Progress Report

Name of Case Study

Environmental flows and point source emissions

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Brief summary of case study for clients/other consultancies

Special Secretariat for Water, being responsible for the implementation of the WFD in Greece, needs to evaluate the efficacy, under climate change pressures, of regulatory measures (Emission Limit Values) imposed on local industry at the Asopos River area.

SWICCA's River Flow indicators will be the key data for evaluating the assimilative capacity of Asopos River under different scenarios regarding average flow 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).

Results following the workflow

Hydrological information: The main hydrological input for the determination of the ELVs is the discharge of Asopos river, which is the receiver of effluent from various industries located in the area. Asopos river basin is divided into two sub-basins according to E-HYPE discretization. Monthly averaged discharge values were downloaded from the SWICCA demonstrator for the reference period and two future climate change periods (2020 and 2050) for each one of the 11 different climatic scenarios simulated. These data were imported on wPOLIS interface. wPOLIS (http://switchon.emvis.gr/polis) is based on a simple water quality model and it is able to determine which is the maximum concentration of pollutant in the industries effluent so that the concentration in the surface water bodies remain below the Environmental Quality Standards.

Local data of industrial activity: Asopos river basin, which is located 35 km north from Athens, hosts a large industrial sector (20% of the total national industrial production). According to previous studies there are almost 450 industries located in the area. While this estimation may be lower than the real number of industries it is considered that the majority of the large facilities associated with the most significant pressures have been listed. The number of industries that are discharging their effluent in Asopos river is 24. This number is quite small compared to the 106 industries with liquid waste that are using other type of receivers (groundwater, soil) for their effluent. However insufficient data for a large number of industries, about 65%, did not allow for the determination of their activity, the quantity of effluent and the type of receiver. In order to account for these industries it is advisable to use lower accepted values for the pollutants concentration than the EQS, in order to leave a safety margin while estimating the assimilative capacity of the water bodies. For this reason the highest accepted concentrations in the river bodies were set to 50% of the EQS. The 24 identified industries are categorized to 6 sectors: food and drinks industry, textile manufacturing, manufacture of chemical products, manufacture of plastic, and manufacture of basic metals. ELVs will be determined for 6 heavy metals namely Chromium (Cr), Cadmium (Cd), Copper (Cu), Lead (Pb), Nickel (Ni) and Zinc (Zn).

Table 1 shows the correlation of industrial activities with presence of heavy metals in the liquid waste.

Table 1. Correlation of activities and heavy metals in the liquid waste (source: WHO)

Sector	Pb	Cu	Zn	Ni	Cd	Cr
Food industry	✗	✗	✗	✗	✗	✗
Drinks industry	✗	✗	✗	✗	✗	✗
Textile	✗	✗	✗	✗	✗	✓
Manufacture of Chemicals	✓	✗	✓	✗	✗	✓
Manufacture of Plastic	✗	✗	✓	✗	✗	✗
Manufacture of Metals	✓	✓	✓	✓	✓	✓

However according to available measurements conducted to treated waste water from various industries, it was found that heavy metals were present in the treated waste water of industries from all 6 industrial sectors, except for Cadmium which was not detected in effluent from industries related with manufacture of drinks.

Following a conservative approach it was decided that Cu, Zn, Ni, Cd and Cr were associated with all (24) industries while Pb was associated with all industries except those belonging to drink manufacturing (22).

Local socioeconomic data: Regarding the future industrial activity three scenarios will be examined. These scenarios will be combined with the 11 climate change scenarios regarding Asopos discharge for the 3 different time periods (reference period, 2020 and 2050). The first scenario is based on the assumption that industrial activity in the area will remain the same and the distribution between industrial sectors will not change. This scenario will be applied for all time periods. The other two scenarios represent an increase and decrease in the future industrial activity in Asopos industrial zone by 20%. These two scenarios will be combined only with the future time periods (2020 and 2050).

Water quality modelling: Table 2 shows the 7 groups of scenarios regarding time period and industrial activity. These scenarios where paired with 11 climate change scenarios yielding 77 scenarios in total for each pollutant. These scenarios were simulated with wPRISMA and ELV values for each pollutant were calculated.

