Progress Report

Name of Case Study

Water Demand and Supply of Metallurgy Sector

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Brief summary of case study for clients/other consultancies

Metallurgy industry groups, HALCOR and ELVAL, need to assess: (a) the adequacy of currently used water resources in near future (15 years ahead) and (b) the need to invest on more effective influent and effluent treatment facilities.

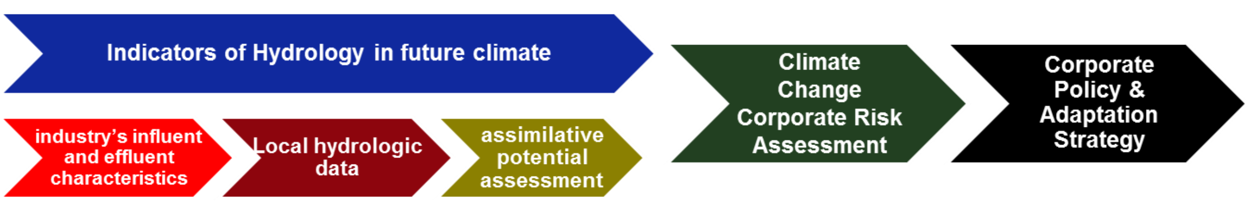
SWICCA indicators are the core data for investigating the supply chain, water related risks and evaluating the assimilative capacity of effluent receiver (Asopos River), under climate change conditions.

Climate impact indicators conveniently accessible, are key data, free of the need for laborious processing. They cannot cover all aspects of local issues but combined with local data can support climate change impact investigations.

What specific indicators have you used?

Indicators used for this study are: River Flow (seasonality), Precipitation (0.5 degree grid), Temperature (0.5 degree grid) and Population.

Results following the workflow



Indicators of Hydrology and future climate – Seasonal River Flow indicators, based on catchments spatial analysis, have been used for Evinos & Mornos reservoir subbasins, which provide the necessary water, and for the Asopos River which is the effluent water receiver. These indicators, in the majority (about 80%) of the available scenarios reveal that available water, through discharge, is going to slightly reduce (5% to 7% of mean annual discharge) in the next 30year period

(2011-2040). Due to differences between simulated and observed (Step: *Local hydrologic data*) river flow which is probably due to differences between modeled and observed precipitation in the catchments of Evinos and Mornos, daily precipitation and temperature data, with spatial analysis of 0.5 degrees, were used for assessing future discharge and reservoir losses due to evaporation. Local data were used (see Step: *Local hydrologic data*) in order to bias correct the SWICCA data. Mean values, mean & variance and Full PDF bias correction was applied, as presented in Figure 1. It is noted that Fig.1b is not representative of the amount of missing data, annual observed values have not been presented for years with missing daily values. Further, indicators for future evolution of population were downloaded from the socioeconomics sector of the Demonstrator, for the greater area of Athens, in order to be used in future water needs assessments.

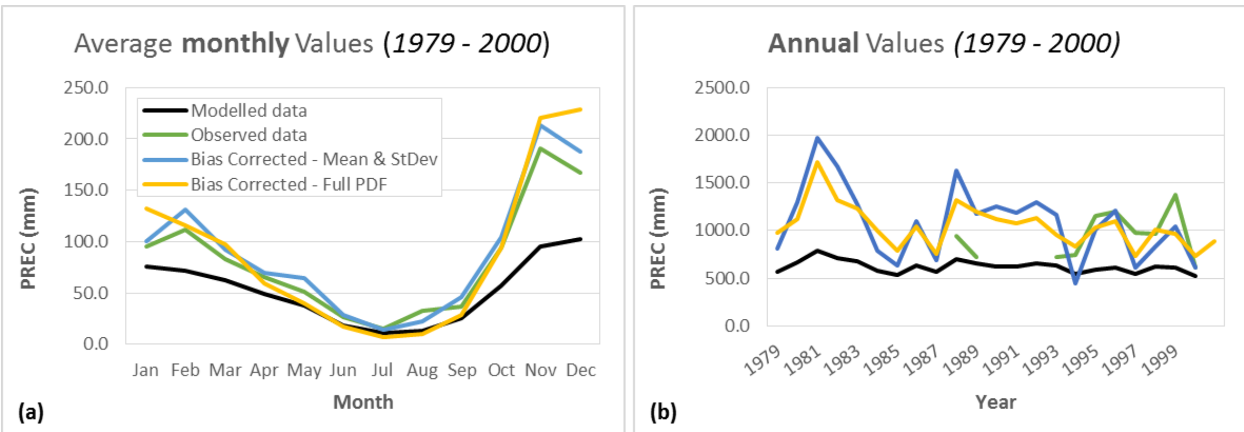


Figure 1. Bias correction of Precipitation daily time series (Scenarios Ensemble), downloaded from the SWICCA Demonstrator for the Monros basin: **(a)** average monthly values and **(b)** Annual values.

