2nd International Conference
ADAPTtoCLIMATE
24-25 June 2019, Heraklion, Greece

Climate change impact assessment on the establishment of maximum water level in Lake Vegoritida, Greece

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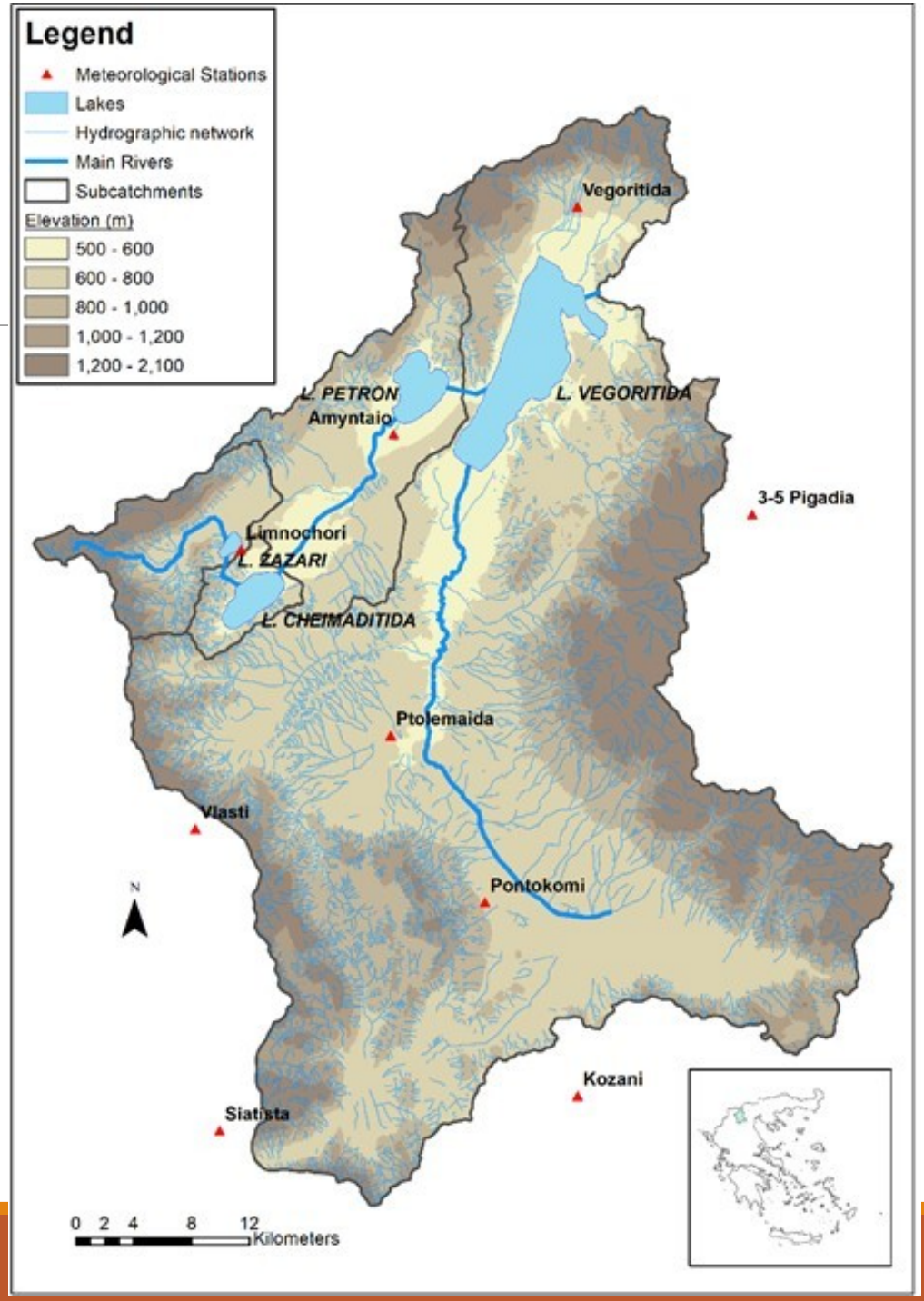
Hydrological catchment of Lake Vegoritida

