CLARA

Clara Project Brochure

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www.clara-project.eu

CLARA

CONTENTS

ABBREVIATIONS AND ACRONYMS

CLARA	Climate forecast enabled knowledge services
C3S	Copernicus Climate Change Service
CS	Climate Services
GFCS	Global Framework for climate services
EC	European Community
EU	European Union
MUF	Multi user Forum
FM	Flood-Mage
DRR	Disaster Risk Reduction
SIS	Sectoral Information Systems
RES	Renewable Energy Sector
PWA	Parma river basin Water Assessment (ARPAE)
ROAT	Reservoir Operation Assessment Tool
WRI	Water Requirements for Irrigation
SCHT	Smart Climate Hydropower Tool
AQCLI	Air Quality in future CLImate
SHYMAT	Small HydroPower Assessment Tool
SEAP	Solar Energy Assessment and Planning Tool
PPDP	Post Processed Decadal Predictions
EQs	Energy Quantified by Montel
UCO	University of Cordova
CMCC	Euro-Mediterranean Center on Climate Change
SMHI	Swedish Meteorological and Hydrological Institute

EXECUTIVE SUMMARY

CLARA (Climate forecast enabled knowledge services) project sets out to boost innovation and uptake of climate services based on front line seasonal and decadal forecasts and climate projections. Building upon the advancements in climate modelling and science in the context of the Copernicus Climate Change Service (C3S), the project aims at illustrating genuine benefits and economic value of climate services for practical policy and decision making. Seasonal forecasts are essential for early-warning decision support systems that can help to reduce the socio-economics related risk associated to events such as heat waves/cold spells, droughts/floods or other anomalous events not necessarily extremes.

The CLARA-enabled climate services in five priority areas of the Global Framework for climate services (GFCS): disaster risk management; water resource management; air pollution control; renewable energy supply; and agriculture. Horizontal services are included, functional to the aforementioned GFCS areas. The selection of the services and domains has been made so as to maximise the project's impact. It is based on the following criteria: (a) maturity of the concepts and technological readiness; (b) estimated economic value-added and marketability of the services; (c) European significance of the services; and (d) exploitation of the results of the past and on-going innovation projects and initiatives. Each service development team comprises primary and secondary service providers, purveyors and end-users. We gather together new purveyors and users and where the earlier prototype of the service already exists, we further extend the climate services to enhance their quality and usability, or in terms of new markets access and extended market share.

The brochure reports the project results for each climate service.

The fourteen forecast climate services are involved in CLARA in five priority areas – (or application domains) of the Global Framework for Climate Services, and two of them provide horizontal support:

1. Disaster risk reduction: FLOOD-MAGE
2. Water resources management: PWA, SMHI AQUA, ROAT
3. Agriculture: WRI, IRRICLIME
4. Renewable energy production: SCHT, SHYMAT, GHW, SEAP
5. Air quality: AIRCLOUD, AQCLI
6. Horizontal services: CLIME, PPDP

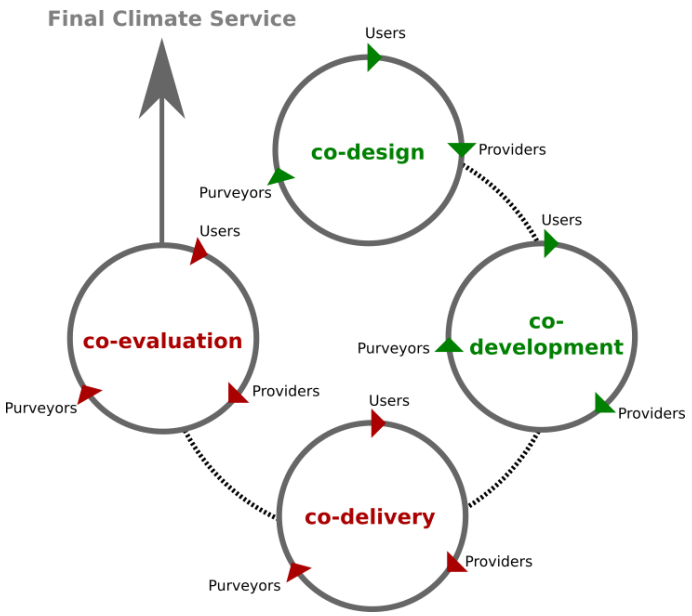
The present document concerns data management and intellectual property rights with respect to the EC Horizon 2020 Project CLARA.

1

INTRODUCTION

Adaptation in all societal sectors is essential to face current and future climate change and variability in Europe and globally. Climate services are not only important as a vehicle of reducing risks and improving resilience, but also a driver of innovation, competitiveness, and growth.

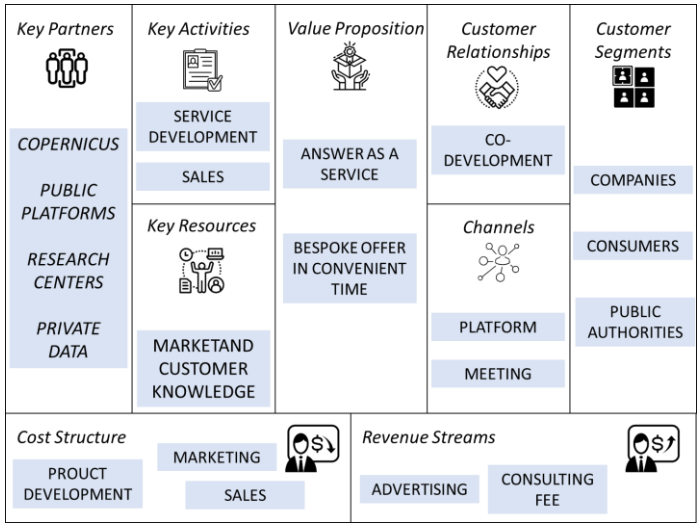
The EU Horizon 2020 project CLARA (Climate forecast enabled knowledge services) is focused on innovation and market uptake of climate services, based on seasonal and decadal forecasts and/or climate projections, in the context of the Copernicus Climate Change Service (C3S). CLARA addresses a portfolio of fourteen climate services, to be co-designed and co-developed (co-generated) by service providers in mutual collaboration with purveyors and users.



The project structure is simple and aligned with project's objectives, and supportive of fulfilling the project's expected impacts:

- engaging end-users, purveyors and service providers in a development oriented dialog;
- developing new or existing climate services and making them operational;
- exploring the economic and social value and fostering market uptake of climate services through marketing strategies and activities.

This brochure reports the result of collaborative effort among partners from different fields of expertise (economics, business and marketing, impact research) and organizations (private sector, research institutes, institutional entities), and embedding various levels of understanding of climate services. The writing process encouraged cooperation, fostered debates, and helped to get a broader vision of the potential applications of climate services.

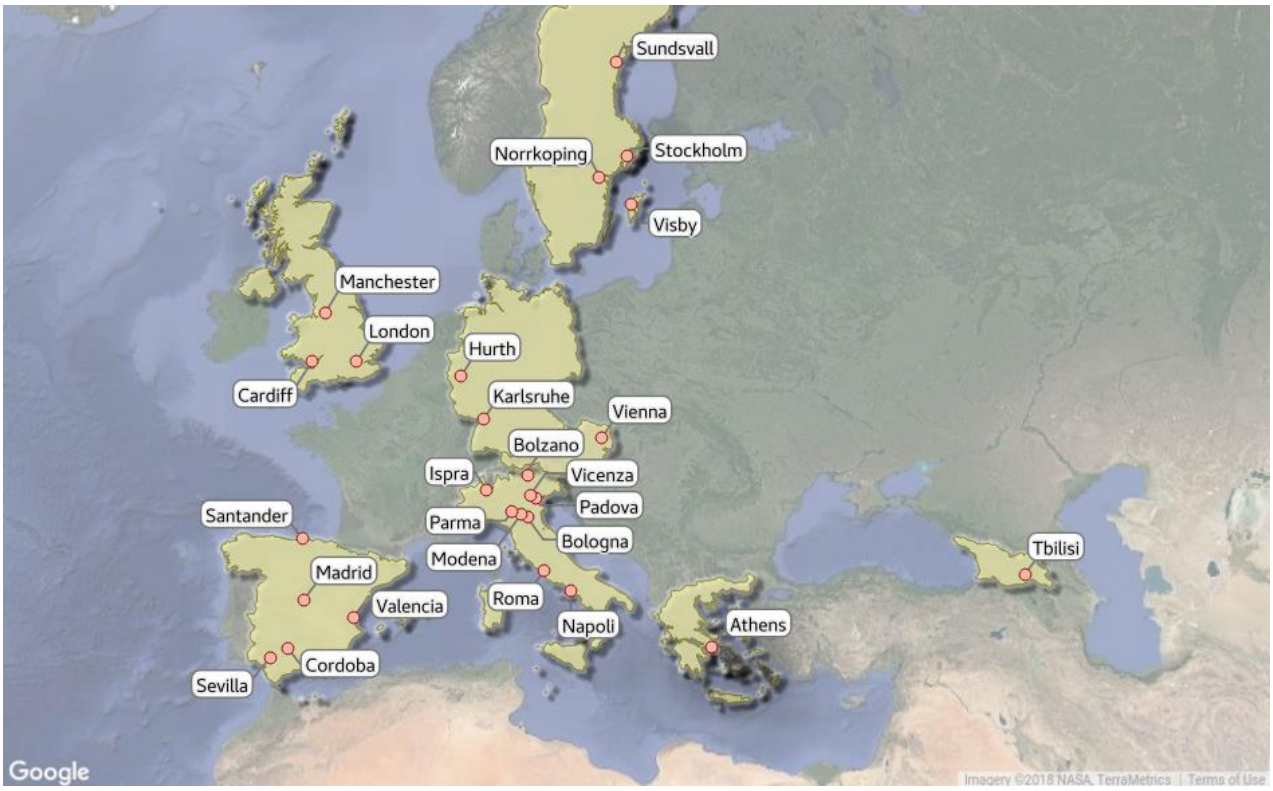


The document is organized as follows.

In Chapter 1, Description of Clara Project and Clara Services brochure, Chapter 2 Perspective and Development, Chapter 3 Staff and community of Clara Project.

Inside Clara Services brochure we summarize:

- the results of co-generation process for an effective **User engagement**;
- the **Development** workflow common to all services: starting with a shared appreciation of the opportunities that climate forecasts offer to purveyors and users while recognising the limits and associated risk, then jointly with the users, applications of the services that are closest to demonstrate their full potential.
- the **Value** of climate services assessed together with end-users, service providers and data purveyors. We first evaluated assessment methods found in the literature and discussed their suitability for CLARA climate services. Then we discussed important criteria to be considered in the design of a pilot application, considered as an effective way to demonstrating the value unleashed by CLARA Climate Services.
- Finally, for **Business and marketing**, we developed the concept of business model with a focus on climate services.

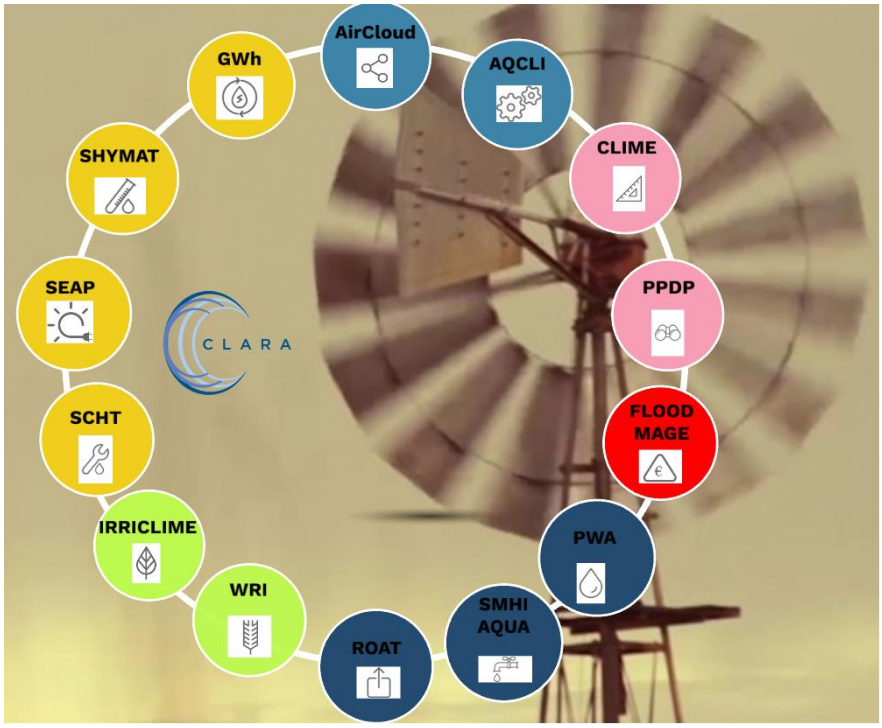


Places of work of the Forum members who have participated in the first Multi User Forum (MUF) workshop

2

CLARA PROJECT

CLARA (Climate forecast enabled knowledge services) is a Horizon 2020 funded innovation action set to develop a number of advanced climate services (fourteen) building upon the newly developed Copernicus Climate Change Services near term forecasts and sectoral information systems (SIS) and sustain their marketability and value. A portfolio of user co-designed and co-developed climate services are designed to help to improve policy and decision makings related to the impacts of human-induced climate change on selected sectors: disaster risk reduction, water resource management, agriculture and food (security), renewable energy sources, and public health. The CLARA climate services are developed for, or co-developed with, specific target users. The services are tailor-made users' decisions and policy context. The data generated by the project describe the pilot applications and demonstration, used within the CLARA project to analyse the economic and social value generated or unleashed by the services, and by external users to grasp the scope of the application and the breath/depth of the CLARA services. Given the wide range of CLARA services and applications, the developer teams use a variety of data formats. Through the experience of three years of work, the development teams is able to present the technical advancements, but also the process through which this 2-way provider-user interaction happened.