Industry's influent and effluent characteristics – Meetings, in person, with the clients have taken place where, through discussions, their needs were explained to the purveyors (EMVIS) and it was made clear to them what services can be provided, what solutions can be given to their problems and which data they should contribute for the assessments. Tools, freely available on the internet, which assess, at some degree, the water related risks of a company and support a long-term water management strategy, were introduced to the clients. They were supported and encouraged to use them which resulted in highlighting the need for more thorough and detailed analysis which is based on climate change indicators. Presentation of the first assessment results stressed out the need for data contribution, on behalf of the clients. An interest in assessing climate change impact on influent quality characteristics such as water temperature, rose up in the latest meeting.

Local hydrologic data – An extended literature review of available studies regarding the water supply of Athens greater area as well as national water management plans for water districts of the area of interest (i.e. GR07 – Anatoliki Sterea, GR06 – Attiki, GR04 – Dutiki Sterea), covering a period from 1988 to 2008, has been carried out. Although the two reservoir system (Evinos-Mornos), which is fully functional since 2000 (Mornos reservoir operates since 1980), has a large water potential, the quantity pressures that are posed upon it, which mainly derive from the water supply needs of the Athens greater area, are significant. Thus, the future availability of these water reserves for uses other than the water supply of the capital (in our case, industry supply) will depend on the development of future water needs of Athens and the change in precipitating and discharging water. According to the literature data, Mornos reservoir, with a useful storage volume of about 630 hm^3, provides a mean annual volume of 450 hm^3. Of this volume, a mean annual 200 hm^3 are provided from Evinos reservoir (useful storage volume of about 135 hm^3). Relations among precipitation and river flow have been extracted for both reservoir basins and they were used for annual and monthly water budgets of the reservoirs (see Step: *Climate Change Corporate Risk Assessment*). The two-reservoir system is designed to store larger volumes than the mean annual water needs which are about 410 hm^3. Regarding socioeconomics of the area, the related population faced a decrease of 2,3% during the decade 2001-2011 and there are not any indications that population is going to rise the next decade. Additionally, historical daily data for precipitation and temperature have been collected from local stations in order to support the bias correction of the available, through the SWICCA Demonstrator, Climate Change Indicators of Precipitation and Temperature daily data (see step: *Indicators of Hydrology and future climate*).

Assimilative potential assessment - The climate change impact on annual discharge of Asopos River is very weak (variation only by ± 1%). However, during summer months a decrease in discharge by 15% is observed in the 2020 period (compared to the reference period). The Emission Limit Values for 6 heavy metals (Cr, Cd, Cu, Pb, Ni and Zn) examined follow the same trends. ELVs in 2020 are decreasing by about 10% depending on the pollutant. It is an indicator that only slight, probably imperceptible, changes are expected for the river's assimilative capacity.

Climate Change Corporate Risk Assessment – Annual water budgets of the Evinos-Mornos reservoirs system were calculated for the 30year period 2011-2040 in order to initially identify if there is a trend for water shortage in the near future. Since the system is designed to store larger volumes than the mean annual water needs, water budgets on a yearly base is an adequate approach. Daily data of Precipitation, provided by SWICCA Demonstrator and biased corrected based on local data, were used for the estimation of annual river flows in the Evinos and Mornos reservoir basins, according to relations extracted from available studies (see

Step: *Local hydrologic data*). Mean annual reservoir losses due to leaching were extracted from available literature and evaporation losses were calculated based on biased corrected, SWICCA daily temperature data. The cumulative probability distribution of net inflow (river flow minus reservoir losses) in the reservoirs is presented in Figure 2. According to these results, although there is a decreasing trend of annual net inflow in the reservoirs, the trend is small. For Evinos, even the smallest annual net inflow is larger than the mean annual withdrawal. For Mornos, there is only a 10% rise of the percentage of years for which the net inflow is less than a safe withdrawal rate that has been defined.