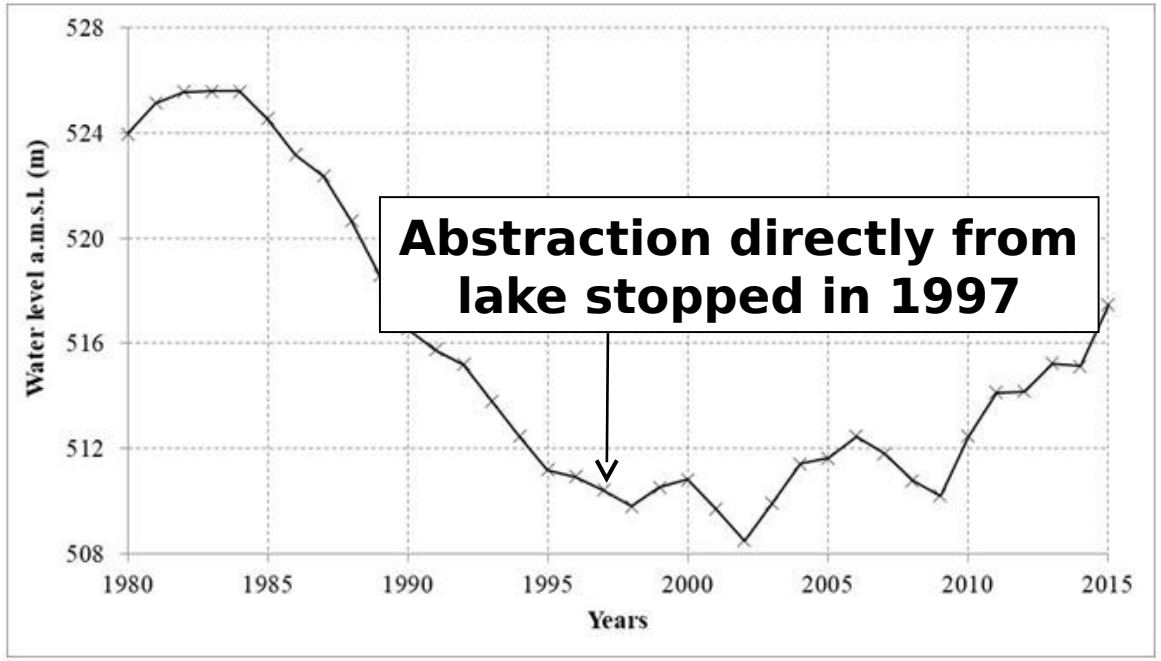
- Lake Vegoritida is located in the water district of Western Macedonia in Northern Greece
- The hydrological catchment covers an area of 2,145 km^2, and includes also the Lakes Petron, Cheimaditida and Zazari
- The four lakes are connected through the hydrographic network of the catchment and the excess of surface water is transferred from one lake to the other, i.e. Zazari -> Cheimaditida -> Petron -> Vegoritida
- The economic activities in the catchment that exert pressures in lakes, and generally in the water resources of the catchment, are mainly associated with



Water level fluctuation of Lake Vegoritida during 1980–2015

- Substantial fluctuations on its water level (WL) in the past century caused by water abstraction directly from the lake
- WL was 525 m a.m.s.l in early 1980's; dropped down to 509 m in 20 years; partially recovered to around 518 m during the last decade

- This WL fluctuation has affected the natural, social and economic environment of the lakeside area
- The recent recovery of the WL triggers a discussion on the definition of lake's maximum level which by itself becomes a source of conflict among stakeholders, including farmers, fishermen, tourists, entrepreneurs, scientists etc. (Doulgeris and Argyroudi in *Lakes & Reserv. 2019;24:24–36*).



