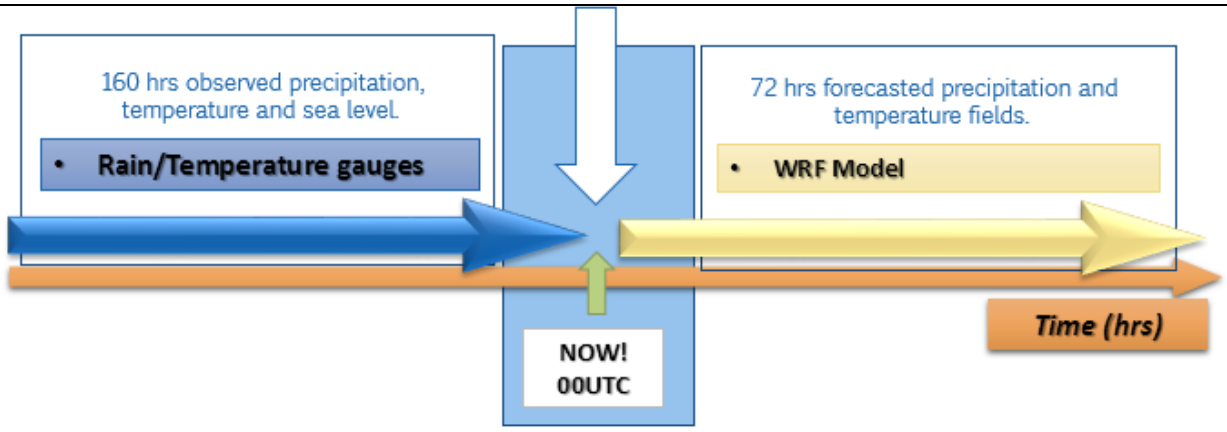

Figure 4. A representation of the Pescara hydrological operational flow

4.1.2 Neretva basin operational forecast

The operational spatial domain includes the whole Neretva catchment, rebuilt with an horizontal resolution of 330 m (see D4.2.1 for technical details about drainage network rebuilding techniques). The operational forecast is organized in three phases:

1) Pre-processing of forecasted meteorological variables;
2) Hydrological operational simulation;
3) Graphical representation of hydrological output.

The meteorological variables used as input are:

- Accumulated hourly precipitation by the WRFAdria model;
- Hourly air temperature at 2 m from WRFAdria model;
- Hourly sea level (when available).

Since the sea level data transfer between the DHMZ and CETEMPS is not an automatic procedure, the simulation with the *waveheight* module is pre-operational and can be carried out at any time, under request, in case of severe event.

4.2 Integration of CHyM hydrological model in the myDEWETRA platform

The data files coming from AdriaMORE **CHyM** hydrological model (CETEMPS Hydrological Model) are loaded daily into the "***scratch" (/ home / adriauser / scratch)*** exchange directory of the *adriaserver.aquila.infn.it server*. It is a series of files in NetCDF format related to the daily "runs" of the model for the different variables and different geographical areas.
Currently the following files are loaded:

- ABbdd_CHyM_ [date] .chym.nc
- ABcai_CHyM_ [date] .chym.nc
- ALbdd_CHyM_ [date] .chym.nc
- ALcai_CHyM_ [date] .chym.nc
- CRbdd_CHyM_ [date] .chym.nc
- CRcai_CHyM_ [date] .chym.nc
- ITbdd_CHyM_ [date] .chym.nc
- ITcai_CHyM_ [date] .chym.nc

Where the date is expressed in the format *yyyyMMddhhmmss*

4.2.1 Import of CHyM hydrological data

The procedure for acquiring the system and organizing the data of the AdriaMORE_CHyM model in the ***Dewetra Data Server (DDS)*** archive takes place by means of a bash script which is launched in a scheduled manner through *the "crontab"* of the *adriaserver.aquila.infn* server. en:

```
0 * * * * /home/adriauser/cima/acquisitions/chym/acquire.sh >>
/home/adriauser/cima/acquisitions/ADRIAMORE_chym/log.txt 2>&1
```

