Final Report on scientific activities completed during the

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HyMIC

Hydrodynamics and Microplastics Impacts in the Chiemsee

Beneficiary

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The Chiemsee (measuring about 80 km^2 and a maximum depth of 73 m) is one of the major German lakes and holds a significant environmental role; moreover it is an important touristic destination and hence its beaches and water quality are highly valuable from a socio-economical viewpoint. As for most of the inland European aquatic environments, the Chiemsee was recently found to be significantly contaminated by microplastic (i.e. plastic fragments smaller than 0.5 mm) with concentrations comparable to those found in marine environments, both in sediments and water. Two main microplastics sources were identified in the Chiemsee: the riverine inputs (mostly from its main tributary, the Tyrol Achen), and the degradation litter from touristic beaches. Hence it is of interest to study the lake circulation and the microplastics dispersion from their sources in order to guarantee a good environmental status.

The overall objectives reported in the proposal where:

- exchange of practices, knowledge and procedures between the two involved groups;
- produce a first description of the lake current field and water mass dynamics;
- identify the dynamics of microplastics once they enter the lake;
- identify the beaches with high risk of contamination from microplastics;
- define future forms of collaboration.

1. Report on activities

The visit at the University of Bayreuth (Germany) lasted from November 14th to December 2nd 2016. The scientific work was performed with the collaboration of Prof. Dr. Christian Laforsch and his research group.

1 Exchange of practices

During the three weeks visit I was able to learn the extraction and analysis methodologies used by Prof. Laforsch group for microplacstic samples. More specifically, to isolate particles smaller than 500 micron the samples are first passed through a 5 mm sieve to remove the bigger fractions and then a pre-sorting is optically done with a 500 mm sieve. To extract particles between 20 micron and 500 micron the Munich Plastic Sediment Separator (MPSS) is used. In the MPSS the sample is diluted in a $ZnCl_2$ solution used as a separation fluid, filtered and then processed with specific enzymes to digest the organic part while leaving the plastic particles unaffected. After separation big particles are analyzed with a stereomicroscope and with an ATR crystal via an FT-IR spectroscopy for smaller ones. With this methodology it is possible not only to extract the microplastic fragments down to the 20 micron size class but also to define the origin and main chemical components of the fragments. A more detailed description of the extraction with MPSS is

available in Imohf et al., 2012.

2 Implementation of a numerical model of Lake Chiemsee

The hydrodynamics of the Chiemsee were simulated during the STM with the Regional Ocean Modelling System (ROMS, Haidvogel et al., 2008, www.myroms.org). In order to run and validate the model several datasets had to be collected:

- Chiemsee bathymetry and coast line. Since no digital charts were available the only option was to digitize a nautical map and then acquire the bathymetry. Once scanned, the chart was georeferentiated in a GIS environment (Q-GIS) and the coastline and isobaths extracted and then interpolated over a regular grid (Figure 1). Two ROMS grid where build with different