SECTION 1

Disaster Risk Reduction

FLOOD-MAGE

Economic assessment of flood risk, risk financing

Engage end-users

The service was co-developed with local authorities, which has been engaged in several occasions during project meetings and internal activities in order to identify their needs and priorities.

The advancements in the service development have been regularly presented during public conferences. A website has been deployed to provide more updates on the service and display results from the pilot demonstrator, together with a public page on Facebook which portray the basic information on the service to a wider public.

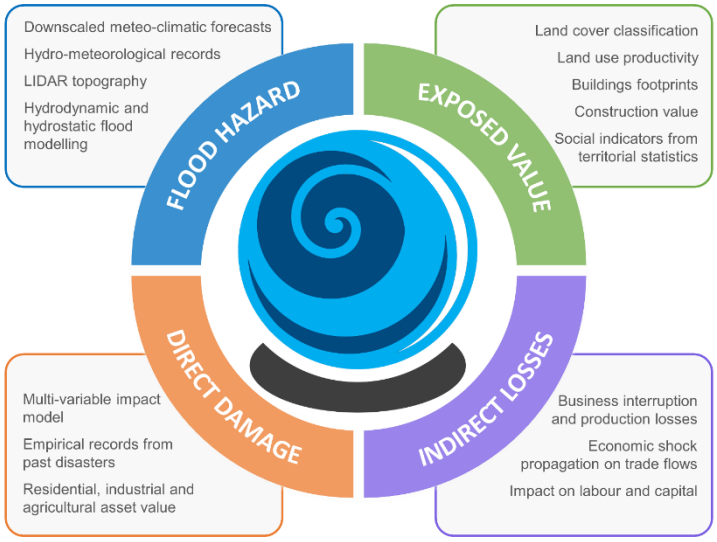
Development

FLOODMAGE is a DRR climate service aimed to estimate the potential economic losses triggered by flood events of different kinds (pluvial, fluvial and coastal) in relation to medium to long term climate conditions. The service adapts to different spatial scales and builds upon seasonal meteo-climatic downscaling, high resolution exposure mapping, hydrodynamic and hydrostatic hazard modelling, and multi-variable risk assessment. FM provides insights on the economic and financial impacts linked to extreme event scenarios and draws a comprehensive outlook on how such impacts may change due to increased climate variability.

FM hazard downscaling looks for the most detailed and updated data available for the area of application. The service combines data about meteorological forcing (precipitation intensity), land morphology (high-resolution terrain model), water network (both natural and artificial features such as drainage networks and retention areas), land cover (buildings and areas categories) and the value of exposed assets. In addition, hydro-meteorological records (precipitation, discharge volumes) are used to calibrate the flood hazard model and to infer important statistics regarding past flood events, such as flood return periods. Existing records or catalogues of past disaster events in the investigated area are accounted in the calibration and validation of the hazard model, and to support the estimation of risk.

Value

FLOODMAGE provides a comprehensive outlook of financial economic losses due to flood disasters in relation to extreme events probability. The service helps to answer common requirements of risk management, such as: where the most critically prone areas and infrastructures are located? What is the current level of flood exposure and risk in the area, and how will it change in the near future due to climate change? The service produces an estimate of expected losses in relation to scenarios of hazard probability in the form of hazard and risk maps, data sheets and short reports. The value of FM has been assessed on the pilot case study of Rimini, addressing both pluvial floods and coastal inundation hazard and measuring the ability to anticipate extreme events by downscaling medium-term forecasts. It also evaluates the implementation of hazard mitigation measures to reduce the risk.



Market

The service is oriented to a variety of users, including the public administration, river basin authorities, land reclamation boards, asset managers, and insurers. The market strategy reflects an ongoing effort to prove the business case to a range of potential clients in different segments. By using a case-study approach, FM will improve technically and business-wise. On the technical side, the team will lower the costs by automatizing processes through the empowerment of hazard modelling tools and stochastic simulations. Business-wise, the service will prove the economic and non-monetary benefits through a co-generation approach in selected case studies. The price of each ad-hoc product is value-driven.By working with a B2B model, FM could turn into an annual subscription-based service and secure a continuous revenue stream.

Link

http://floodmage.eu

https://www.facebook.com/FloodMage

Developers team (CMCC)

M. Amadio (Service development and Risk assessment), A. Essenfelder (Hazard modelling), J. Mysiak, (Supervisor)
jaroslav.mysiak@cmcc.it

SECTION 2

Water Resources Management

PWA

Parma river basin Water Assessment

Engage end-users

Public end users have been involved during design, planning and management activities, through institutional and public meetings. Private sector, experts and the general public have been involved through web sites news, interviews, publications and workshops. Service suppliers and service providers are all those subjects able to exchange information, tools, expertise and skills within project, planning, management and monitoring activities. The involvement of and the dialogue with end users, service providers and service suppliers allowed to identify their real needs and priorities, in order to implement the most suitable operational tools (data, indicators, models) within PWA Service.

Development

PWA, developed by Arpae is a platform for sharing, through a set of web services, hydro meteorological observations and climate projections combined with hydrological, water balance, water quality, ecological and solid transport models. The Service may support operational decision making useful for public and private stakeholders involved in managing water resources, preventing damages related to water extremes and supporting environmental and spatial planning and management. PWA may use different data: climate and hydrologic historical series; water bodies quality data; information on P/N point and diffuse sources; information on water withdrawals; catchment and river network data; river bed and sediment transport information; Weighted Usable Area - Discharge Curves (WUA-Q). PWA also uses climate projections to 2100 of daily precipitations and temperatures (based on simulations RCP4.5 CMCC-CM+COSMO-CLM + bias correction). PWA includes different models: Topkapi - RIBASIM for water management; RIBASIM - DELWAQ for water quality; WUA - Q for habitat suitability; virtual velocity method and parametric method for solid transport. Business model consider a shorter supply chain, adopting a freemium revenue model. PWA integrates the efforts and expertise of local stakeholders maximizing the collection of inputs and the quality of outputs.

Value

PWA can manage different data, metadata, forecasts, projections and models and can be implemented in many river basins, considering different physical, environmental and anthropic properties. Deriving the Service from the effort of different professional figures, hydrologists, informatics, water managers, environmental experts, PWA end users can find operational tools, datasets, and modeling results, suitable for inter sectoral and multi objective applications. The value of PWA has been assessed in a case study for the summers 2015-2018, focused on water management; main features, that affect the final value, collect the model outcomes in terms of simulations, predictions and projections of different variables (for example daily river discharge) but also skill of the results and their ability to correctly predict the variables' trends.

Market

Interested users to PWA are mainly organizations in charge of water management, with another market segment in natural and cultural valorization. PWA's financial structure includes public efforts in data collection, modeling, research and IT development; the market strategy is based on the network of Institutions involved, and is implemented through a two-way co-development and through stakeholder feedbacks. Environmental information is an institutional duty for the PWA provider (Arpae), where competitors are other public authorities and it is not possible to sell the outcomes on an actual marketplace. Therefore the Service will be offered through an open source web-based platform, freely accessible by the final users. Only the most advanced results would be on-demand, offering space to private initiatives (consulting, engineering, design). Indirect revenues of PWA are related to natural capital accounting and improvement.

Link http://demanio.ddns.net/wp-clara/

Developers team (ARPAE)

A. Agnetti, C. Alessandrini, F. Bordini, M. Brian, M. Del Longo, V. Dell'Aquila, P. Leoni, C. Montecorboli, S. Pecora, F. Tonelli, S. Ziccardi, E. Comune

ecomune@arpae.it

FIGURE 1

WORKFLOW WITH DETAIL

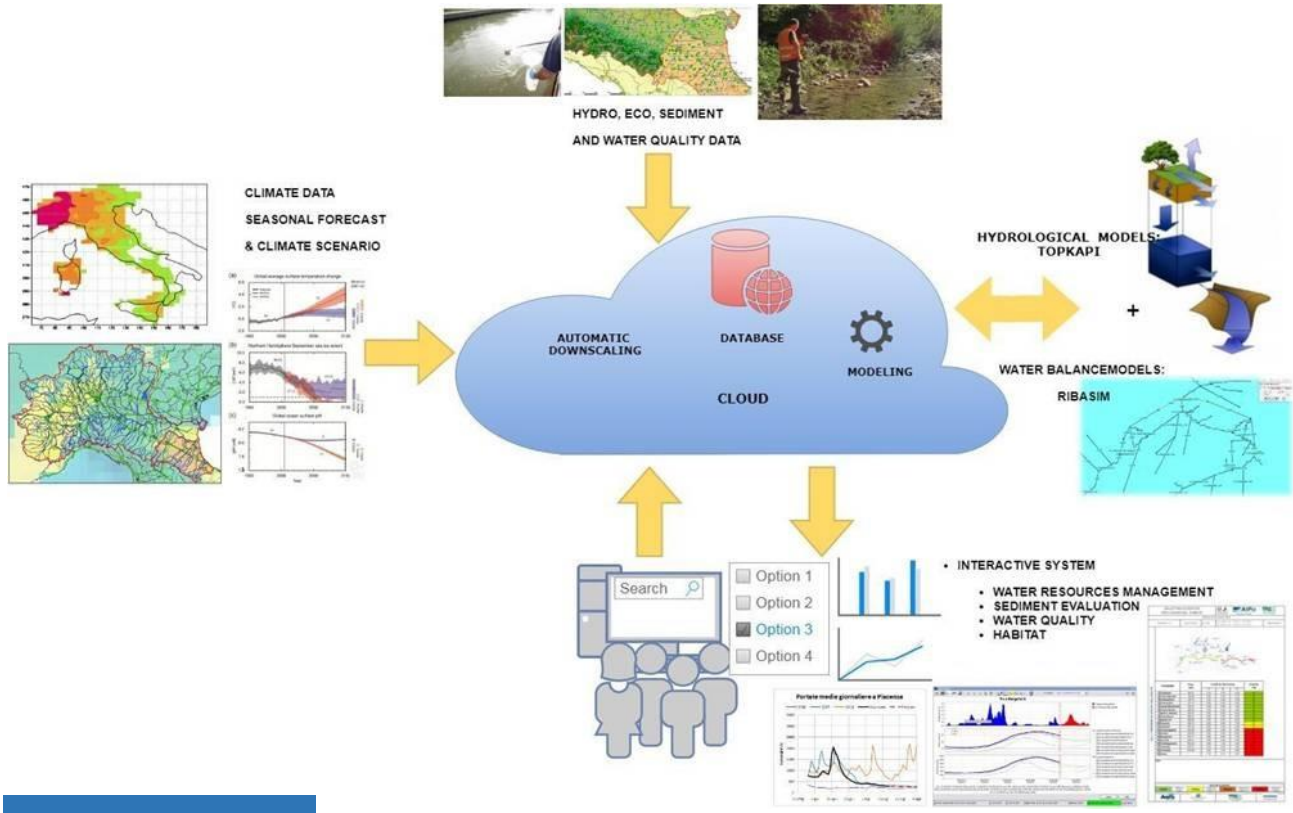
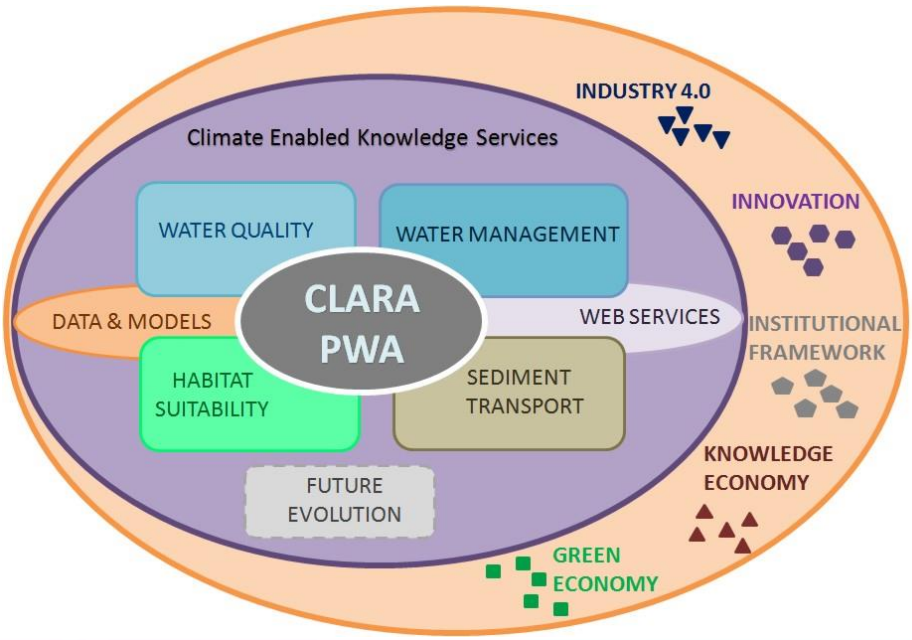