Hydrological model set up of Lake Vegoritida catchment

- As a first step, the water balance of each lake is simulated (in a spreadsheet) based on a simple algebraic equation that takes into account the water inflows-outflows:

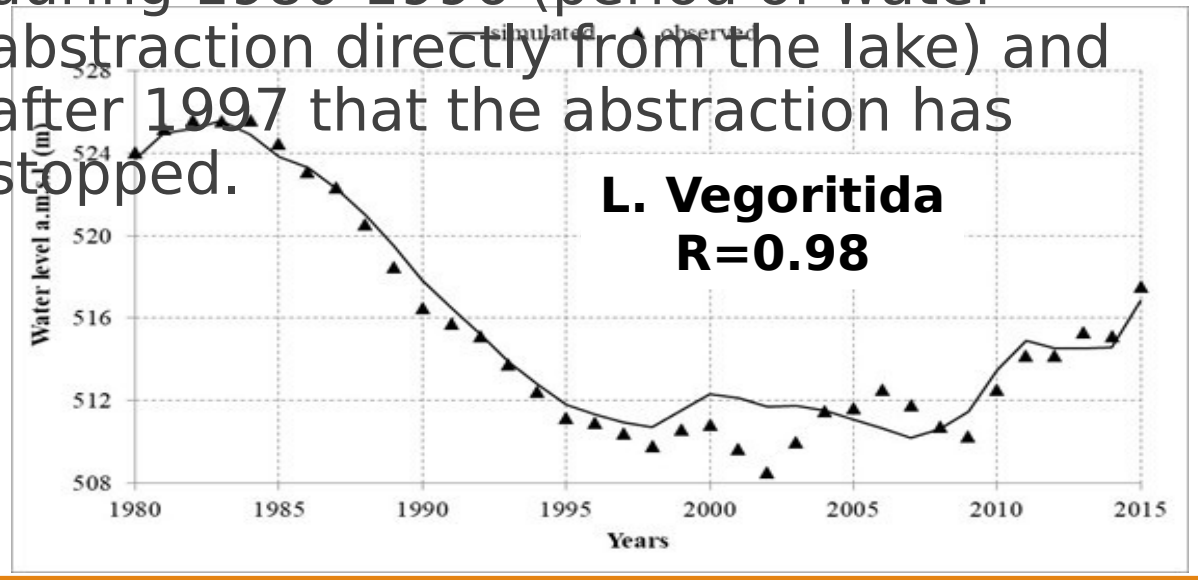
$$S(i+1) = S(i) + Qin + P - E + Gin - Gout - Qusers - Qout$$

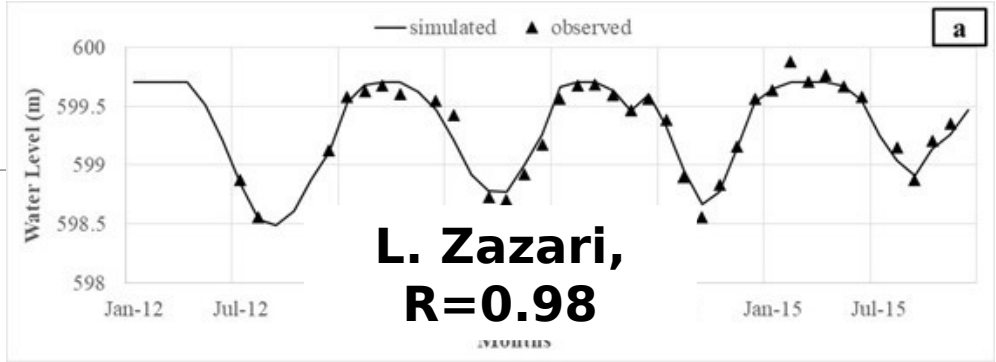
S: water volume, i: time, Qin: catchment water inflow, P: precipitation, E: Evaporation, Gin & Gout: groundwater inflow & outflow , Qusers: water abstraction, Qout: surface outflow