Table 2. Scenarios examined

Group	Time period	Socioeconomic scenario (industrial activity)	Hydrological scenario (discharges)
1	Reference	Base	11 scenarios
2	2020	Base	
3	2020	20% decrease	
4	2020	20% increase	
5	2050	Base	
6	2050	20% decrease	
7	2050	20% increase	

Chromium: Chromium ELVs for the reference period range from 509 ppb to 625 ppb with a median value of 602 ppb. This number is quite higher than the currently legislated value which is set at 200 ppb. Chromium ELVs for the 2020 base scenario are lowering due to the decrease of Asopos discharge and range from 362 ppb to 684 ppb with a median value of 454 ppb. However in one scenario (SMHI_RCA4_HadGEM2-ES_rcp45) river flow of Asopos increases thus leading to lower ELVs. Chromium ELVs for the scenarios featuring a change in industrial activity by ±20%, follow more or less the same pattern. In the scenario of increased industrial activity, ELV values are lower by 13% from those of the 2020 base scenario, while in the decreased industrial activity scenario ELVs were increased by 19% on average.

For the 2050 base scenario the picture is slightly different. ELV values are in general higher than the reference period due to an increase in discharges during summer months. Also for 2050 time period the scenarios with change in the industrial activity follow the same pattern with the 2050 base scenario with ELV values 19% higher and 15% lower for decreased and increased industrial activity respectively.

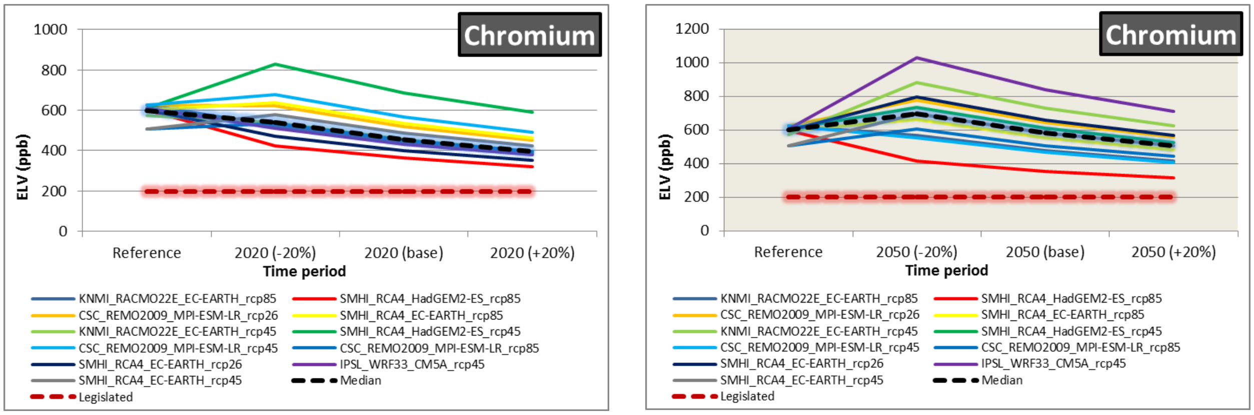

Figure 1. Variation of Chromium ELVs for various climate change scenarios and time periods examined.

→ <u>Copper:</u> Copper ELVs for the reference period range from 169 ppb to 208 ppb with a median value of 200 ppb which is in accordance with the currently legislated value which is set at 200 ppb.