FIGURE 2

CONCEPTUAL SCHEME



SMHI Aqua

Water Supply Assessment Tool

Engage end-users

Availability of freshwater became a sensitive topic due to the hotter summer temperatures and lack of precipitation in the past recent years. This made it difficult for the public and private sector to provide urban water supply in the dry season. The AQUA service helps water managers and drinking water producers in monitoring and planning management of water resources throughout the year in an optimal way.

Data providers, service purveyors and potential end-users were involved since the early stages of development in frequent local meetings and videoconferences. Users were also invited to the Multi User Forums to share their experience with other users and have a better insight on useful scientific innovations. The cogeneration approach helped in building trust between users and service providers for addressing the needs of the users and design efficient solutions to make the service usable in the operation work.

Development

SMHI Aqua is a hydro-climatic service modelling freshwater availability from surface and groundwater reservoirs. The service provides 10-day and seasonal climatological forecasts of water levels and inflow under different long-term water management strategies. Aqua includes an intuitive online visualization tool designed to provide hydrological information to drinking water producers and water managers. The web-based system shows meteorological and hydrological observations from stations, as well as modelled data and forecasts of freshwater availability. If available, historical data are also displayed to facilitate the comparison of the current and future situation against “below”, “near” and “above” normal historical values.

Value

The co-generation of the hydro-climate service named Aqua has proven the potential in bridging the gap between scientific innovation and operational management. The tool provides the users with valuable insights in both planning of groundwater withdrawal and support in taking actions, such as restrictions for water use or installation of extra production capacity.

Displayed observations, modelled results and forecasts improve awareness of the current hydro-meteorological situation as well as future dry/wet periods, facilitating good communication and understanding of results also to non-expert users. This helps public and private organizations working with water-related issues to increase preparedness to extreme conditions, ensure municipal water supply and reduce risks for infrastructure damages.

Market

SMHI Aqua is a value-driven climate service. Users are willing to pay for the implementation and maintenance of a climate service offering clear and reliable information of water availability from now until the next season.

The tool is customized according to the users’ needs and it is updated daily with the newest run of the hydrological models and the produced forecasts. Aqua’s business model is based on a one-time implementation fee and a yearly subscription to the service, which guarantees the online system to be monitored and the users to be informed timely on disruptions or bugs on the system. In addition, a yearly development of the service is included in the subscription to keep the climate service updated and modern.

Link

https://aqua.smhi.se/

Developers team (SMHI)

C. Cantone, H. Ivars Grape

carolina.cantone@smhi.se

FIGURE 1

VISUALIZATION OF LONG TERM FORECASTS FOR GROUNDWATER LEVELS. THE GRAPH SHOWS OBSERVED VALUES (BLACK LINE) SIX MONTHS BACK AND FORECASTS (BLUE AND GREEN LINES) SIX MONTHS AHEAD THAN TODAY. FORECAST LINES SHOW HOW THE LEVELS ARE AFFECTED FROM DIFFERENT WATER EXTRACTION STRATEGIES. THE BACKGROUND REPRESENTS THE HISTORICAL MEASURED LEVELS IN THE RESERVOIR AND THE COLOUR FIELD IS DIVIDED ACCORDING TO THE DEVIATION FROM NORMAL CONDITION (HIGH ABOVE NORMAL, ABOVE NORMAL, NORMAL, BELOW NORMAL, HIGH BELOW NORMAL). CRITICAL LEVELS ARE VISUALIZED ON THE

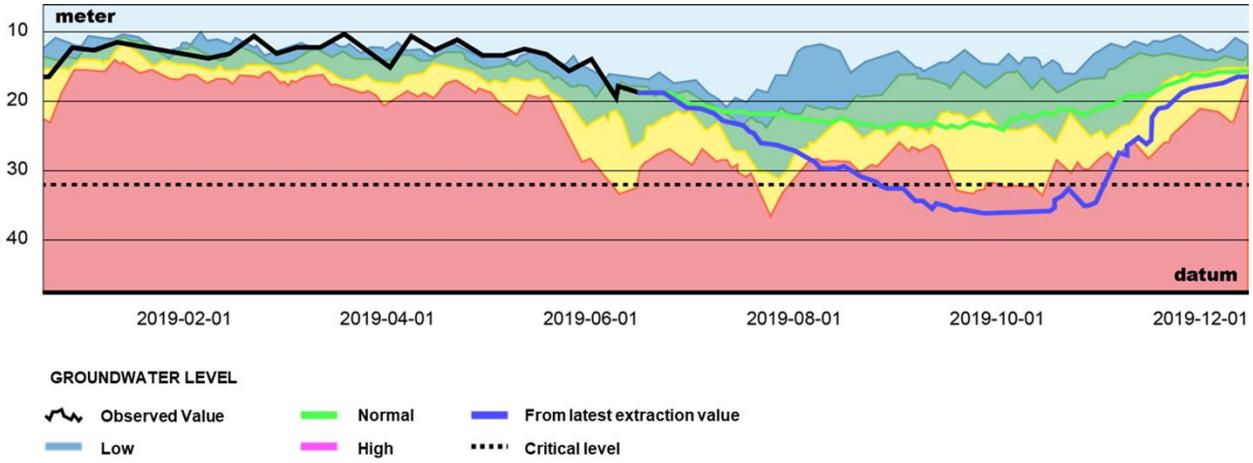
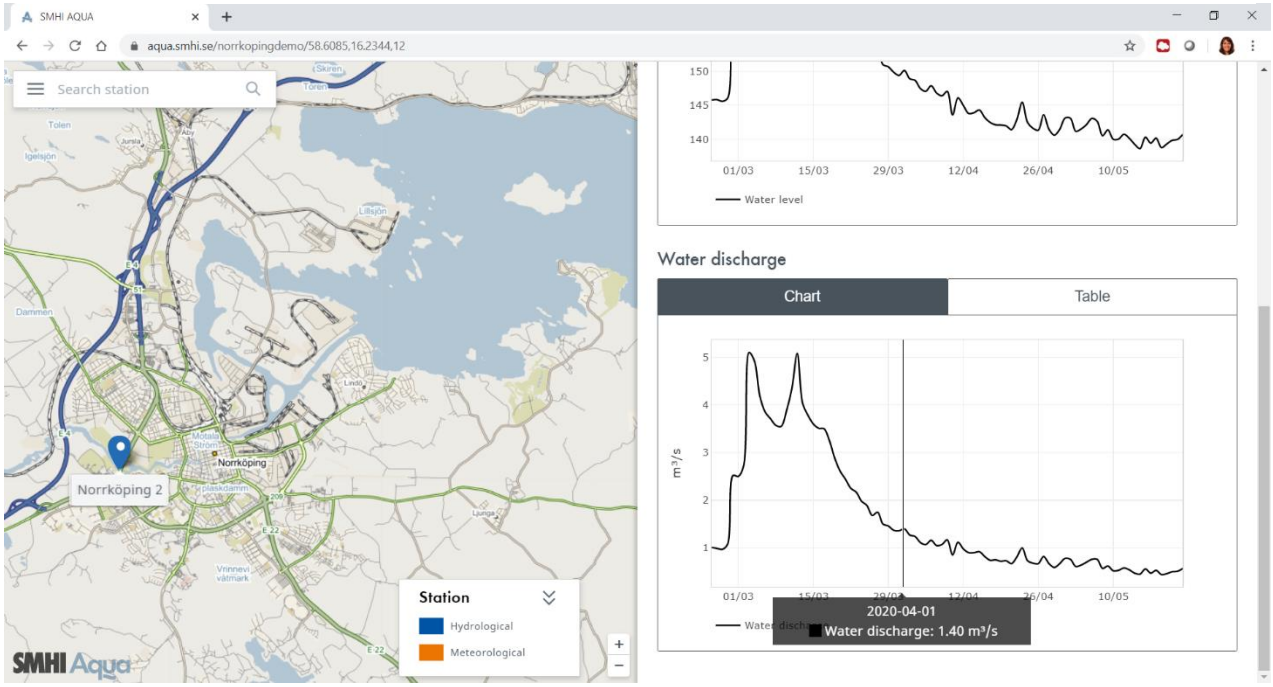


FIGURE 2

VISUALIZATION OF HYDROLOGICAL MEASUREMENTS FROM STATIONS IN AQUA. STATIONS ARE DEPICTED AS POINTERS ON THE MAP. BY CLICKING ON ANY OF THEM, A DIAGRAM SHOWING DATA FOR THE PAST THREE MONTHS POPS UP. TIME SERIES CAN ALSO BE VISUALIZED IN TABLES WHICH ARE EASILY EXPORTABLE TO STANDARD FORMAT FILES AS CSV OF TXT.



ROAT

Reservoir Operation Assessment Tool

Engage end-users

ROAT has followed the philosophy of co-generation through an intense dialogue of the service developer with the end user from the beginning of the project. This process was carried out with more than a dozen face-to-face meetings with the managers of the reservoir selected as a pilot case, who were also involved in the Cordoba MUF. Their views and current working methods have shaped the appearance and scope of the service in all its dimensions.

Development

ROAT service aims to help managers in taking their operational decisions in multi-purpose reservoirs located in areas prone to disadvantageous meteorological conditions (i.e. intense flood and severe drought episodes).

An easily scalable web application with restricted access that shows an intuitive diagram of the reservoir system, composed of various interconnected elements (basins, rivers and reservoirs). Customizable graphs and tables show measured and simulated historical and real time data, as well as seasonal forecast data, specific to each element. ROAT follows an Access provision business model, covering new geographical areas and providing new methods to communicate with clients. It uses cost-efficient contracting forms with multi-product revenue generation opportunities.

Value

This service is a unique tool for the managers of the reservoirs since it brings together on the same platform hydro-meteorological data in real time and a seasonal forecast that they are not currently using in their daily management. The service supports operational decision making through: (1) anticipating the risk of drought in the future and setting a “scarcity level”, (2) offering decision options on the monthly distribution of water demands among uses through forecasts of available water to increase profits, (3) allowing the managers to anticipate water excess discharges from snowmelt to avoid damages downstream the dam as to avoid discharging more water than necessary.

The application of ROAT in the pilot study area, a system of reservoirs in southern Spain, shows a potential benefit conditioned by an improvement in the accuracy of the seasonal forecast, currently not good enough for this region.

Market

ROAT is a value-driven climate service

Users are willing to pay for the implementation and maintenance of a climate service offering clear and reliable information of the current water availability and seasonal forecast of hydro-meteorology, volume of water in the reservoir, and demands satisfaction rate.