The code for the script acquisition is:

```
#!/bin/bash
echo
echo "----------------$(date)"
```

```
cd `dirname $0`

LOCK_DIR=$(pwd)
LOCK_FILE="${LOCK_DIR}/acquisition_chym.lock"
if [ -e ${LOCK_FILE} ]; then
        echo "file di lock esistente: ${LOCK_FILE} ...Abort!"
        exit
fi

touch ${LOCK_FILE};
FILES=`find /home/adriauser/scratch -name "*_CHyM_[0-9][0-9][0-9][0-9][0-9][0-9][0-9][0-9][0-9][0-9][0-9][0-9].chym.nc"`

DSTBASEDIR="/home/adriauser/idro/chym"

for IN_FILE in ${FILES}; do

        FILENAME=`basename ${IN_FILE}`

        echo -n "found ${FILENAME}... "

        declare -i FNLEN=${#FILENAME}

        #echo $FNLEN

        declare -i YFROM=$FNLEN-20
        declare -i MFROM=$YFROM+4
        declare -i DFROM=$MFROM+2
        declare -i RFROM=$DFROM+2

        #echo $YFROM $MFROM $DFROM $RFROM

        YEAR=${FILENAME:${YFROM}:4}
        MONTH=${FILENAME:${MFROM}:2}
        DAY=${FILENAME:${DFROM}:2}
        RUN=${FILENAME:${RFROM}:4}

        DSTDIR=${DSTBASEDIR}/${YEAR}/${MONTH}/${DAY}/${RUN}

        if ! [ -e ${DSTDIR} ]; then
                mkdir -p ${DSTDIR}
        fi

        mv ${IN_FILE} ${DSTDIR}

        echo "moved in ${DSTDIR}"
```

```
done
rm ${LOCK_FILE}
```

Basically the acquisition script creates the folders in the format */ YYYY / MM / DD / RUN* in the base directory of the hydrological models ***("/ home / adriauser / idro / chym"),*** consistently with the date contained in the same file name. The file after that is copied to the above defined folder.

For example, the complete path of a file in the archives of *Dewetra Data Server (DDS*) is like:

/home/adriauser/idro/chym/2019/11/12/0000/ABbdd_ADRIAMORE_CHyM_201911120000.chym.nc

4.2.2 Implementation of a DDS component for the delivery of the CHyM data

A specific component of *Dewetra Data Server (DDS)* has been implemented for managing and publishing the AdriaMORE **CHyM** data in *Web Map Service (WMS)* format so that it can be viewed and queried by the *Dewetra2* application of the *myDEWETRA* platform.
The *ChymCoverageManager* component implements the interface that defines the list of all the **CHyM** "runs" available in the time interval required for a specific model variable.

Once the data to be displayed has been selected, the DDS component reads the **CHyM** data, of the interested variable, in the NetCDF format and publishes it using the *WMS* service, implemented by the *geoserver* present at this address: http://adriaserver.aquila.infn.it/dds/wms.
The *DDS* component is configured using the *XML file (CHYM00_ [REGION] _ [var] .xml)* as regards: the *base directory* where the model data resides, *the file name* and the model *description.*

For example, in the case of *CHYM00_AL_cai.xml* the configuration is*:*

```
<coverage  name="CHYM00_AL_cai"
component="com.acrotec.data.dds.coverage.managers.ChymCoverageManager">
        <attribute name="description" value="CHYM - Albania - CAI Index"/>
        <attribute name="dir" value="/home/adriauser/idro/chym"/>
        <attribute name="filename" value="ALcai_CHyM"/>
        <attribute name="hgap" value="0"/>
</coverage>
```

4.2.3 Publication of the CHyM data in the Dewetra2 application

The **CHyM** AdriaMORE data can be visualize from the *Dewetra2* application at http://adriaticionian.mydewetra.org/apps/dewetra2/index_crn.html

Accessing *Dewetra2* with the ***MasterCapRadNet*** profile it is possible to load the data through the *FORECAST menu -> Hydrological Models -> CHYM - [VAR] INDEX (REGION).*
Two examples are provided at figures 5 and 6.