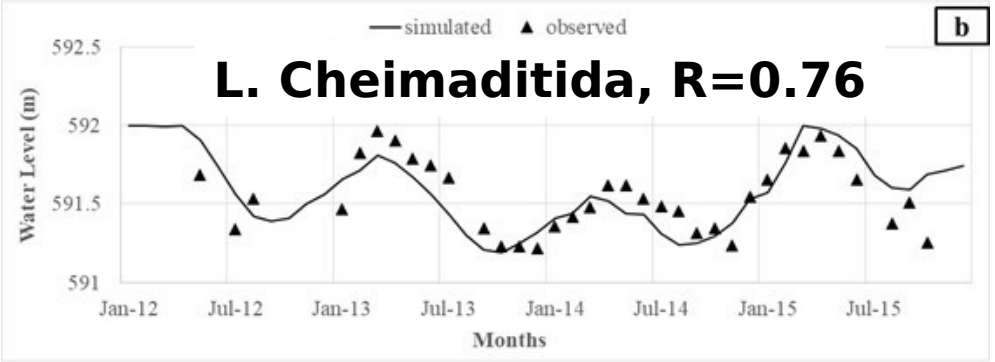
- After that, the MIKE 11-NAM rainfall-runoff model for each subcatchment of the lakes was set up and calibrated based on the subcatchment water inflow into the lake (Qin)
- Finally, the MIKE BASIN model (www.dhigroup.com) was used for the simulation and the analysis of the water balance of the lakes and their subcatchment for the historical period (1980-2015) and the projected period (2021-2050)

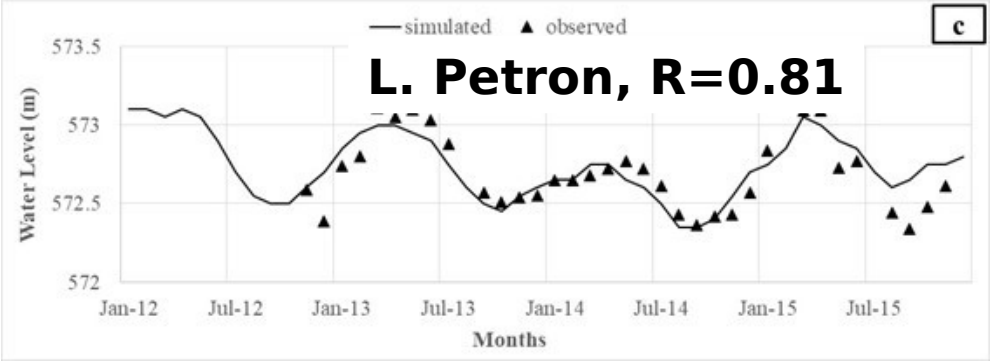
Calibration of hydrological model based on water level measurements in lakes

- The model was calibrated successfully and the water level fluctuation in lakes simulated satisfactorily
- An agreement between simulations and observations exist in Vegoritida, both during 1980-1996 (period of water abstraction directly from the lake) and after 1997 that the abstraction has stopped.