Link

http://150.214.115.7:5002/login/

Developers team (UCO)

J. Herrero Lantarón, E. Contreras Arribas, M. J. Polo Gómez, C. Aguilar Porro

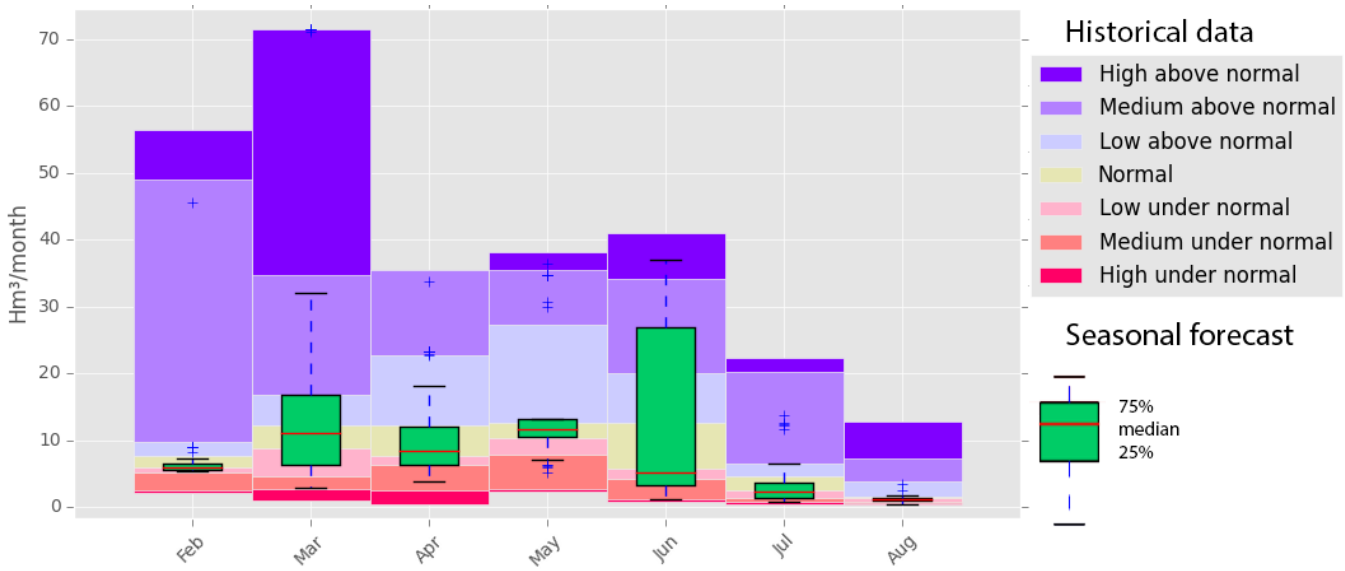
javier.herrero@uco.es

FIGURE 1

RULES DAM BOTTOM OUTLET IN GRANADA, SPAIN (PHOTO JAVIER HERRERO)

FIGURE 2

PUENTE DE ORGIVA. MONTHLY RIVER FLOW SEASONAL FORECAST (FEB. 2020)



SECTION 3

Agriculture

WRI

Water Resources for Irrigation

Engage end-users

The co-generation has been the process through which WRI climate service was designed with local users. An intense exchange of information and ideas was carried out, in particular with Consorzio di Bonifica Burana, also involved in project MUF. This co-design approach has brought several improvements in the original idea of WRI: for instance monthly replications of the seasonal irrigation forecast have been implemented to cope with expected earlier irrigation needs in spring. Finally, quality assessment was a key factor for the co-development and prototypes were tested with field data independently provided by users (water pumping volumes, irrigation practices and amounts, etc.)

Development

WRI provides mid-term and seasonal forecasts of irrigation needs for crops on a webGIS platform.

The output data that WRI displays are: I. Early crop classification maps, II.Precipitation 7-day forecast (at daily time step), III. Irrigation 7-day forecast (at daily time step), IV. Maximum evapotranspiration 7-day forecast (at daily time step), V. Previous irrigation assessment (at daily time step), VI. Seasonal irrigation anomaly forecast (at monthly time step). WRI has the typical features of a webGIS platform, where the user can display data on the platform as thematic maps; they can be zoomed in and out, the time slider allows to browse all the available maps (see figure 1). Each computational unit can be selected and a time plot showing irrigation, precipitation and maximum evapotranspiration 7-day forecast is displayed (see figure 2).

WRI is foreseen to be provided by means of a license-based business model. In more details, a freemium business model can be applied: premium content (such as ad-hoc and customised areas of interest) will be charged by a consulting fee, while basic functionalities will be offered by mandate to the customers.

Value

WRI is a climate service in which probabilistic seasonal forecasts and deterministic mid-term forecasts are translated into information for water management in agriculture by providing forecasts of potential irrigation demand of crops. WRI combines information on current crops in fields from satellite data, observed weather data, climate data, (seasonal and mid-term) forecasts and a soil water balance model.

The early irrigation forecasts of WRI make water managers aware of the expected seasonal demand allowing them to manage the irrigation demand at medium-term (strategic support). Moreover, repeated forecasts can help them in fine tuning water procurement and distribution to farming districts in order to better set up the supply and the distribution of water to irrigation districts (tactical support). At the end of the irrigation season, final statistics are very helpful for evaluation and further analysis (i.e. the sharing of the cost of water management between users) also to regional environmental and water policymakers.

Market

WRI is a value-driven climate service.

Users are willing to pay for a climate service providing forecasts on crop irrigation, updated and customized on water manager needs. This implies that the tool is as simple and clear as possible, it is daily/monthly updated with mid-term/seasonal forecasts, information are provided on specific territorial areas useful to better manage water delivery.

Link

https://servizigis.arpae.it/moses/home/

Developers team (ARPAE)

A. Pirola (Remote Sensing), V. Pavan and W. Pratizzoli (Seasonal and short-term forecasts), F. Tomei, G. Villani (Soil water balance model and irrigation forecasts), V. Marletto (Supervision) vmarletto@arpae.it

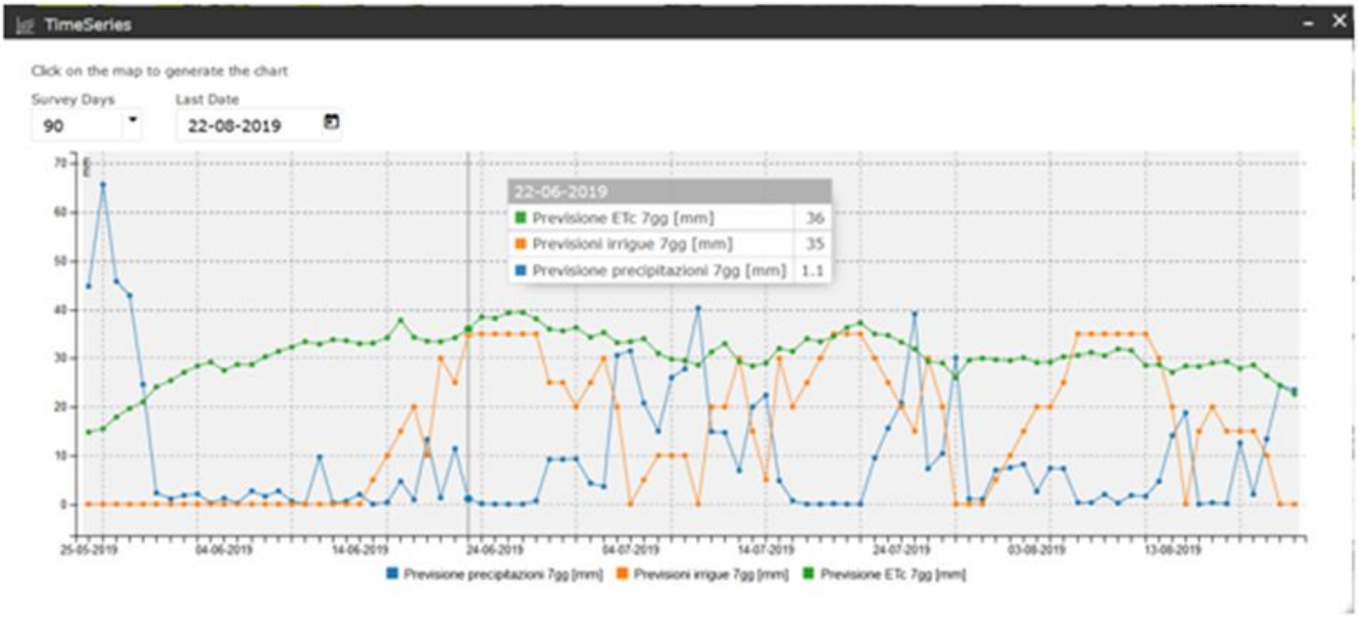
Beta tester: Cinalberto Bertozzi, Fabio Paglione (Consorzio di Bonifica Burana)

FIGURE 1

VISUALIZATION ON THE WRI PLATFORM OF THE 7-DAY IRRIGATION FORECASTS, ONE OF THE PRODUCTS PROVIDED BY WRI

FIGURE 2

EXAMPLE OF VISUALIZATION OF IRRIGATION, PRECIPITATION AND MAXIMUM EVAPOTRANSPIRATION 7-DAY FORECAST ON THE TIME PLOT (2019 SEASON) FOR A COMPUTATIONAL UNIT, SELECTED ON THE MAP OF THE WRI PLATFORM

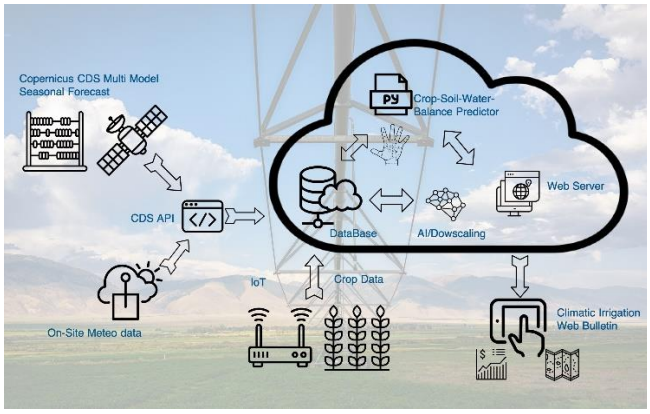


IRRICLIME

Climate Smart Irrigation Tool

Engage end-users

From Design to deployment users have driven the development. 360 ° feedbacks collected through the MUF provided the framework on the service more general expectations. Romagna Land reclamation Authority was designed as the pilot user of the service. The service was applied and validated on Castiglione irrigation district. Authority's Technicians actively contributed through in person and web hosted meetings, guiding service development with specific technical and functional requirements all through the service creations phases. The beta version counted on the support of two highly recognized scientific partners: Euro-Mediterranean Center on Climate Change (CMCC) and Regional Environmental Agency of Emilia Romagna (ARPAE) that provided it's CRITERIA 1D crop specific soil water budget model to be embedded in the service.



Development

A web cloud-based service tailored for providing seasonal and long-term irrigation demand forecast . IRRICLIME estimates if and to what extent water irrigation infrastructure is adequate under a changing climate. IRRICLIME is a two components web tool: i) a spatially and temporally explicit evaluation tool (at irrigation district level) to evaluate if the irrigation infrastructure can sustain the demand. This module shows how water demand will change in different scenarios; ii) a seasonal forecasts module, for short-term planning and management purposes. This component can influence farming practices and water allocation depending on the user.

The business model is a pay-per-use, with access through a subscription-based mechanism (based on annual or monthly fees). The service can exploit partnerships to build a crowd-sourced and jointly-created platform with other players, splitting market segments accordingly, or be proposed as addon to existing synergic platforms of services for agriculture already on the market.

Value

IRRICLIME is applicable to a wide range of users: irrigation managers and farmers in the first stage, and water authorities in a later one. This adaptability is one of the major strengths of the service. This Software as a Service is able to map and plot seasonal forecast and climate projection on irrigation demand and support economic risk reduction and selection of best climate mitigation measures in agriculture. The seasonal prediction of water irrigation demand is valuable information to reduce crop harvesting losses, manage in a sustainable manner the available water resources and drive the agricultural practices towards sustainability and climate resilience. Application have shown potential value of several thousand €/ha of savings when used for example to choose a proper irrigation technology to face CC conditions.

Market

The service is valued driven. The arena of irrigation forecast requires up to date and viable solutions and IRRICLIME represents one of them. The main added value for the client is related to water availability, scarcity and use, but also to the adequacy of the infrastructure given potential new needs. Customization of the interactive web service over user specific areas and cultures of interest, and annual maintenance are the main activities worth paying for.