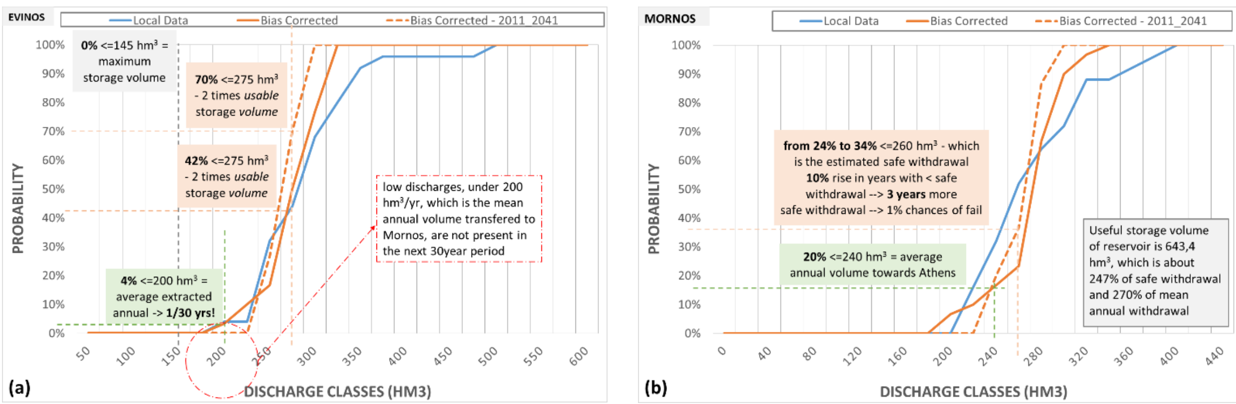


Figure 2. Cumulative probability distribution of net annual inflow (river flow minus reservoir losses), calculated combining local data and Pan-European indicators for the period 2011-2040, in the reservoirs of **(a)** Evinos and **(b)** Mornos.

Results based on the 11 SWICCA climate change scenarios and a more detailed analysis of monthly water budgets for the Evinos-Mornos reservoir system, presented in Figure 3 show that, if the mean annual withdrawal remains the same, at about 450 hm^3, the system will sufficiently cover the water needs. Even if the annual withdrawal rate increases above the defined safe withdrawal (about 460hm^3), still the water supplies will remain safely high. Additional, worst case scenarios, based on the assumption that the driest years appear in sequence, at the beginning of the period 2011-2041, reveal a resilient water supply system, as presented in Figure 4.

Taking into account the fact that local data and European socioeconomic indicators (see Step: *Indicators of Hydrology and future climate*), regarding the population of the Athens greater area, show a slight decrease in the near future, it seems highly probable that current water resources are adequate and the client will not have to seek for alternative water sources.