It is possible to load the data in *Dewetra2* once the search time interval has been selected, understood as the period for which you want to obtain the AdriaMORE **CHyM** "runs" available for a specific model variable. The search period is defined by means of the standard *Dewetra2* dashboard.
The visualization responds to a predefined style, present on the *DDS geoserver*, which can obviously be modified during data configuration. By default is loaded the most recent *run* in the chosen interval.
By accessing the data properties menu, you can choose to load any of the available runs in the required interval (figure 7).

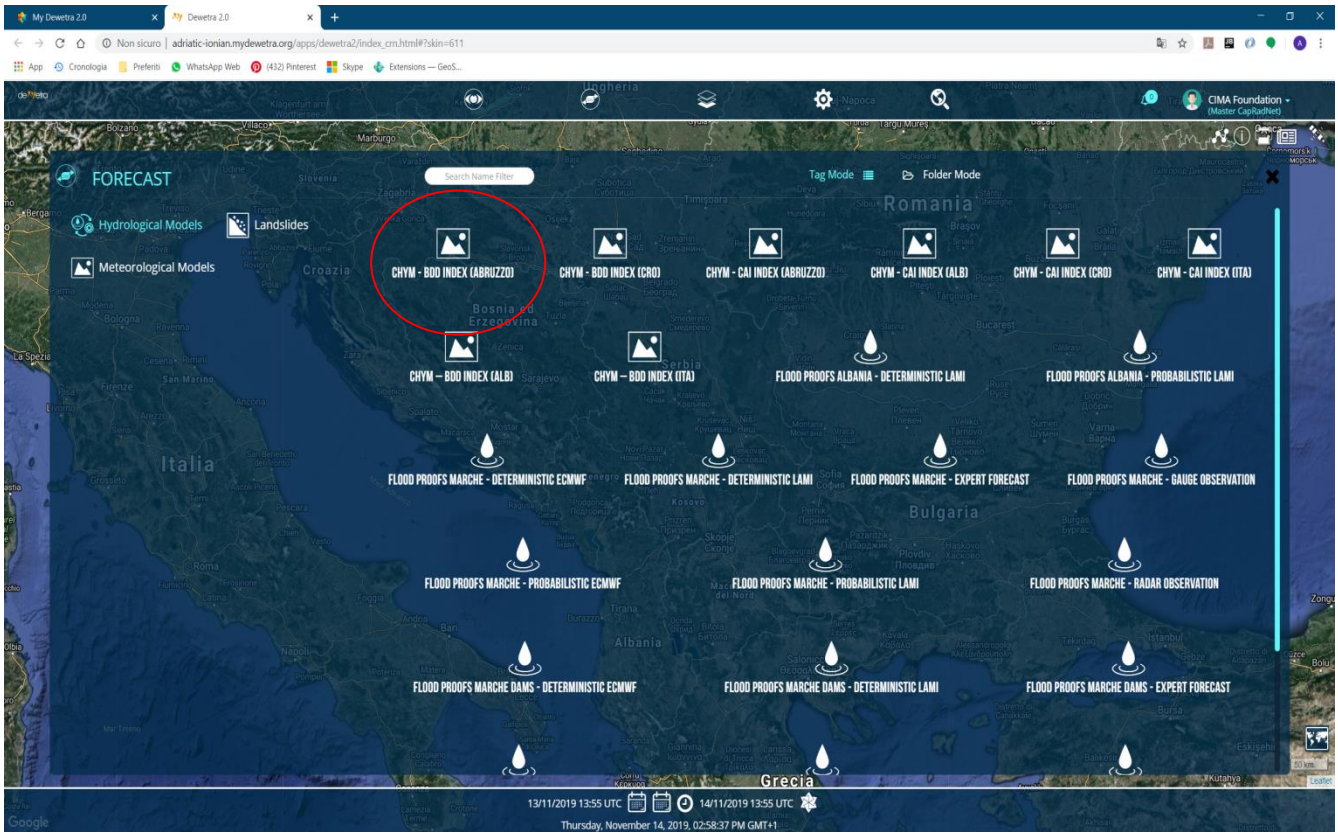

Figure 5. The ADRIAMORE CHyM hydrological data published under the FORECAST menu

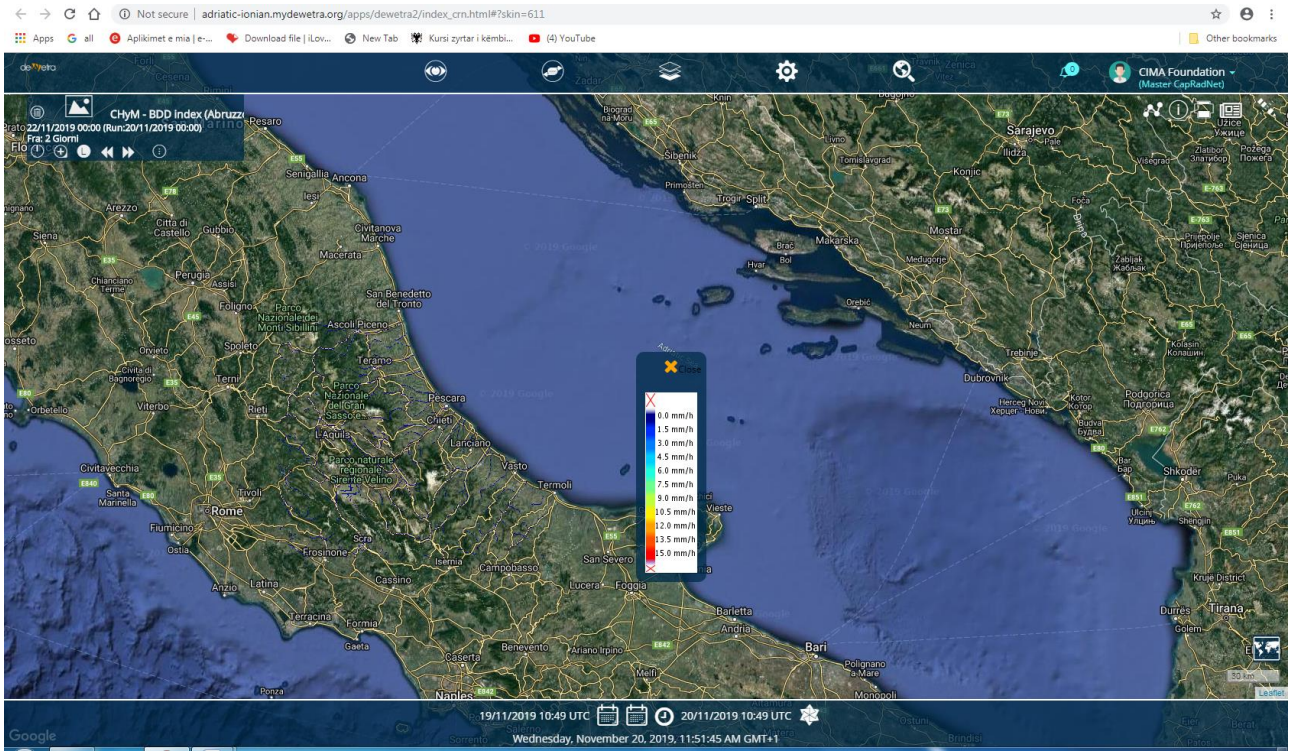

Figure 6. The ADRIAMORE CHyM Hydrological forecast for Abruzzo Region- run date 20 Nov. 2019(00:00)

