



AQUACLEW case study progress report

Title of Case Study

Fluvial and Coastal Interactions under Mediterranean Climate Conditions

Authors

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Client Organisations

- Andalusian Regional Government
- Provincial Coastal Service of Granada
- Management Service of the Rules-Béznar reservoirs' system
- Hydrological Service of the Andalusian Mediterranean Basin
- Port Authority of Motril, Granada.

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Water management issue

Deltaic systems are unique landscapes of a high environmental value in continuous transformation due to the sculpting action of marine and fluvial dynamics. In the last two centuries, the growth of tourism and its occupation for agricultural and industrial activities, has favoured the irrational use of their resources. Sometimes they are also suffering severe erosion problems due to the regulation of their rivers' flows. Mediterranean deltas such as those at the Guadalfeo and Adra river mouths (Spain) are especially vulnerable to sea level rise, which is one of the most important causes of delta retreat around the globe. Therefore, the present issues found in these systems and the erosion in the adjacent coasts will become aggravated in a climate change scenario that includes sea level rise and changes in the frequency and persistence of storms and precipitation events.

We propose to analyse changes in physical processes such as sea waves, fluvial discharges and sediment transport, that interact and control the dynamics of these zones as well as the integrity of the physical environment and ecologic condition under different climate change scenarios to contribute to the quality and usability of climate services at fluvial, coastal and transition zones of semiarid watersheds in this region.

Use of Climate Data

According to the interviews to the different clients, we found that the clients are using historical climate atmospheric and maritime data (measured and from numerical modelling) but they are not currently using any climate change projections data. The most used services are REDIAM, AEMET and Puertos del Estado databases without any major training.

The clients use climate data in the planning of coastal and hydraulic works such as, nourishment projects, the design of infrastructures such as dykes for river and beach protection and the operational planning of reservoirs.

Preliminary Workflow Results



Assessment of needs and applications – In order to identify the end-users’ needs, we set up a series of interviews to get the input and co-design the main results expected from this work.

We met with people from the following entities:

- Provincial Coastal Service of Granada. Ministry of Agriculture and Fisheries, Food and Environment
- Port Authority of Motril (Granada)
- Coastal Demarcation of Andalucia – Mediterranean. Ministry of Agriculture and Fisheries, Food and Environment
- Management Service of the Rules-Béznar reservoirs’ system. General Secretary of the Environment and Climate Change. Andalusian government (Junta de Andalucía).
- Hydrological Service of the Andalusian Mediterranean Basin. Regional Delegation of the Environment and Land Planning in Málaga. Andalusian government (Junta de Andalucía).

The different end-users are concerned regarding the erosion problems in several coastal areas and expressed their interest in our work regarding the climate change scenarios and variations in storms’ frequency and intensity as well as flooding mitigation and adaptation recommendations.

To improve our knowledge regarding the use of climate services and their usability by end-users and decision makers, the member of the team Andrea Lira Loarca attended the *ERA4CS Summer School on Climate Services from the user’s perspective* on September 10-14th, 2018 in Pisa, Italy organized by JPI Climate and the Institute of Geosciences and Earth Resources CNR. This summer school has helped us to understand better the end-users perspective and their needs for climate services.

From the inputs of the interviews and the summer school, a methodology for the analysis of storm events and flooding in coastal areas involving the use of different model projections (weather data),



wave propagation models to obtain maritime data, simulation techniques, among others was designed.

Analysis of coastal and river mouth dynamics – We have performed an assessment of the current state of the coastal dynamics in the Guadalfeo and Adra river mouths.

This step included the use of downscaling and statistical techniques and stochastic analysis and simulation, among others. The development of this techniques and their application on the coast of Granada led to the following presentations:

- *Lira-Loarca A., Cobos M., Magaña, P., Millares, A., Baquerizo, A., 2018. An Integrated Statistical Modeling Framework of Maritime Data in a Climate Change Context: Application to MSc. Teaching, in Proceedings of the 10th International Conference on Education and New Learning Technologies EDULEARN18. Palma de Mallorca, Spain. 2-4th July, 2018.*
- *Lira-Loarca A., Cobos M., Baquerizo, A., Losada, M.A., 2018. A multivariate statistical model to simulate storm evolution, in Proceedings of the 36th International Conference on Coastal Engineering ICCE. Baltimore, USA. July 30th – August 3rd, 2018.*
- *Lira-Loarca A., Cobos M., Baquerizo, A., Losada, M.A., 2018. Multivariate forecasting of extreme wave climate and storm evolution, in Proceedings of the International Conference on Time Series and Forecasting ITISE. Granada, Spain. 19-21st September, 2018*
- *Lira-Loarca A., Cobos M., Losada, M.A., Baquerizo, A., 2019. Storm characterization and simulation for damage evolution models of maritime structures. Under review in Coastal Engineering.*