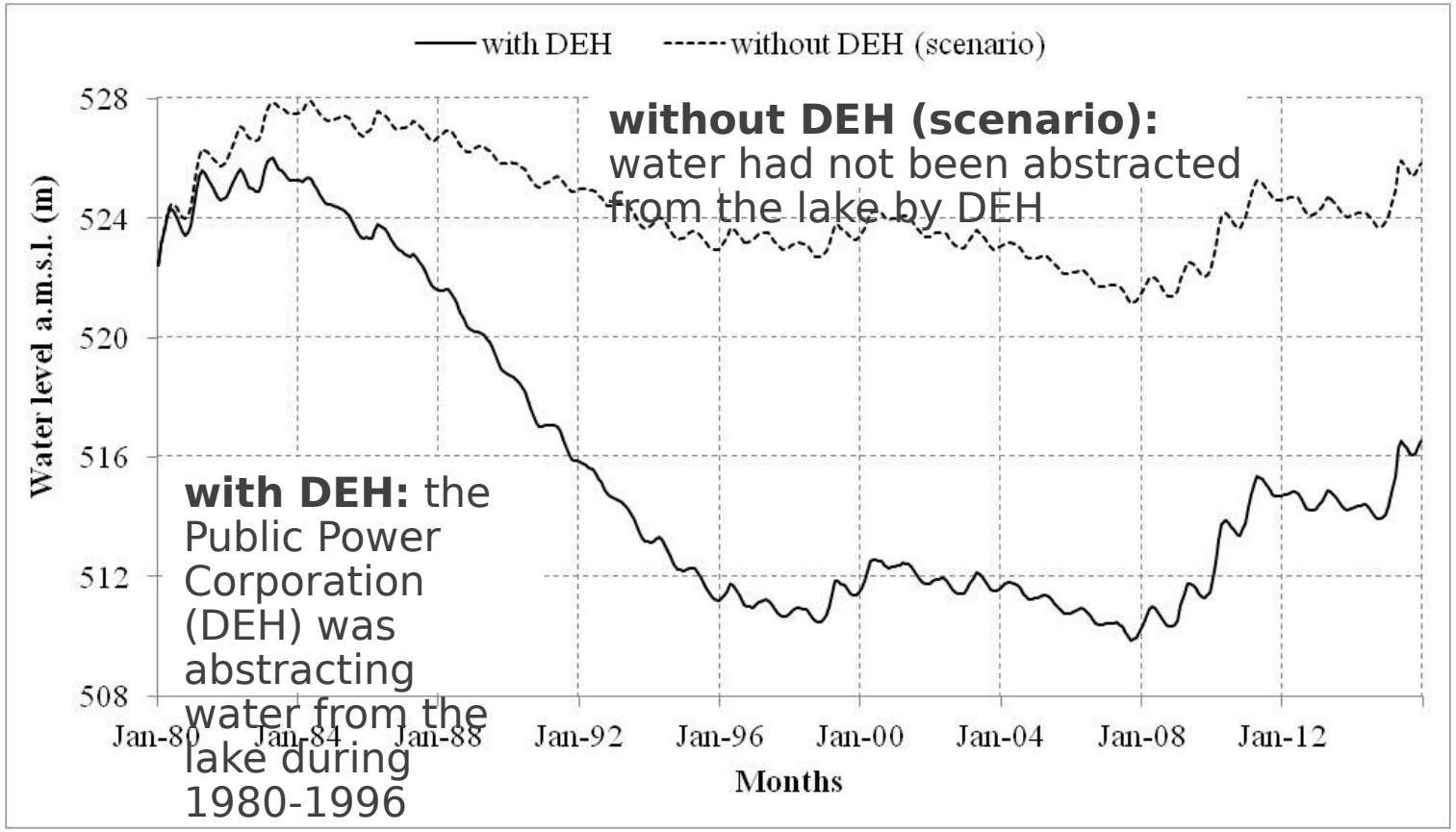






Impact on the water level of Lake Vegoritida by the Public Power Corporation (DEH) water abstraction