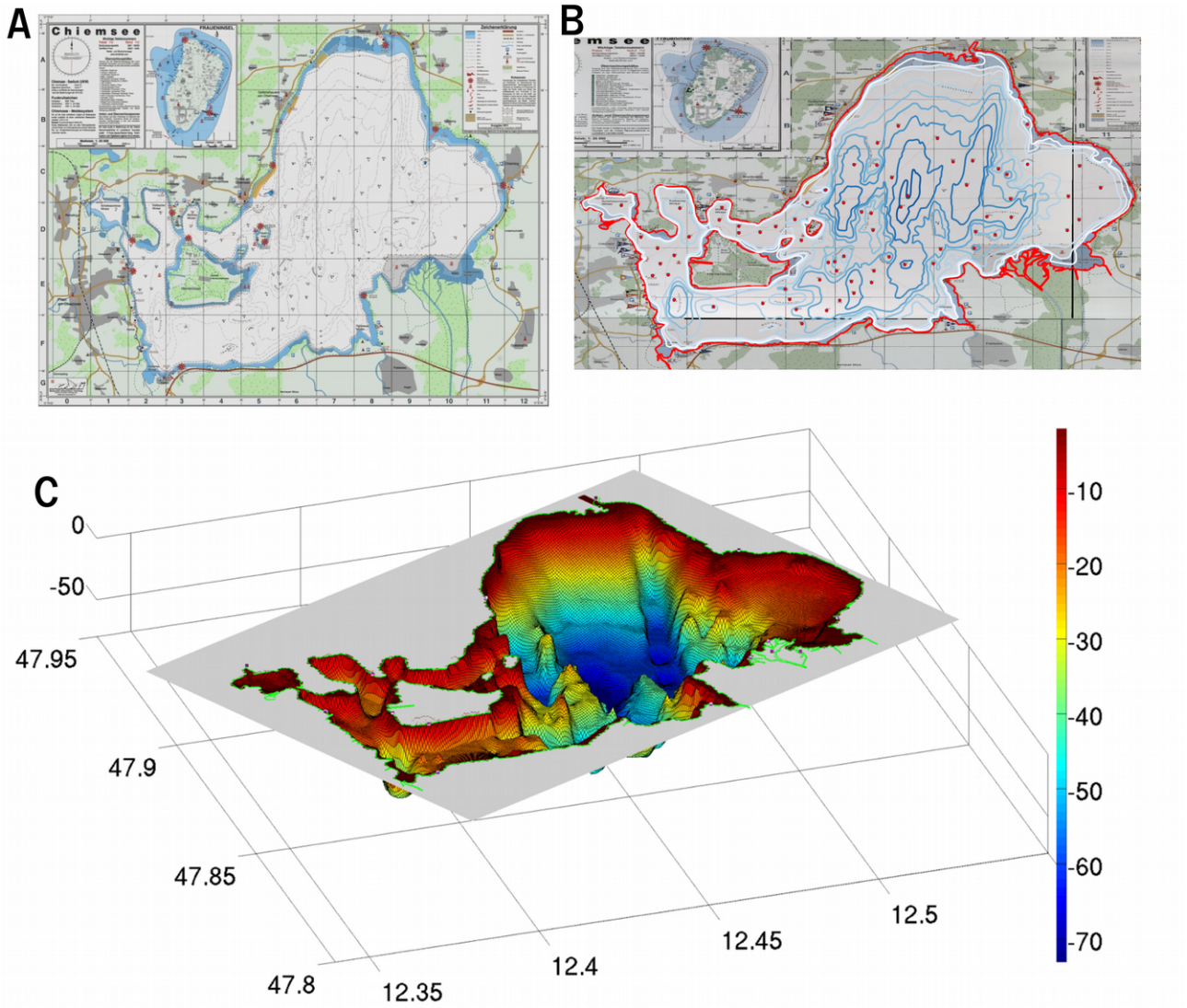

Figure 1: the three steps to digitize the bathymetry of the Chiemsee: the nautical chart used as reference (panel A); shows the georeferentiated version with highlighted the coast line (red) and the isobaths acquired (panel B); the final bathymetry interpolated over the model grid (panel C)

horizontal resolution (40 m and 50 m) and different levels of bathymetry smoothing. Both grids were tested in idealized configuration to verify their stability. The 40 m grid with low smoothing was chose for the subsequent runs.

- riverine inputs. stream flow data in proximity of the Chiemsee tributaries mouths were collected from the Bayerisches Landesmat für Umwelt (the Bavarian Environmental Agency) and are reported in figure 2. The Chiemsee presents 7 tributaries: three branches of the Prien river, the Bernaure Achen, the Uberseek Achen, the Weise and the Tiroler Achen (the major contributor to the lake water budget); the Alz is the only one effluent of the lake. Data time series were collected with high frequency (one record every 15 minutes) but have been reduced to one record per hour to be used as inputs for the simulations.
- atmospheric forcing. Two type of atmospheric forcing were prepared to be used as atmospherical forcings:
    - ERA-INTERIM reanalysis obtained from the ECMWF site