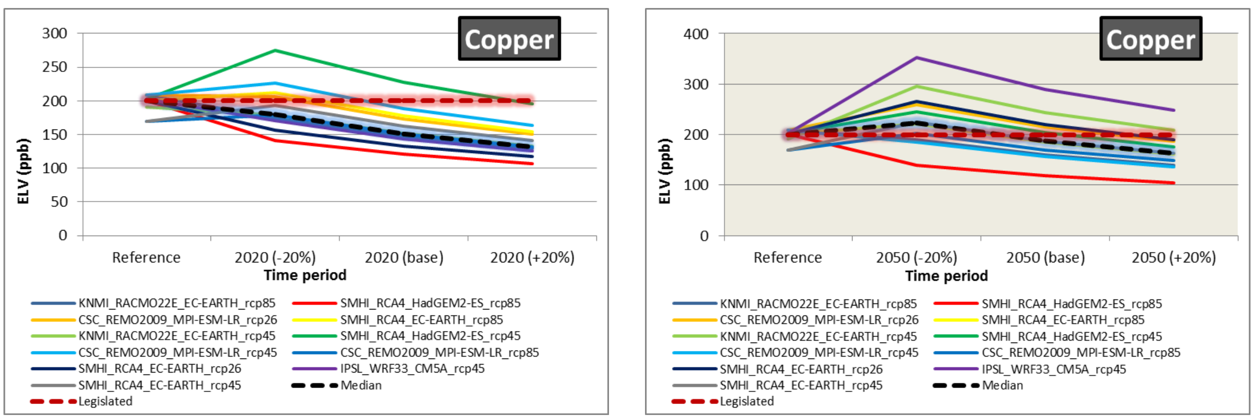

Figure 2. Variation of Copper ELVs for various climate change scenarios and time periods examined.

For the 2020 base scenario ELVs are getting lower for 10 out of 11 scenarios with their median value dropping to 151 ppb. In the 2050 base scenario 7 out of 11 scenarios show an increase in ELVs due to increased flows with the median value increasing to 187 ppb. Regarding the socioeconomic scenarios the results are similar to Chromium. For both the 2020 and the 2050 time periods ELVs decrease by about 13% when industrial activity is increased by 20% and increase by 19% when industrial activity is decreased, compared to the base (no change in industrial activity) scenario.

→ <u>Zinc, Nickel, Lead, Cadmium:</u> The following graphs show the estimated ELVs for the reference and the 2020 period for all climate change scenarios along with the legislated values. In general the conclusions drawn for chromium and copper regarding the ELVs variation due to climate change and socioeconomic scenarios are also valid Zinc, Nickel, Lead and Cadmium.