The study of the erosion and sediment dynamics of the river basin of the Guadalfeo and Adra rivers led to the following presentations:

- *Arjona, S., Millares, A., Baquerizo, A., 2018. Reservoir sedimentation impact downstream in a semi-arid basin with greenhouses cultivation, in Proceedings of the 9th International Conference on Fluvial Hydraulics RIVER FLOW. Lyon-Villeurbanne, France. 5-8th September, 2018.*
- *Millares, A., Moñino, A., Arjona, S., Baquerizo, A., 2018. Suspended sediment dynamics by event typology and its siltation effects in a semi-arid snowmelt-driven basin, in Proceedings of the 9th International Conference on Fluvial Hydraulics RIVER FLOW. Lyon-Villeurbanne, France. 5-8th September, 2018.*

Given that our case studies focus on ocean-river dynamics, the variables of interest can be derived into two groups: significant wave height, peak wave period, mean wave direction, mean wind speed, mean wind direction, mean sea level, astronomical tide from a maritime viewpoint and precipitation, temperature and river flow from a hydrological approach.

The numerical model Delft3D is being set-up and calibrated for the wave propagation and simulation of local hydrodynamics processes. To analyze fluvial dynamics, the model WiMMed is being used on both case studies.

Maritime climate projections and impacts – In order to gain knowledge of the different climate change models and its use towards the analysis of sea level rise and the modeling of maritime data



and its impacts due to climate change, the member of the team, Andrea Lira Loarca, attended the *CLIVAR-FIO Summer School on Past, Present and Future Sea Level Changes* and *UNESCO/IOC-ODC Training Course on Ocean Forecast Systems* in Qingdao, China from June 25th until July 7th, 2018 where she presented the preliminary results of this case study:

- *Lira-Loarca A., Cobos M., Millares, A., Baquerizo, A., Losada M.A. 2019. Sediment Transport and Coastal Erosion Processes in Southern Spain under Climate Change Scenarios. CLIVAR Exchanges, 76, pp. 27.*

UGR has started cooperation with researchers of the DICCA department of the University of Genova, Italy who are currently working on the MED-CORDEX initiative for wave projections in the Mediterranean. Offshore maritime data was obtained for RCP8.5 forces by wind data of 7 EURO-CORDEX models using WavewatchIII with calibrated source-term parameters following the same configuration as Mentaschi et al, 2015.

UGR is currently working on trend analysis of the offshore conditions and the propagation of RCP8.5 offshore maritime data to shallow conditions using the model Delft3D.

The preliminary results of this work will be presented on:

- *Lira-Loarca A., Cobos M., Besio, G., Baquerizo, A. 2019. Coastal flooding due to extreme events in the Mediterranean coast of Spain, in Proceedings of the International Conference on Regional Climate ICRC-CORDEX 2019. Beijing, China. 14-18th September, 2019.*

Development of end-user tools and feedback – Within the work of different projects of the Environmental Fluid Dynamics group, a series of Python-based tools are being developed which will allow the maritime climate characterization and the statistical analysis and simulation of long term time series of maritime and hydraulic climate.

Client perspective

During the interviews, the clients emphasized the need of efficient and user- friendly tools for climate characterization and stochastic simulations. The clients are not currently using any climate change projections data given that they don't have the access and/or means to successfully analyse the data. We are currently working on the development of tools for the analysis and characterization of maritime and hydrological variables. The development of maritime data under climate change scenarios is a complicated and time-consuming process which we are tackling in both the Guadalfeo and Adra fluvial and coastal areas and have plans to expand to the rest of the Mediterranean coast. We agreed with the clients that this was going to be a working-process and was not going to be completed within AQUACLEW project.



Task list

We are currently working on the wave propagation of the 7 models RCP8.5 offshore maritime data and the trend analysis of both offshore and shallow-water conditions. This is being done while also developing Python-based tools. We hope to have this finished by December 2019.

After this we will move to present and discuss the case studies results with the clients. We hope to have a set of tools which will allow for their decision-making process and will take their input on these tools and results in order to develop a series of recommendations and user-friendly tools. We hope to get a first meeting with the clients during January 2020 and work on the last months of the project with them for the competition of a series of recommendations and tools.