Link

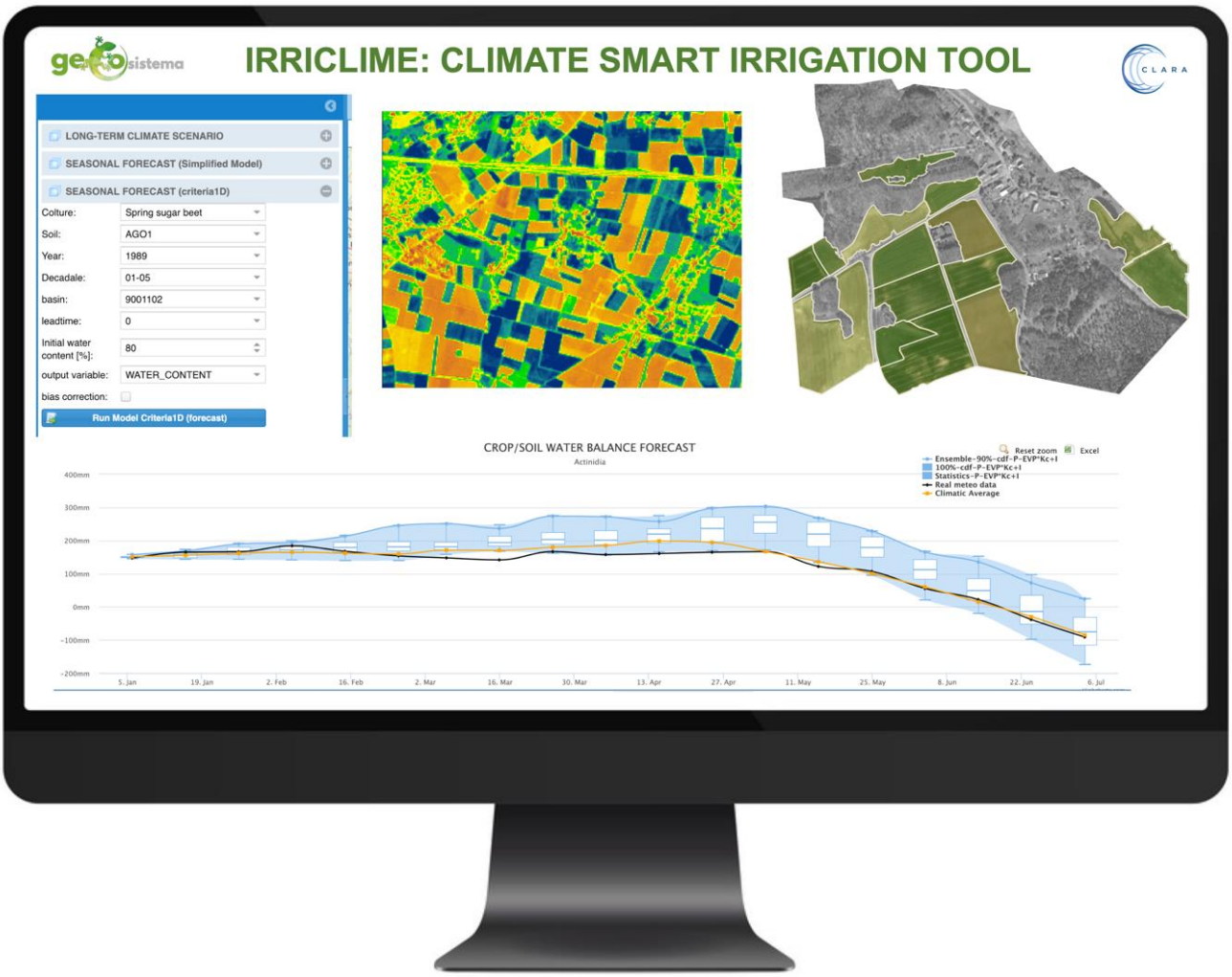
https://gecosistema.com/climate-tools/irriclime/

https://climate.copernicus.eu/gecosistema

Developers team (Gecosistema)

P. Mazzoli, S. Bagli, V. Luzzi, D. Broccoli,

home@gecosistema.it



SECTION 4

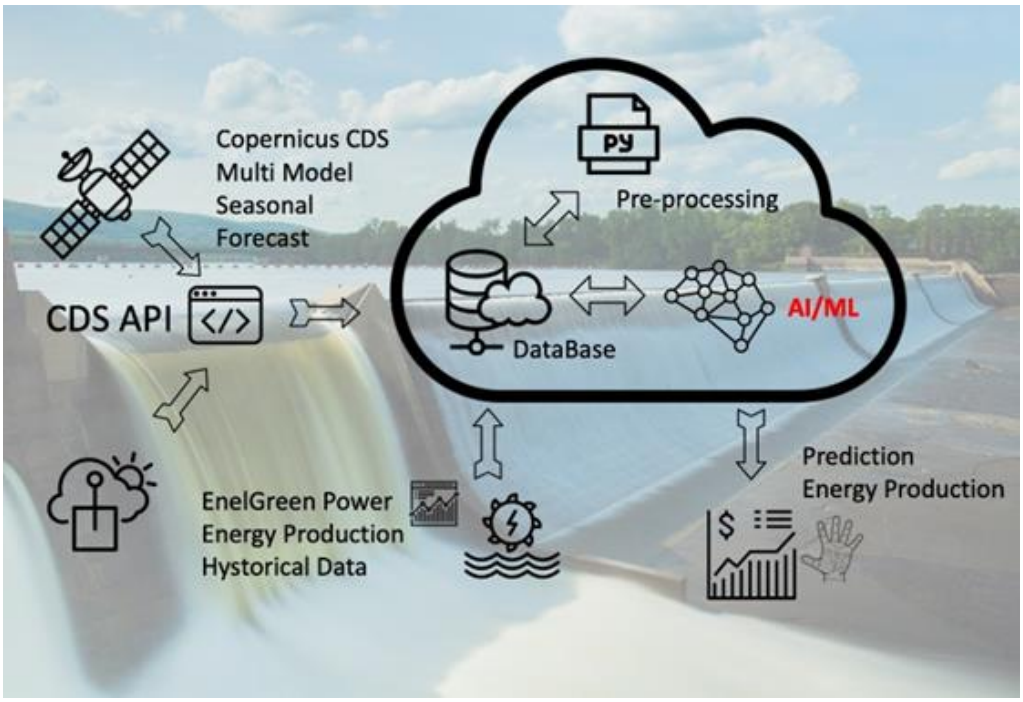
Renewable Energy Production

SCHT

Smart Climate Hydropower Tool

Engage end-users

From Design to deployment users have driven the development. 360 ° feedbacks collected through the MUF provided the framework on the service more general expectations. Enel Green Power was designed as the pilot user of the service throughout the past two years. The beta version counted on the support of two recognized scientific partners: Euro-Mediterranean Center on Climate Change (CMCC) and Swedish Meteorological and Hydrological Institute (SMHI). EGP actively contributed through in person and web hosted meetings, guiding service development with specific technical and functional requirements all through the service creations phases.



Development

A technology-driven service tackling the needs of energy producers and traders with enhanced seasonal forecasts for energy production. The service combines Artificial Intelligence algorithms and cutting-edge seasonal forecasts (by Copernicus C3S) to deliver timely river discharge and subsequent producible energy. Tailored to user requirements and scalable virtually anywhere in the world, the service can offer different lead times (1 to 6 months currently) and time scales (months to days). An annual subscription mechanism with an initial setup disbursement is the setup business model, with ad-hoc packages to multinational companies, based on the number of plants covered (usage-based) to lower unit costs per plant. An initial equity injection will complement CLARA's funding brings the starting capital invested, used to cover full-time technical professional, launch a marketing plan, and expand data-related aspects.

Value

The tool targets energy companies and supports both their day-to-day management (operations) and their market (trading) activities. The client is supported in two distinct but complementary phases: i) by optimizing energy production reducing the risks and costs associated with inefficient production; ii) by forecasting reservoir discharge and energy production/incomings in the next season. When and if applied to multiple reservoirs, SCHT also provides information about the regional and global production of a given firm.

Market

The Tool provides a value driven service, based on forecast accuracy, improvement over existing benchmark, and worldwide applicability.

What if past years decisions would have been taken with service accurate forecast Vs. actual day to day alternative (if any)? Answering this question triggers user's willingness to pay for initial setup and annual maintenance and performance check of the forecast system.

Link

https://gecosistema.com/climate-tools/scht-smart-climate-hydropower-tool/

Developers team (Gecosistema)

P. Mazzoli, S. Bagli, V. Luzzi, D. Broccoli,

home@gecosistema.com

SHYMAT

Small HYdroPower Management and Assessment Tool

Engage end-users

Data providers, service purveyors and potential end-users were involved in local meetings and Multi Users Forums, during which end-users closely participated in the design of SHYMAT and local data provision. This Co-generation has led to a correct scale of the forecast information and the right tools to convey it, which results in a more effective knowledge system but also a more robust knowledge and contextual applicability of the seasonal climate forecast.

Development

SHYMAT is a scalable web user interface aimed at using climate data forecasting to foresee operation feasibility of run-of-river hydropower plants. The service offers a cloud web application with restricted access but also an intuitive and friendly user interface: 1) A geolocation map which presents the user all the hydropower systems included in the service; 2) A topological panel module which shows the elements of the system (basins, rivers, load chambers, hydropower plants, and power grid) and their interactions; 3) A water availability and operation module which provides users with past, present and future information. SHYMAT follows an Access provision business model, covering new geographical areas in Spain and Europe thanks to its scalable software architecture. The service uses multi-product revenue generation opportunities, including local implementation, customization and maintenance.

Value

SHYMAT provides end-users with the most up-to-date hydrological combining measurements and modelling with the most advanced seasonal forecast that currently exists at European level. The service supports managers to anticipate: (1) High production periods and shutdown periods, for maintenance and repair tasks planning; 3) Possibility of compliance with environmental river flow restrictions; (4) The spilling of water, giving managers the opportunity to quickly tune up additional turbines; 5) Energy production, clearly valuable information for market issues. These opportunities provide hydropower managers with potential benefits conditioned by an improvement in the accuracy of the seasonal forecast.

Market

SHYMAT is a value-driven climate service. Users are willing to pay for the implementation and maintenance of a climate service offering clear and reliable information of water availability for the next season and how it affects the operation planning.

Link

http://150.214.115.7:5001/login/

Developers team (UCO)