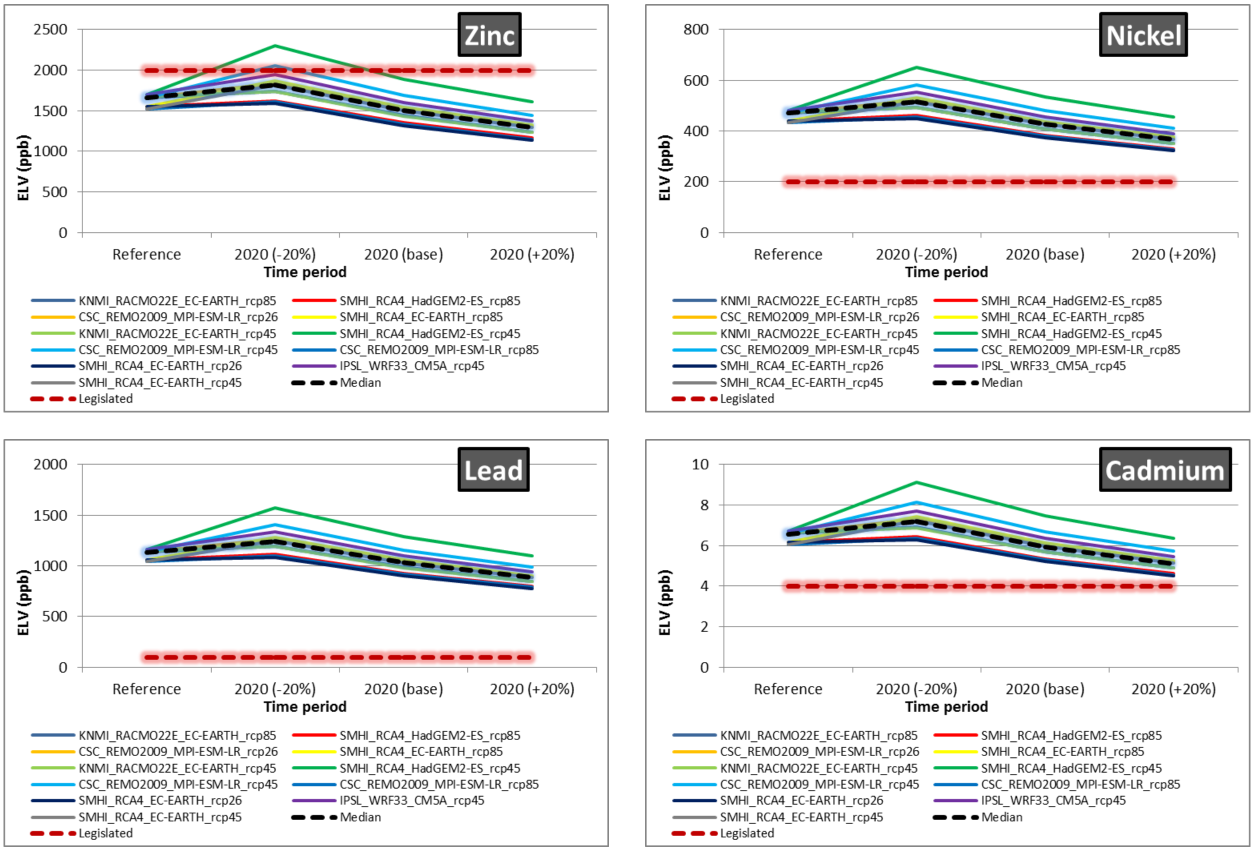

Figure 3. Variation of Zinc, Nickel, Lead and Cadmium ELVs for various climate change scenarios for the 2020 time period.

According to the indicators of SWICCA demonstrator there is no significant variation in the annual discharge of lower Asopos river Basin. However during summer months an increase in discharges is foreseen in the 2050 period compared to the reference as well as to the 2020 period. For example the average monthly discharge in August reduces from 0,41 m^3/s for the reference period to 0,37 m^3/s in the 2020, but for the 2050 period increases by almost 40% to 0,52 m^3/s. The discharge during summer months is critical for the determination of ELVs since the low flow period is when maximum pollutant concentrations appear.

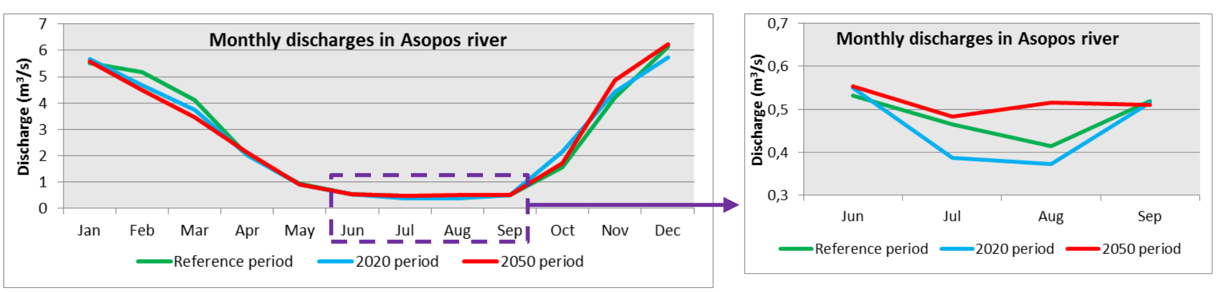

Figure 4. Comparison of monthly discharges in Asopos lower basin for three time periods (reference, 2020 and 2050) calculated as average value of the 11 climate change scenarios.

Specific Case Study Description Updates:

Decision support - including how indicator supports the listed decisions

Current study's results will be used for the evaluation of the efficacy of (a) relative National Management Plans and (b) regulatory measures imposed on local industry for environmental protection of Asopos River, under climate change conditions.

Indicators downloaded from SWICCA Demonstrator combined with local data allowed for an initial assessment of the climate change impact on monthly river discharges which in turn affects the water quality of Asopos River. These data support maintaining the fragile balance between environmental protection and economic viability and sustainability of the significant industrial activity in the area.

Policy aspects

The present case study is related to water quality issues of the Asopos River, a major effluent receiver of an extended industrial area. The Special Secretariat for Water needs to evaluate the efficacy of the currently established effluent quality limitations and if necessary adjust the relevant local policy, in relation to the goals of the EU Water Framework Directive.

Lessons Learnt

Indicators downloaded from SWICCA Demonstrator combined with local data allowed for an initial assessment of the climate change impact on monthly river discharges, in a comprehensive way without the use of complicated climate and hydrological models. While further analysis will be attempted using hydrological output from VIC and Lisflood models, initial results show that river discharges in Asopos area are not likely to change drastically, posing a risk for the surface water quality. In the scenarios examined, ELVs remain practically the same in the 2020 and 2050 time period. A re-evaluation of the ELVs in the future may be necessary only in response to an increase in the industrial activity of the area, however this is not considered the most likely scenario.