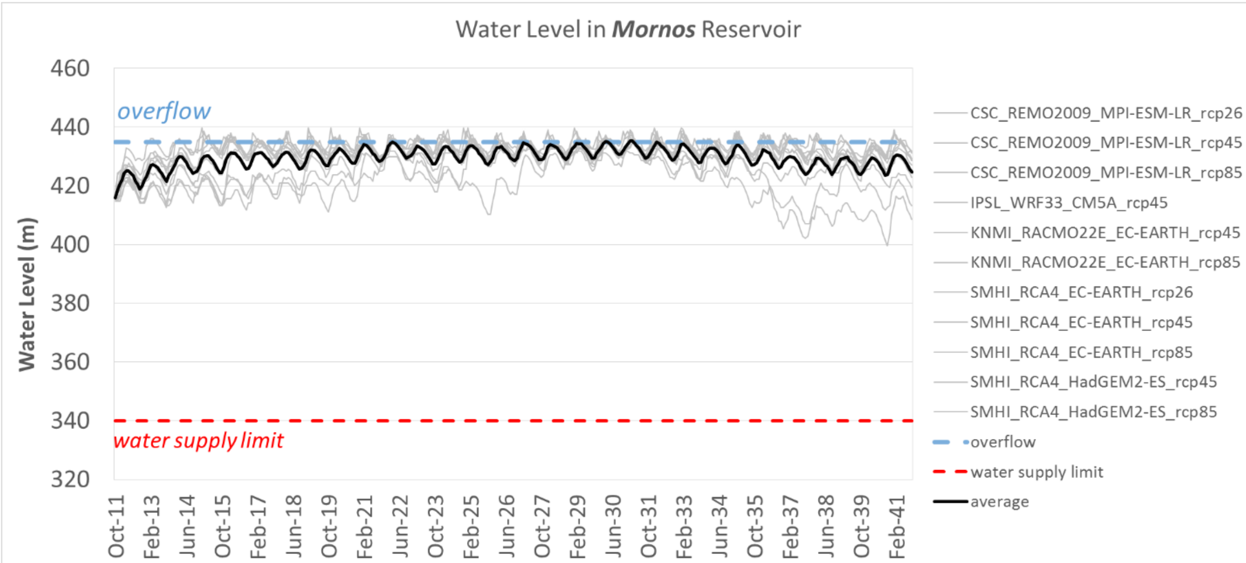


Figure 3. Water level, calculated combining local data and Pan-European indicators for the period 2011-2040, under the 11 SWICCA climate change scenarios and the average annual withdrawal, for Mornos reservoir.

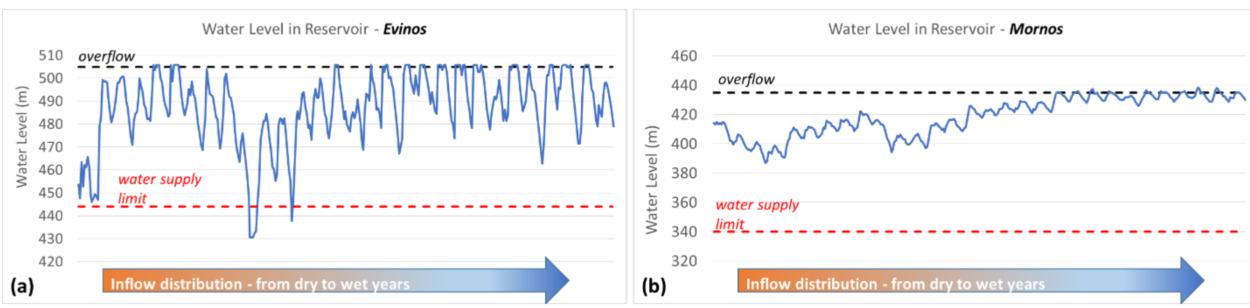


Figure 4. Water level, calculated combining local data and Pan-European indicators for the period 2011-2040, under the CSC_REMO2009_MPI-ESM-LR_rcp85 scenario and worst caste (dry years) inflow distribution, for **(a)** Evinos and **(b)** Mornos reservoirs.

Corporate Policy and Adaptation Strategy – The estimated marginal climate change impact on the quantity of water resources that the metallurgy group is based on for production, will guide the corporate climate change adaptation strategy towards other concerns, such as the quality of available water resources, with emphasis on inflow water temperature.

Specific Case Study Description Updates:

Decision support - including how indicator supports the listed decisions

The current assessment addresses two major concerns of the interested metallurgy industry groups: (a) the need to invest on other than the currently used water resources in near future (15 years ahead) and (b) the need to invest on more effective influent and effluent treatment facilities.

SWICCA indicators provide the core data to evaluate climate change impact on the client's water resources and effluent treatment procedures. Up to now the analysis indicates that the client should focus the climate adaptation strategy towards water quality issues (influent and effluent) and not water availability.

Policy aspects

The present case study, apart from water availability, is related to water quality issues of the effluent receiver, the Asopos River. The metallurgy groups will estimate the need for investing on better effluent treatment facilities in order to conform to restrictions imposed by the local policy and in relation to the the goals of the EU Water Framework Directive.

Lessons Learnt

SWICCA Maps, Graphs and download interactive web map proved to be a useful tool in the interaction with the clients which allowed for (a) quick demonstration of climate services potential for business relative information and (b) and raising awareness on potential climate change impacts, for which the clients may be unaware of or not alarmed enough to initiate a climate change adaptation policy. Additionally, the climate service provides the means for conveying the nature of uncertainty which characterises climate change and is not easily perceived by the clients.

Indicators which are produced after a series of processing are very useful and save a lot of time, however they cannot cover all aspects of local issues. Pan-European indicators of daily time series can be an efficient supplement to the analysis, in combination with local data.

The near future water availability has been assessed based on precipitation, temperature and population indicators in combination with local hydrological and water needs data. Results indicate that the investigated water sources will suffice to satisfy future water demand for all current uses and therefore, the client will not have to invest on changing the industry's water source. Results presentation and further interaction with the clients highlighted a new potential need for climate change impact evaluation on inflow water temperature. Further analysis, in combination with expected client's data is planned for evaluating effluent-treatment needs for the next 10 to 15 years.