E. Contreras, J. Herrero, M. J. Polo, C. Aguilar

econtreras@uco.es

FIGURE 1

INTERFACE OF THE SHYMAT SERVICE WEBSITE

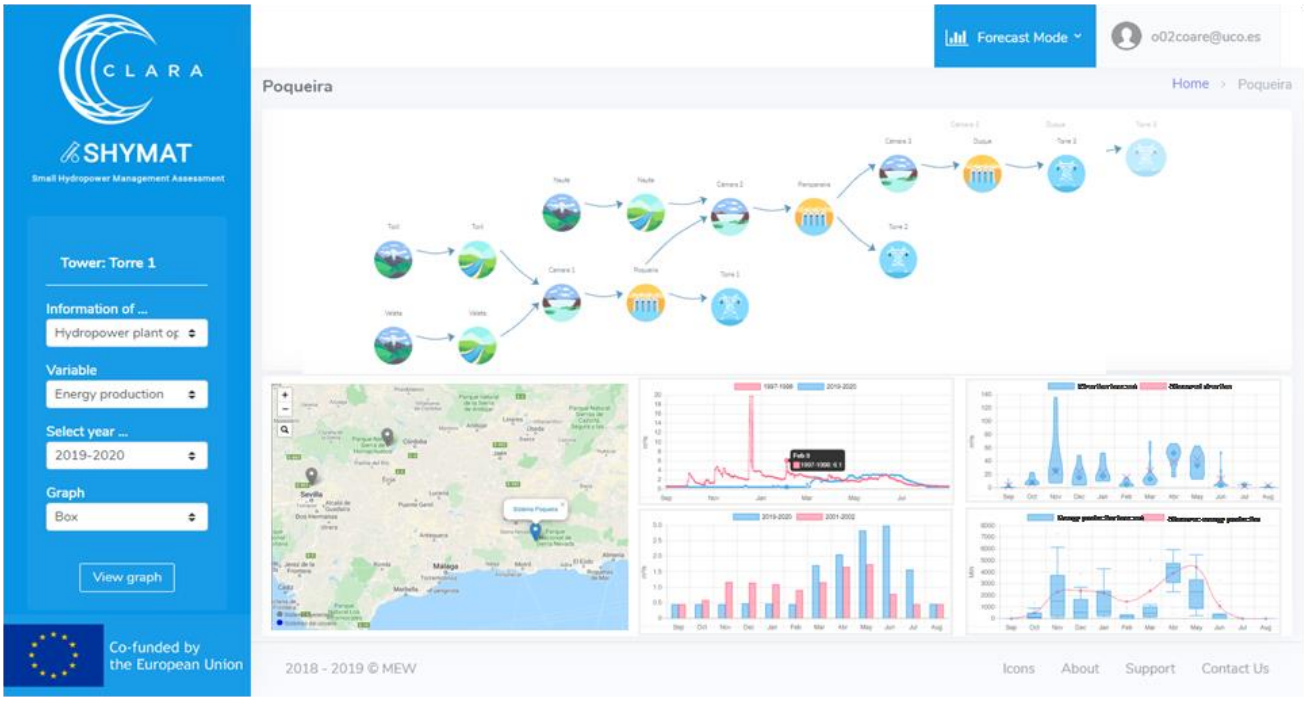
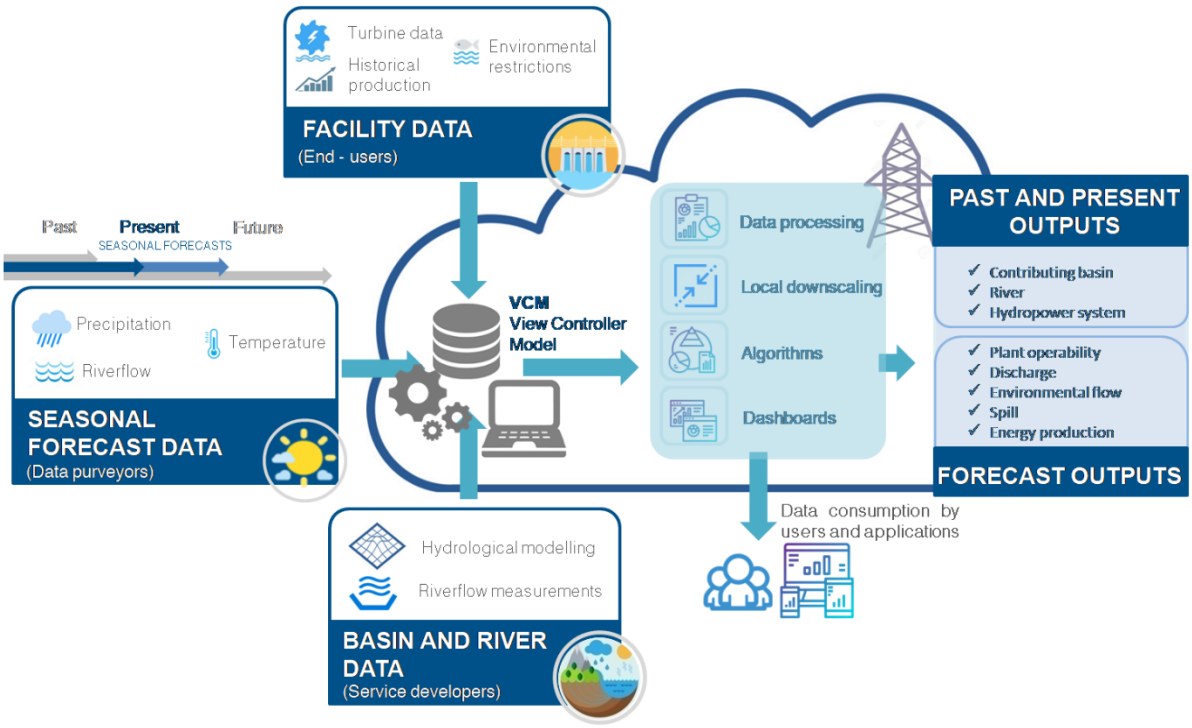


FIGURE 2

WORKFLOW OF SHYMAT SERVICE



SMHI Hydro GWh

Inflow Forecasts for European Countries for Energy Traders

Engage end-users

Hydrologists from four energy trading companies have been involved throughout the development process and have had early access to the service on mail and later through (Energy Quantified by Montel) EQs webpage. Uniper have been involved as end user in the Clara project and have been giving feedback and had demands on 15-day forecasts rather than the initial 10-day forecasts. Our clients Fortum and Statkraft have also been giving feedback on quality and presentation. Our partner EQ has been involved in the setup of the models with indata and quality check.

Development

Trading on the Nordic and European energy market calls for in-depth knowledge of water availability in the countries with major hydropower production. SMHI Hydro GWh gives you inflow forecasts in GWh for the coming 15 days for Sweden, Norway, Finland, Italy, Switzerland, Austria, France, Germany, Spain, Portugal, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Macedonia, Montenegro, Romania, Serbia and Slovenia. 15 day forecasts and historical modelled values expressed in GWh on Inflow, Efficient precipitation, Soil water and Snowpack are updated twice a day and presented on the EQ Webpage in graphs, tables and can be extracted in excel format. Inflow forecasts for more European countries and long range forecasts are yet to come. You can choose to see the information in daily or weekly resolution. The results are based on the European hydrological model - EHYPE that is under continuous development at SMHI. Recalibration of E-hype with new subbasin division and a new seamless indata feed which also requires recalibration of all GWh models is in process and will be done during 2020. Forecasts for more countries and long range forecasts for the coming 45 days are other requests from EQ.

Value

Users Benefits are: 1) GWh-forecasts per country and per price area; 2) Daily updates of 15 day inflow forecast for Sweden, Norway, Finland, Italy, Switzerland, Austria, France, Germany, Spain, Portugal, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Macedonia, Montenegro, Romania, Serbia and Slovenia; 3) the ability to take advantage of the hydrological situation and to react swiftly; 5) access to extensive experience in hydrological modelling at SMHI.

Market

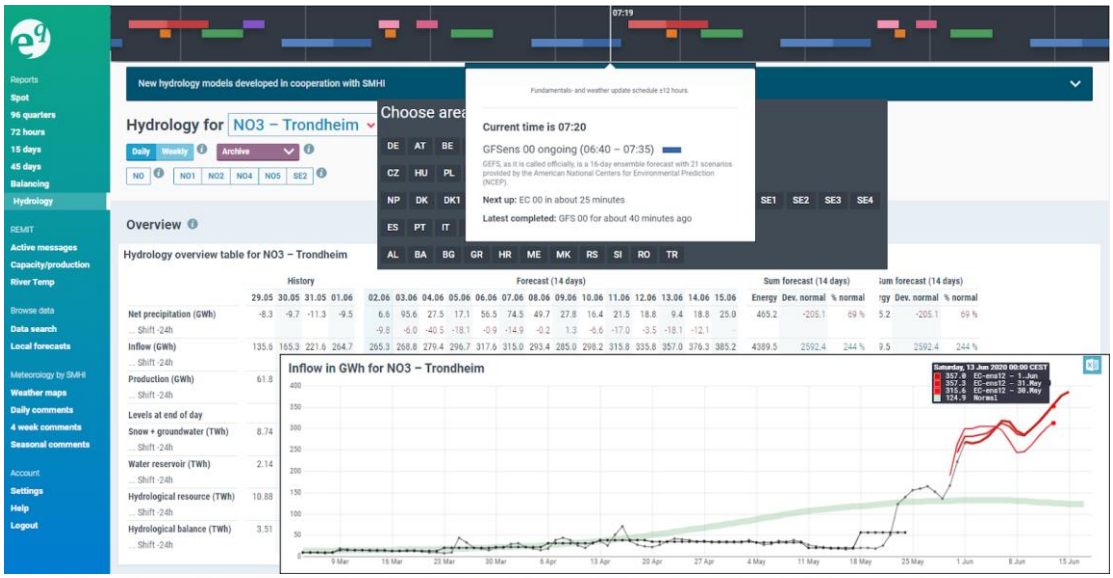
GWh is a value-driven climate service. Users are willing to pay for the daily updated forecasts and historical inflow data in GWh together with complementary EQ-data.

Developers team (SMHI)

H. Ivars Grape, D. Vallot and A. Johnell
helen.ivars.grape@smhi.se

Link

https://www.energyquantified.com/features/hydrology



SEAP

Solar Energy Assessment and Planning Tool

Engage end-users

SEAP was developed following a co-generation process, where service providers and end-users are closely involved in the design of the tool. This process was carried out through face meetings during a 12-month period when service providers and pilot end-users were discussing the users-needs and the specifications and requirements to be implemented in the climate service. The end-user involvement has provided a better balance between the needs of energy system operators and the use of solar production forecast information to improve the production of photovoltaic installations.

Development

SEAP is a web presentation tool for automating both spatial and operational assessment of **utility-scale PV plants**. The SEAP service is a technological tool which provides a forecast of solar radiation and PV energy production, displaying it in a user-friendly web interface, together with other information useful for PV plants managers. The service provides: 1) Predictions from weather forecasts to seasonal predictions; 2) Down-scaling forecasting for specific decisions; 3) Assessing and combining uncertainty information in individual data sources. 4) Understanding of the quality of datasets for energy production regarding climate estimation. SEAP follow an access provision business model, covering new geographical areas and providing new methods to communicate with clients. It uses cost-efficient contracting forms with multi-product revenue generation opportunities.

Value

SEAP provides the best alternatives for those plants the user can act on, either managing the priority of consumption in autonomous installations or determining the most appropriate tracking for each day. The service supports managers to: (1) Operational assessment of solar energy systems on different time scales, daily, monthly, or seasonal, (2) Anticipating or ordering the general working model of the electricity network, 3) Information about the best solar tracking strategy for collectors, (4) Robust decision-making by planning offices. The value of SEAP is particularly remarkable in the case of dynamic plants, where the user can modify the tracking policies to improve production. Having prior knowledge of solar radiation through SEAP service allows the policy of solar trackers to be programmed in advance to optimize the uptake.

Market

SEAP is a value-driven climate service. Users are willing to pay for the implementation and maintenance of a climate service offering clear and reliable information of solar energy availability forecast and how it affects the operation tasks.

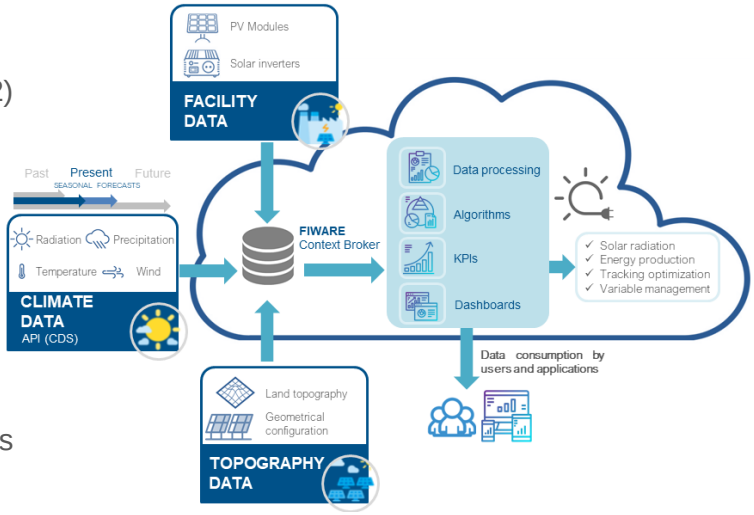
Link

http://www.smartservice.es:8080/user/login

Developers team (UCO)

R. López, I. Moreno, M. Varo, J. Ramírez, L. M. Fernández, F. Casares

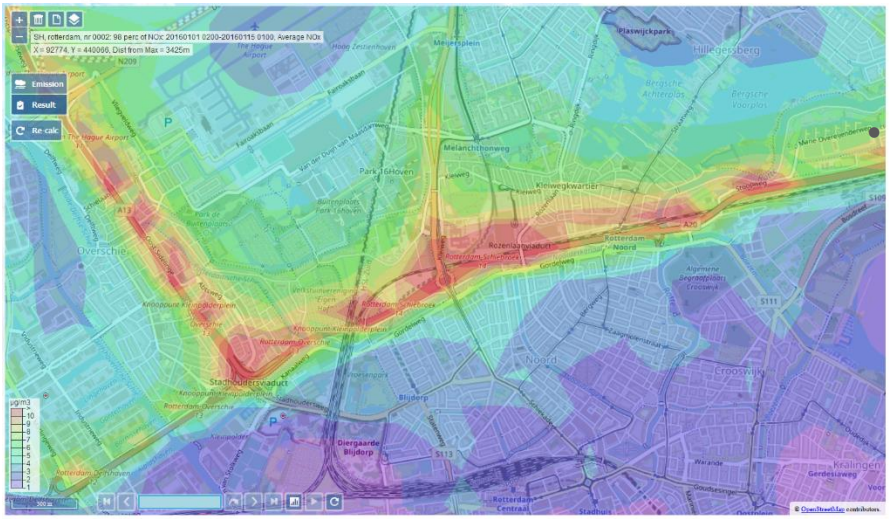
fa1lolur@uco.es



SECTION 5

Air Quality

AIRCLOUD



Engage end-users

The service was co-developed with regional authorities and air quality consultants, they have been engaged in several occasions during MUF:s, project meetings and internal activities in order to identify their needs and priorities. A number of meetings and demonstrations has been carried out with potential users of the service including SLB Analys (Stockholm), EERC (Estonia), Sweco (Gothenburg), IVL (Gothenburg) and Ministerio de medio ambiente (Santiago Chile).