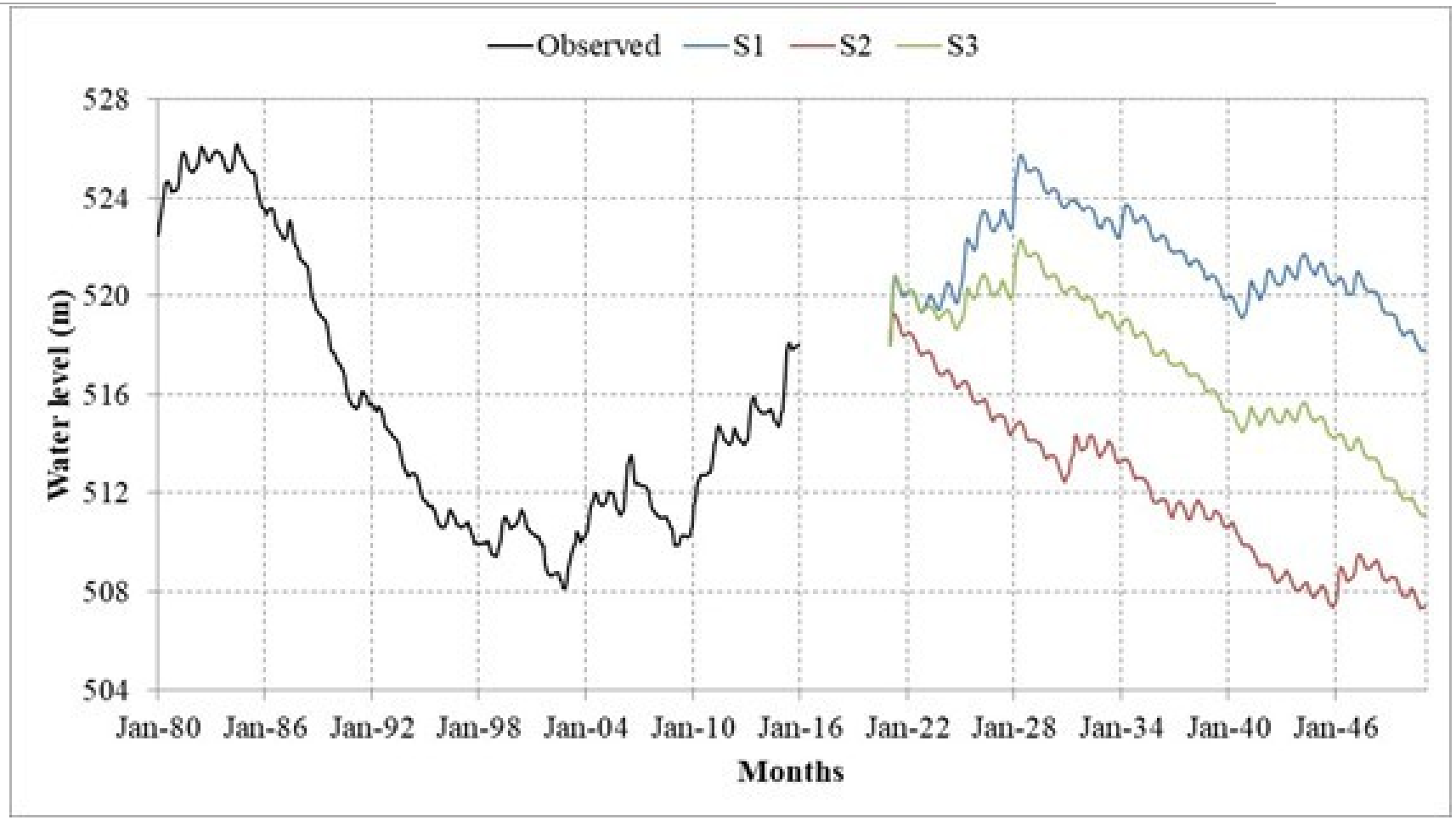
- Impact on water level (WL) of L. Vegoritida was quite significant
- If water had not been abstracted from the lake, the WL would be above 520 m, providing equilibrium and sustainability in the lake area.
- During this period, the lake has lost 45% of its volume and 29% of its surface area
- The water quality of the lake has progressively



population and an increase in eutrophication, from oligotrophic to mesotrophic status

Impact on the water level of Lake Vegoritida according to three climatic scenarios

- Impact of future climatic conditions on lake's water level is contradictory.
- In scenario S1, the water level is not particularly affected by climate change
- In scenarios S2 and S3, the water level is significantly affected by



Impact on the water balance of Lake Vegoritida according to three climatic scenarios

- Compared to the historical period, the inflow from catchment was decreased by 9%, 48% and 36%, for the scenarios S1, S2 and S3, respectively.
- Similarly, precipitation to lake (mm) was decreased by 8%, 21% and 15% [illegible] %, for the

	Inflow from catchment	Precipitation to lake	Evaporation from lake
Scenario/time period	(10^6 m^3)	(mm)	(mm)
1980-2015	40.7	596	1099
S1/2021-2050	37.2	547	1228
S2/2021-2050	21.1	474	1208
S3/2021-2050	25.9	507	1167

Conclusions

- A hydrologic model for Lake Vegoritida catchment was set up and calibrated successfully based on water level measurements of the four lakes, Vegoritida, Petron, Cheimaditida and Zazari.
- The model was also used to disclose the significant impact on the water level of Lake Vegoritida by the Public Power Corporation (DEH) water abstraction during the period 1980-1996.
- The application of three climatic scenarios, under RCP4.5 emissions scenario, for the projected period 2021-2050 revealed contradictory water balances and associated water level fluctuations in Lake Vegoritida for the near future.
- In one of the scenarios (EC-Earth) the water level is not expected to be affected by climate change while in the other two scenarios (HadGEM2-ES and MPI-ESM-LR) is significantly affected.
- Thus, it is uncertain if climate change will affect the current water level and more scenarios would be necessary to clarify safely the climate change impact on the establishment of the maximum water level in Lake Vegoritida.

Thank you

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