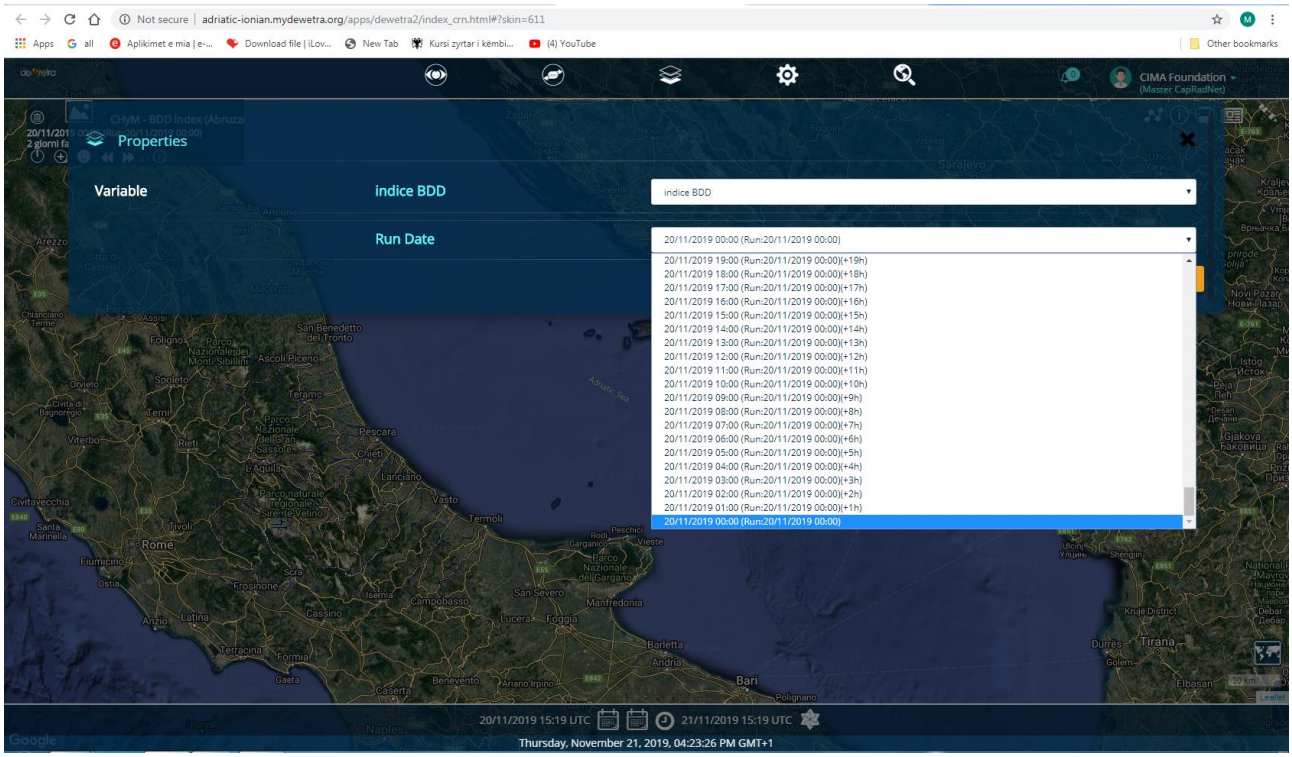

Figure 7. The available runs in the required interval

4.3 Integration of WAVE Forecast model in to myDEWETRA platform

The data produced by the **WAVE forecast model** substantially follows the same methodology with by **CHyM hydrological model** for data import, integration and publication in to the myDEWETRA platform, using the *Dewetra2* application.

The unique things that change is:

- the name of the files: [*date] _waves_ASA.nc (eg 20191111_waves_ASA.nc)*
- the base directory of the *DDS archive (eg "/ home / adriauser / models / wave)*
- the DDS component: *WaveCoverageManager*
- the menu where the data is displayed in *Dewetra2*

The WAVE model files are loaded daily into the "scratch" *(/ home / adriauser / scratch)* exchange directory of the *adriaserver.aquila.infn.it server*. It is a series of files in NetCDF format related to the daily "run" of the model.
The name of the uploaded files (for example: 20191119_waves_ASA.nc) follows the following syntax:

• [date] _ADRIAMORE waves_ASA.nc

Where the date is expressed in the *yyyyMMdd* format.