Development

The Apertum AirCloud service is an in-cloud air quality modelling tool based on the air quality system Airviro. The service is used for high resolution assessments on the local level and street level, using Copernicus Climate Change Service C3S_441 Lot3 (URBAN-SIS) data as input and boundary conditions. The cloud service aims at being used in consultancy studies.

Specification:

- A cloud service that will have background concentrations, maps, topography and physiography preloaded for a simulation area. The user will be able to set up its own domain, physically separated from other domains on the hard disk.
- Other data needed such as meteorology and emission data will have simplified interfaces for uploading of information.

The user will have a simplified user interface for running smaller environmental studies such as consultancy work but will also, on demand, have access to all the functionality within the Airviro product.

To support its sustainability, AircCoud will exploit a SaaS (Software as a Service) business model.

Value

The main benefit with AirCloud is that it is cloud-based with most data necessary for air quality environmental impact studies pre generated for the user. This reduces the setup time for a study and hence the cost of making the study. A typical use case in Rotterdam had an estimated time consumption of 24 hours. To do the same with AirCloud required 20 hour for an inexperienced AirCloud user. Our estimation is that AirCloud with an experienced user would gain about 50% of the time.

Market

AirCloud is a cost driven service.

The main users will use AirCloud for environmental impact assessments. They need to use the cloud based functionality of AirCloud to make the assessment. The client will pay for the setup of a geographical area covering the study area.

Link

www.airviro.com

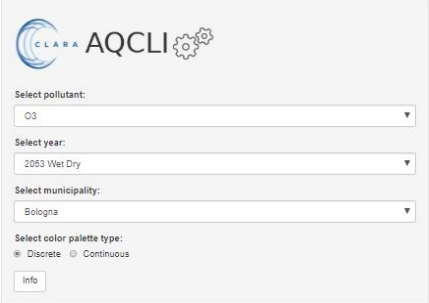
Developers team (APERTUM)

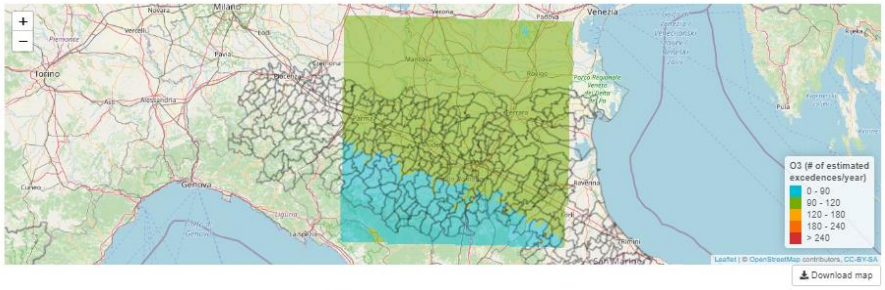
L. Örtegren, P. Ivarsson

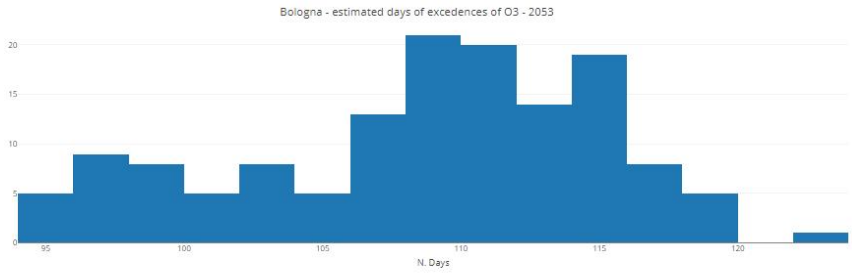
info@apertum.se

AQCLI

Air Quality in future CLImate







Engage end-users

The motivation for this service arises from the increasing awareness of the impact of air quality on human health. The demand for knowledge by people is growing so that the demand of knowledge by local authorities is increasing as well. ARPAE is naturally involved in decision support for public administrations. Cooperation between institutions was the basis of the development of the service.

Development

AQCLI service is a web platform to visualize maps and elaborations. Users may also download all the required data and make their own elaborations.

The AQCLI service produces an evaluation of future meteorological conditions on accumulation of pollutants. The service focuses on single municipalities and is able to estimate the variation of possible exceedances of pollutants in the target area.

Value

The users of AQCLI service may improve the knowledge of climate change impact on a local scale air quality. The users will have a tool to estimate the impact of future meteorological conditions if no emission reduction policy is undertaken. The service may strengthen the planning of air quality improvement policies.

Market

The AQCLI provider is asked by mandate to provide services for the air quality. The value chain is oriented towards the generation and delivery of a given value to customers. In the context of a public authority such as ARPAE, network of data suppliers and customers is built around the common good and represents a truly unique leverage. Ad-hoc requests are managed through the payment of pre-defined fees.

Link

https://sdati.datamb.it/aqcli-vis
https://dati.arpae.it/dataset/clara-aqcli

Developers team (ARPAE)

R. Amorati, M. Stortini

ramorati@arpae.it

SECTION 6

Horizontal Services

PPDP

Post Processed Decadal Predictions

Engage end-users

We engaged with Acclimatise, a leading climate change adaptation consulting company, and SMHI, a research institution specialized in Hydrology, to assess the use and the value. The direct engagement allowed discussing the useful skill level for decision-making.

Development

The PPDP service will provide bias-adjusted and downscaled decadal forecast based on ERA5 reanalysis data as a general service. Other observational data sets can be used in an on-demand service for user specific custom applications.

The business model for sustainability is a mix of products and on-demand services based on value.

Value

There are two types of users benefits. First, the ability to have a forward-looking strategy at the decadal scale ("forecast value") for decision-making. This has the greatest value. Second, an easy access to decadal forecast for research purposes independently of forecast skill. This has value as an outsourcing service (reduce cost, faster availability).

Market

PPDP is a value transversal service and holds great potential for many sectors. However, because forecast skill is not yet sufficient for decision-making, the use of decadal forecast on the short term is limited to scientific and research impact studies. Soon, the Copernicus Climate Change Service will make multi-model decadal projections available allowing sufficient skill for the development of the PPDP service as a downstream transversal service.

Users are willing to pay for forecast skill that allows decision-making that can be different according to sectors. Research users are willing to pay for custom processing of decadal forecast.

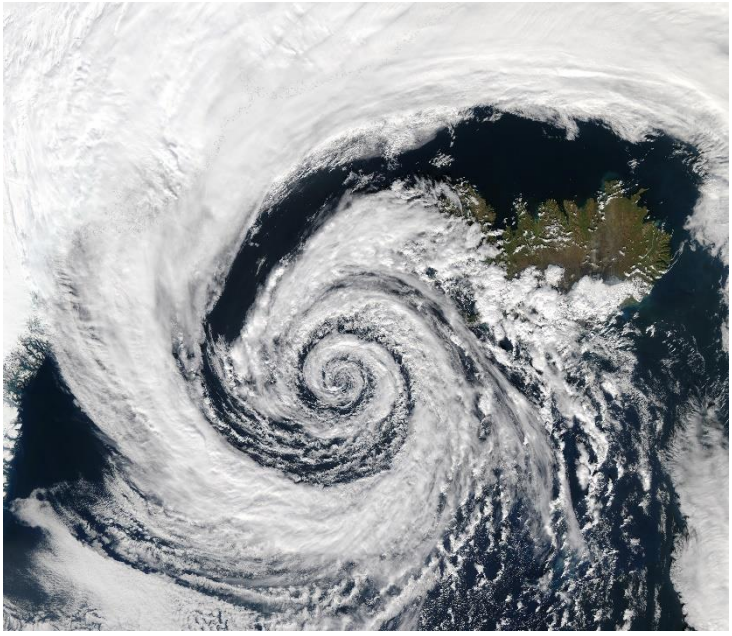
Link

https://theclimatedatafactory.com

Developers team (TheClimeDataFactory)

H. Loukos, T. Noël, F. Cochard

decadal@theclimatedatafactory.com



DATACLIME Clime

Engage end-users

Do you need to know detailed climate conditions? CLIME service allowed to integrate to users to have what really they expects! To support the effective development of CLIME service, CMCC has scheduled web conferences and physical meetings encouraging the direct access to CLIME interface and to collect their feedback and then improve the service. The CLIME service already supports different types of users such as: consultancy companies, engineers, academic researchers, scientists, public administrators. Users with programming skills can furtherly tailor the results provided by CLIME, while for users that don't have advanced programming skills, many different climate analysis are already available; however CLIME service is in continuous development following evolution of the climate studies at CMCC.

Development

CLIME is a climate service developed by REgional Models and geo-Hydrological Impacts Division (REMHI) of CMCC Foundation (www.cmcc.it). CLIME provides observed and simulated climate data (e.g. EURO-CORDEX, COSMO-CLM developed by CMCC) but derived products and solutions for different scopes and users. CLIME take a care of the whole information production chain: from the climate data collection/storage since processing of climate data according to user needs. The processing of climate data includes bias correction and climate analyses using the high-resolution climate projections. CLIME is also able to provide climate data in support further impact studies(e.g. floods, drought, landslides, heat waves, windstorm). The strengths of CLIME are:

- Easy access to a huge amount of climate data;
- Customization of climate analysis on different temporal and spatial scales;
- Different statistical analysis: time series, trend, extreme indices, climate anomalies, multi-model approach and associated evaluation of uncertainty;
- Results available in different format (tables, graphics and maps) to be adoptable in other platforms for additional analysis
- Training materials to support user step-by-step.

To support its sustainability, CLIME may exploit a usage-based business model. Conceived as a web-based and multi-product tool, CLIME aims at supporting decision-making by offering highly scientific results in user-friendly formats. CLIME translates a typically research-dominated approach in a ready-for-market product.

Value

The service supports the decision-making process of users with different expertise by improving understanding and detailed analysis of climate and of related impacts. Most of the services features are designed on the base of interactions with users and stakeholders. Climate results, obtained using CLIME in the pilot application, have been used for further analysis related to the quantitative evaluation of the variation of the impacts, in terms of frequency and magnitude, induced by climate change. Therefore CLIME represented an useful tool to integrate climate change issues into the planning process and so to improve the decision-making process.

Market

DATACLIME is a value-driven climate service. The functionalities are continuously updated in agreement with the standard of scientific community, CMCC finding and users requirements. The users are available to pay for using it if needed; the amount, of course, should be linked to how much data are needed (time spans, concentration scenarios) and required post-processing activities (bias correction, calculation of indices).