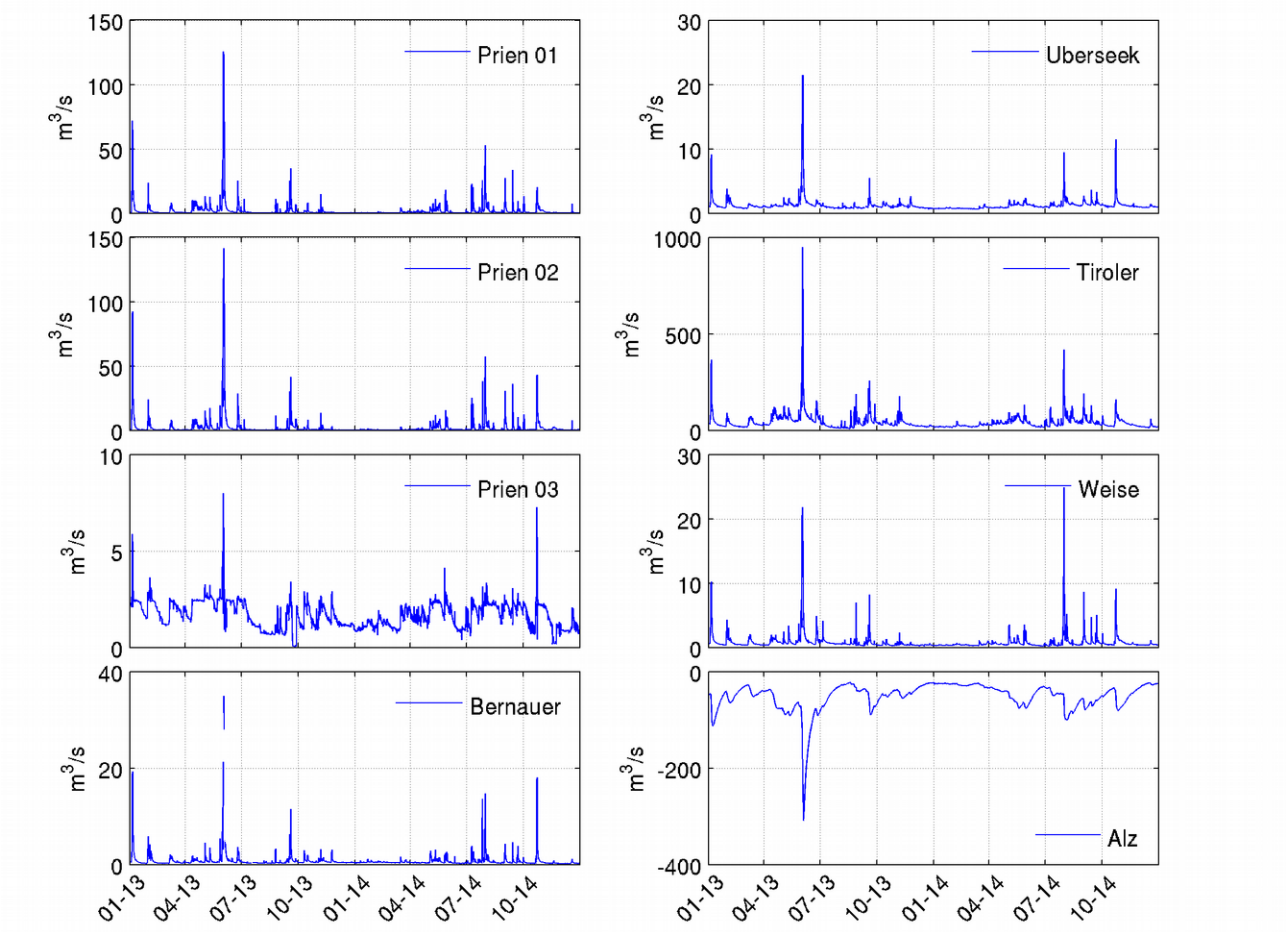

Figure 2: riverine inputs and outputs into the Chiemsee between January 2013 and December 2015. The Alz river is presents negative values since it is the effluent of the lake.

- an ad hoc WRF (Weather Research and Forecasting model Skamarock et al., 2005) simulation implemented for the period of the run.

At the moment of the compilation of this report the WRF simulations are under way.

- observations for validation: all the available observations for model validation were collected. Specifically the LFU monthly monitoring at the lake deepest point. Moreover a sampling field campaign was planned for late spring 2017.

3 Future collaborations

During the STM the possible future form of collaboration were discussed both in European schemes (MSCA ITN) and national founding. It was agreed that observation and modeling chain tested during the STM program are of interest and could be applied to other sites.

At the moment two abstracts have been submitted for the EGU GA 2017 (Falcieri et al. and Atwood et al.) and two papers are in preparation.

Bibliography

Imohf H.K., Schmid J., Niessner R., Ivleva N.P. and Laforsch C., A novel, highly efficient method for the separation and quantification of plastic particles in sediments of aquatic environments. 2012 *Limonogy and Oceanography: Methods*, 10, pp. 524 – 537.

Haidvogel D.B., H. Arango, W.P. Budgell, B.D. Cornuelle, E. Curchitser, E. Di Lorenzo, K. Fennel W.R. Geyer, A.J. Hermann, L. Lanerolle, J. Levin, J.C. McWilliams, A.J. Miller, A.M. Moore, T.M. Powell, A.F. Shchepetkin, C.R. Sherwood, R.P. Signell, J.C. Warner, J. Wilkin, 2008. Ocean forecasting in terrain-following coordinates: Formulation and skill assessment of the Regional Ocean Modeling System. *Journal of Computational Physics*, 227(7), pp. 3595 – 3624.

Skamarock W.C., Klemp J.B., Dudhia, J., Gill D., Barker D.M., Wang, W., Powers, J.G., 2005. A descritption of the Advanced Research WRF Version 2. NCAR technical note, NCAR/TN-468+STR.