4.3.1 Import of WAVE data into the myDEWETRA platform

The procedure for acquiring the system and organizing the data of the WAVE model in the *Dewetra Data Server (DDS)* archive takes place by means of a bash script which is launched in a scheduled manner through the *"crontab"* of the *adriaserver.aquila.infn* server. en:

```
0    *    *    *    *    /home/adriauser/cima/acquisitions/wave/acquire.sh    >>
/home/adriauser/cima/acquisitions/wave/log.txt 2>&1
```

Below is the code for the acquisition script:

```
#!/bin/bash
echo
echo "------------------$(date)"

cd `dirname $0`

LOCK_DIR=$(pwd)
LOCK_FILE="${LOCK_DIR}/acquisition_wave.lock"
if [ -e ${LOCK_FILE} ]; then
       echo "file di lock esistente: ${LOCK_FILE} ...Abort!"
       exit
fi

touch ${LOCK_FILE};

FILES=`find    /home/adriauser/scratch    -name    "[0-9][0-9][0-9][0-9][0-9][0-9][0-9][0-
9]_waves_ASA.nc"`
```

```
DSTBASEDIR="/home/adriauser/models/wave"

for IN_FILE in ${FILES}; do

        FILENAME=`basename ${IN_FILE}`

        echo -n "found ${FILENAME}... "

        declare -i FNLEN=${#FILENAME}

        #echo $FNLEN

        declare -i YFROM=$FNLEN-19
        declare -i MFROM=$YFROM+4
        declare -i DFROM=$MFROM+2
        declare -i RFROM=`00`

        #echo $YFROM $MFROM $DFROM $RFROM

        YEAR=${FILENAME:${YFROM}:4}
        MONTH=${FILENAME:${MFROM}:2}
        DAY=${FILENAME:${DFROM}:2}
        RUN=${FILENAME:${RFROM}:4}


        DSTDIR=${DSTBASEDIR}/${YEAR}/${MONTH}/${DAY}/${RUN}

        if ! [ -e ${DSTDIR} ]; then
                mkdir -p ${DSTDIR}
        fi

        mv ${IN_FILE} ${DSTDIR}

        echo "moved in ${DSTDIR}"

done

rm ${LOCK_FILE}
```

Basically the acquisition script creates the folders in the format */ YYYY / MM / DD / 0000* in the base directory of the hydrological models *("/ home / adriauser / models / wave")*, consistently with the date contained in the file name same. The file is then copied to the above defined folder. For example, the complete path of a file in the *Dewetra Data Server (DDS)* archive will be of the type:
/home/adriauser/medels/wave/2019/11/12/0000/20191119_waves_ASA.nc

4.3.2. Implementation of a DDS component for the delivery of the WAVE data

A specific component of *Dewetra Data Server (DDS)* has been implemented for the management and publication of the **WAVE** data in *Web Map Service (WMS)* format so that it can be viewed and interrogated by the *Dewetra2* application of the myDEWETRA platform.
The *WaveCoverageManager* component implements the interface that defines the list of all the **WAVE** "runs" available in the time interval.
Once the data to be displayed has been selected, the DDS component reads the WAVE data of the affected variable, in the NetCDF format and publishes it by means of the WMS service implemented by the *geoserver* present at :

http://adriaserver.aquila.infn.it/dds/wms.
The DDS component is configured using the XML file (WAVE.xml) as regards: the base directory where the model data resides, the file name and the model description.
For example, in the case of *Wave00_ cai.xml* the configuration will be:

```
<coverage  name="WAVE"
component="com.acrotec.data.dds.coverage.managers.WaveCoverageManager">
      <attribute name="description" value="WAVE"/>
      <attribute name="dir" value="/home/adriauser/models/wave"/>
      <attribute name="filename" value="waves_ASA"/>
      <attribute name="hgap" value="0"/>
</coverage>
```

4.3.3. Publication of the WAVE data in the Dewetra2 application

The WAVE data can be viewed from the dewetra2 application at
http://adriaticionian.mydewetra.org/apps/dewetra2/index_crn.html

Accessing *Dewetra2* with the *MasterCapRadNet* profile it is possible to load the data through the *FORECAST menu -> Sea Models -> **ADRIAMORE_WAVES*** (see figure 8).