Link

Developers team (CMCC)

P. Mercogliano (Scientific leader and product Manager), G. Barbato, (Product Engineer)

V. Villani and A. L. Zollo, (Product developers) N. C. Zollo (Product controller)

clime@cmcc.it

FIGURE 1

WEB PLATFORM PROTOTYPE

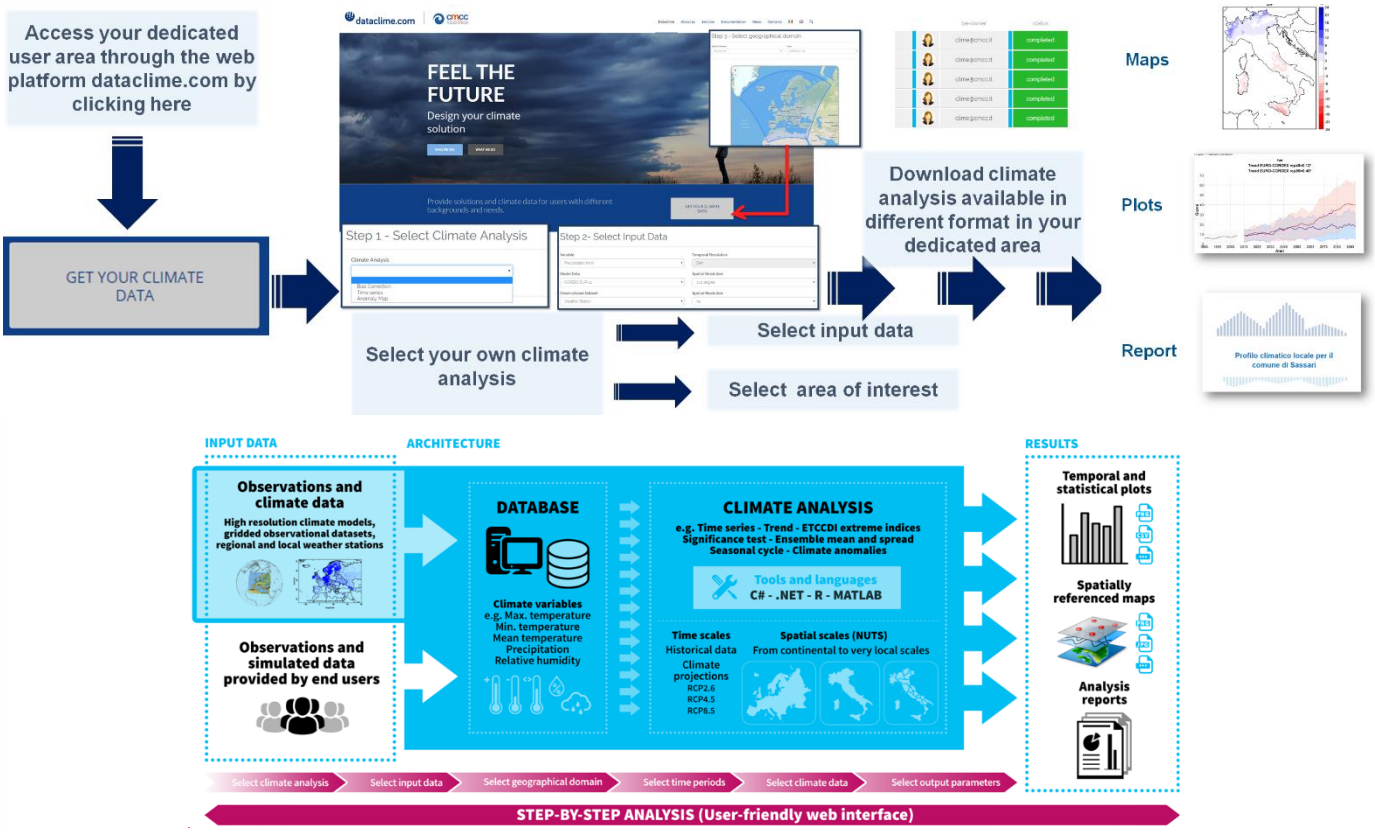
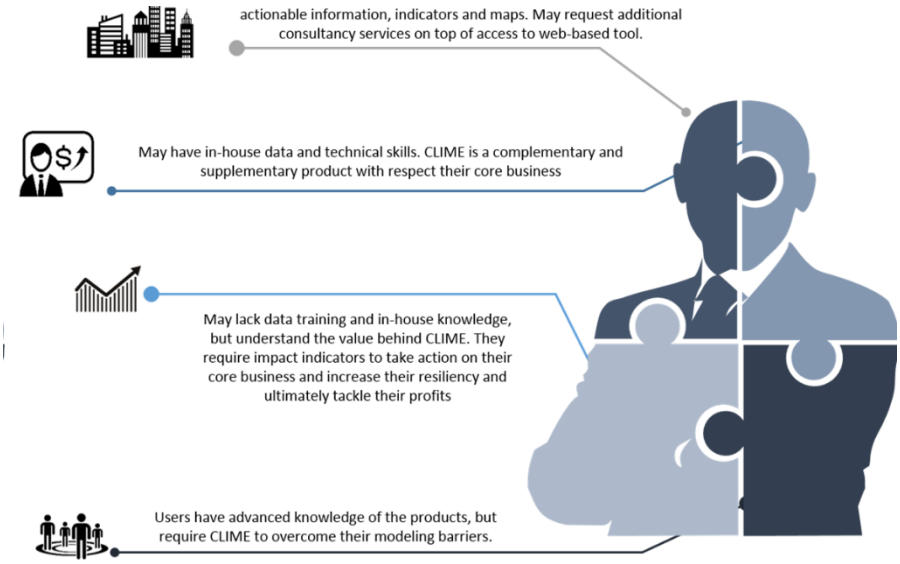


FIGURE 2

CLIME CUSTOMER SIDE



3

PERSPECTIVES AND DEVELOPMENT

Implications and recommendations for a successful CS

Food security and Health

CSs can support in projecting future towards a more sustainable and resilient agriculture and a better air quality. CSs can be introduced for decision making and also for assessing benefits of best practices.

Therefore, the EU funding mechanism could be boosted to promote the use of CSs in selecting sustainable farming and irrigation practices, improving air quality, define adaptation and mitigation measures and finally compute benefits in terms of sustainable use of resources and environmental impacts. Innovation cannot flourish without a strong and continuous flow of funds. Further funding waves may work to support the marketability of these complex innovations, but strongly call for a co-funding mechanism. Users and stakeholders recognized the importance of a common legal framework to reconcile interests and the creation of an intermediate body which reports the interests of low administrations to the higher level (eventually, also EU). Member States of the EU have agreed on rules to improve the lives of European citizens: contribute to climate change mitigation and adaptation; foster sustainable development and efficient management of natural resources such as water, soil, and air; contribute to the protection of biodiversity, enhance ecosystem services and preserve habitats and landscapes.

Water and Climate Change

Feedbacks and comments collected from the users perspective show that the Clara project has produced powerful climate services for the water resource management sector. Provision of tools displaying the current and the future water situation is of great importance to water managers and land use managers for securing water availability and water quality in the following months, or to make big investments that require knowledge for the next 20 to 50 years. These operational advantages not only confirm the enormous economic value generated by climate services but also validate the need to base the development on tailored business models.

Climate services provide not only data and modelling results but most importantly they give access to information that is valuable to water management operations and participatory processes for environmental sustainability. Data is processed and then delivered in a way to facilitate communication and understanding of results to non-expert users and to the public. Thanks to the interactive approach between users and services providers enabled by the cogeneration process, the valuable information is identified from the early stage of development, while innovative solutions are drawn to design services often supported by intuitive and user-friendly online presentation systems.

The customization of hydro-meteorological and climate information represent the nucleus of the economic potential upheld by climate services, which should therefore be supported for commercialization. Different marketing strategies shall be applied for the commercialization of CSs in water management, whether it is addressed to the public of the private sector. Availability of funding from the governments could allow smaller authorities such as municipalities, regions or county boards to set up and employ the use of climate services in their operational activities. At the same time, competitive grand schemes could be implemented to support existing projects and their maintenance in the early stages, until the CS is self-reliant and self-sustaining.

From a regulatory perspective, one of the main issues related to water management arises because of socioeconomic drought, which occurs when different sectors dependent on the same water body or river basin use more water than sustainably available. Effective multi-risk decision support systems already exist within the European framework of flood prevention. In a scenario of climate change and water use where water is becoming increasingly scarce, flood forecasting interacts with medium-term water management, since the water that is "wasted" due to an incorrect flood forecast cannot be used later for irrigation in the critical dry periods of the following months. A better defined regulation for improving water governance during periods of drought is hence needed for guaranteeing an even distribution of water between the involved actors. In some of the European countries that are already strongly affected by droughts (mainly in the Mediterranean region) this is already a key factor, and in the future it may become a conditioning factor on the Northern region too.

Renewable Energy and Climate Change

Under a technical point of view flexibility and in depth customization shall be taken into account in such highly specialized services. For example being able to forecast one specific variable of interest, or tailoring and adapting the service to the geographical area of interest by downscaling the raw forecast data to the local spatial resolution. A specific time scale may be required as well (i.e. hydropower managers are traditionally more interested on short term forecast than seasonal forecast, of greatest interest for market departments).

To overcome reluctancy in the renewable energy sector to apply innovative forecasting CS, attention should be paid in creating confidence and showing accuracy and skills and uncertainties of the provided forecast. While performance metrics of the output information are well known, they imply presence of local observed data (historical and real-time) sometimes unavailable due to a lack of measuring device in energy facilities.

Provided forecasts shall be reliable enough to avoid frequent strategy changes in the decision makers, assessing the damages or losses deriving from wrong forecasts.

Co-development and interactions with the users in the Energy sector (despite relevant technical background) preference should be given to provide simple and clear information’s (i.e. correct scale and the right

tools to convey information, which results in a more effective knowledge system). The human factor shall not be overlooked in this co-development process. This opens an interesting window of opportunity for the consultancy sector actor to promote innovation playing as a bridge between "complicated" CS and users "that look for simpler information".

Value for the users is evident when skilful predictions in weather, climate and hydrology are translated in monetary metrics (i.e. more revenues, extra profits or avoided costs). Playing with a new CS in what could have happened scenarios (with or without the added climate knowledge) with past data helps disclosing such value.

Encouraging innovation starts from a tangible co-developed proof of concept, a basic privacy agreement on exchanged information and (often sensible) data, and training for users (a process to help overcoming tendency to keep "old habits" and support the innovation adoption and enhance in house capacity building).

Targeting Business and economics aspects, to foster a systemic innovation is needed in the RES sector, national governments should provide energy companies with guidance, information about available climate services, shared platforms, which will facilitate energy companies the access to relevant climate information innovation. Unfortunately most of the National Renewable Energy Action Plans (NREAPs) do not provide incentives to encourage energy companies and stakeholders to implement climate adaptation actions.

Also introducing new ambitious regulatory frameworks to push towards innovative CS adoption (i.e making accurate energy forecast a vehicle for getting premiums from the produced energy or facing penalties in case of mismatch).

The experience of existing EU-funded projects, the know-how and expertise but also the IT-based technology needs to be exported to the rest of Europe, thus contributing to the Energy Union. However, a longer time funding needs to be considered to improve the emerging climate services and ensure their scalability, viability and commercialization involving the private sector.

Access Provision Business Model is preferred in the developed CS, covering new geographical areas and providing new methods to communicate with clients. Users are willing to pay for the implementation and maintenance of a climate service offering clear and reliable information of water availability for the next season and how it affects the operation planning. Cost of the CS depends on the type of service and the level of public support to invest in capacity building and education for behaviour changes in the RES sector.

For a successful marketability and commercialization of the climate services, a European macro framework with an institution which centralizes the information and links climate services providers with end-users would facilitate the communication and market channels. In addition, the success of the climate services for the energy sector relies on the development of formal partnerships and collaborations with agencies, organizations and bodies working on energy (e.g. WEC, UN Energy, IRENA, IEA), which support shared platforms including targeted climate services based on Copernicus dataset and promoting them among business associations in the energy sector in order that they can support their members in building climate resilience. Platforms need to be also promoted by global renewable energy communities of actors from science, governments, NGOs and industry (e.g. REN21), helping to foster a dialog between meteorologists and energy business communities and to identify major challenges which should be addressed in a co-design approach in the coming years.

4

STAFF AND COMMUNITY OF CLARA PROJECT

The CLARA Consortium is composed by work-package Leaders of CLARA Project, which are: ARPAE, UCO, SMHI, ISPRA, CMCC, and Co-Leaders, that are RER, ISPRA, GECOS, ARPAE, SMHI. Leaders and co-leaders share responsibility with the Project Coordinator for the timely and effective implementation of the activities planned in each WP of the project.

Main activities cover:

- ensuring performance and progress of the activities with regard to the deliverables and project milestones;
- coordination and monitoring on a day-to-day basis of the progress of the Workpackages, with a particular attention to the activities carried out within the other WPs;
- ensuring communication between members of the WP and to the PSC of any plans, deliverables and information concerning the work packages;
- delivering regular activity reports, i.e. referring to work progress and budget-development to the PC, alerting in case of delay or default and if necessary with suggestions for the solution of problems.

The Clara Consortium has appointed a high-level panel of distinguished experts to advise the strategic orientation and implementation of the project. The High Level External Advisory Board (HLEAB) is composed by appointed internationally renowned experts with strong expertise and experience in developing and deploying climate services. The role of the HLEAB includes:

- to advise the Consortium regarding direction, performance and results;
- to guide the users engagement and dialogues, and ensure practical relevance of the project results;
- to provide directions to the Users ‘Forum;
- to participate in the project events and provide feedback to the Consortium.

Roger Street is a Senior Research Fellow within the UK Climate Impacts Programme at the University of Oxford. Carlo Buontempo is manager of the Sectoral Information System of the Copernicus Climate Change Service at ECMWF. Sara Venturini is a senior policy advisor on climate change and a development economist.Thomas Klein is a senior analysis at the Swedish Agency for Marine and Water Management.

cmcc
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Contacts

clara_info@cmcc.it

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Contributing layout by Renato Dallavenezia