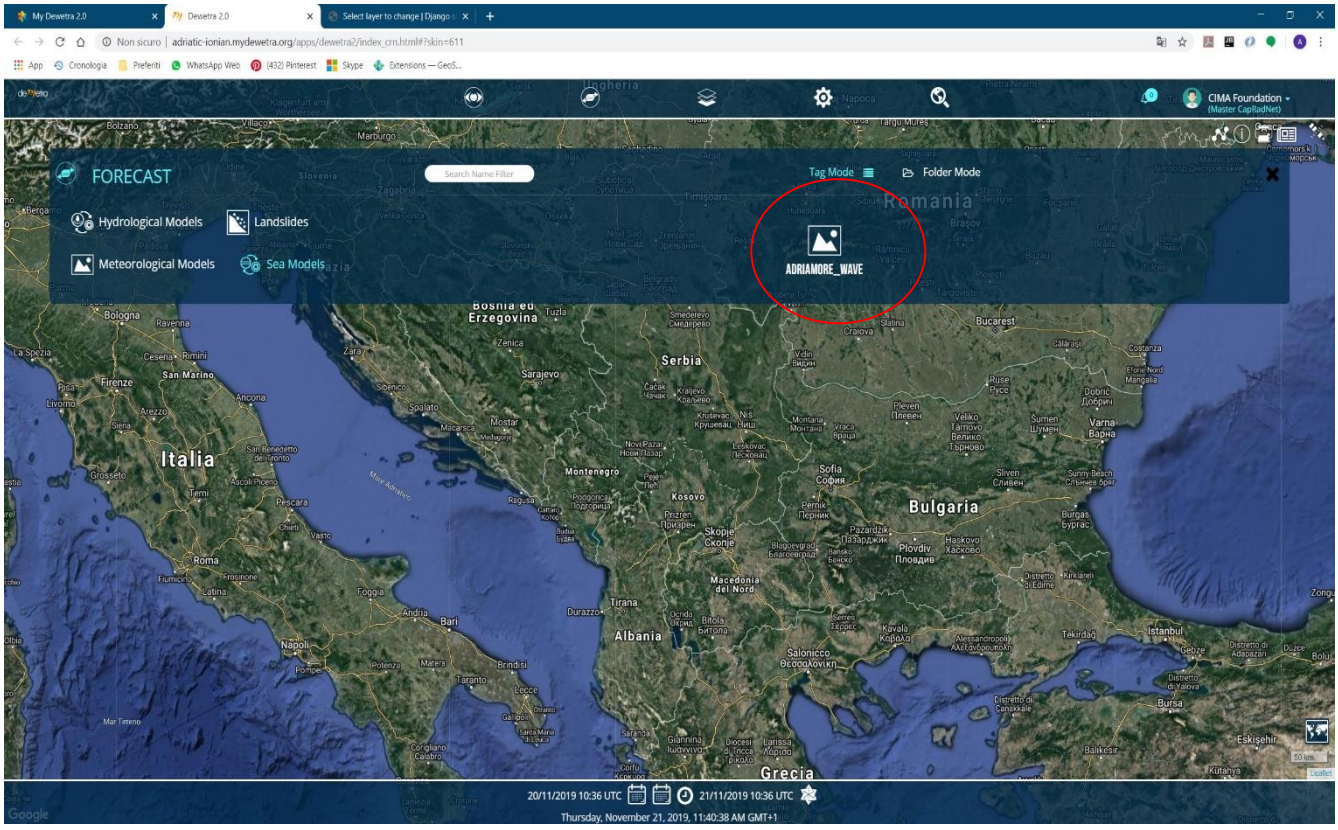

Figure 8. The ADRIAMORE WAVE hydrological data published under the FORECAST menu

It is possible to load the data in *Dewetra2* once the search time interval has been selected, understood as the period for which the "runs" of the available WAVE model are to be obtained. The search period is defined by means of the standard dewetra2 dashboard.

The display responds to a predefined style, present on the DDS geoserver, which can obviously be modified during data configuration.

By default the most recent run in the chosen interval is loaded.