Federal Agency
for Water Management

Federal Ministry for
Agriculture, Forestry, Regions and Water Management

NUTRIENT STOCKS AND FLUXES OF CARP POND SLUDGE

E. Peham , E. M. Schmaltz, H. Forsthuber, M. Konzett, T. Brunner, D. Ramler, P. Strauss and C. Bauer

Federal Agency for Water Management, Scharfling 18, 5310 Mondsee, Austria, elisabeth.peham@baw.at

Introduction

In the Waldviertel region, carp pond farming has a long tradition. Besides the production of fish, ponds play an important role as landscape elements, wetland ecosystems, water retention and storage basins in agricultural landscapes. The question of whether ponds act as nutrient and sediment sinks or as sources is a topic of ongoing debate in the community (e.g. Potužák et al. 2012, 2016). Presumably, this is largely dependent on the catchment area and the management of the pond. During the harvesting of the pond, the pond sludge is disturbed and – depending on the structural design of the outlet – potentially transported out of the pond. For pond farmers in the EU, the outflow of high nutrient loads during harvesting can present a significant challenge. On the one hand, contamination of receiving waters during fish harvest might result in a conflict with the EU Water Framework Directive. On the other hand, excessive loss of sludge and, consequently, a reduction in nutrient availability, has the effect of reducing pond productivity and therefore affect the economic quality of the pond.

receiving stream: more nutrients (eutrophication) → poor water quality

pond: less nutrients → less fish production → less economic income

To create a sound knowledge base, we now focus on research on carp pond sludge quantity, quality and distribution.

Method

The volume and mass of sludge in a carp pond in the Waldviertel region (Lower Austria; Fig. 1) were quantified through a combination of methods (directs measurements of sludge depth, airborne-supported mapping of spatial sludge extent, spatial interpolations, sludge sampling, laboratory analysis and difference models; Fig. 2). In the laboratory, Total Organic Carbon (TOC), Total Nitrogen (TN), Total Phosphorus (TP) of the sludge (in sections with a depth of 10 cm), the pond water and the three main inlets were determined.

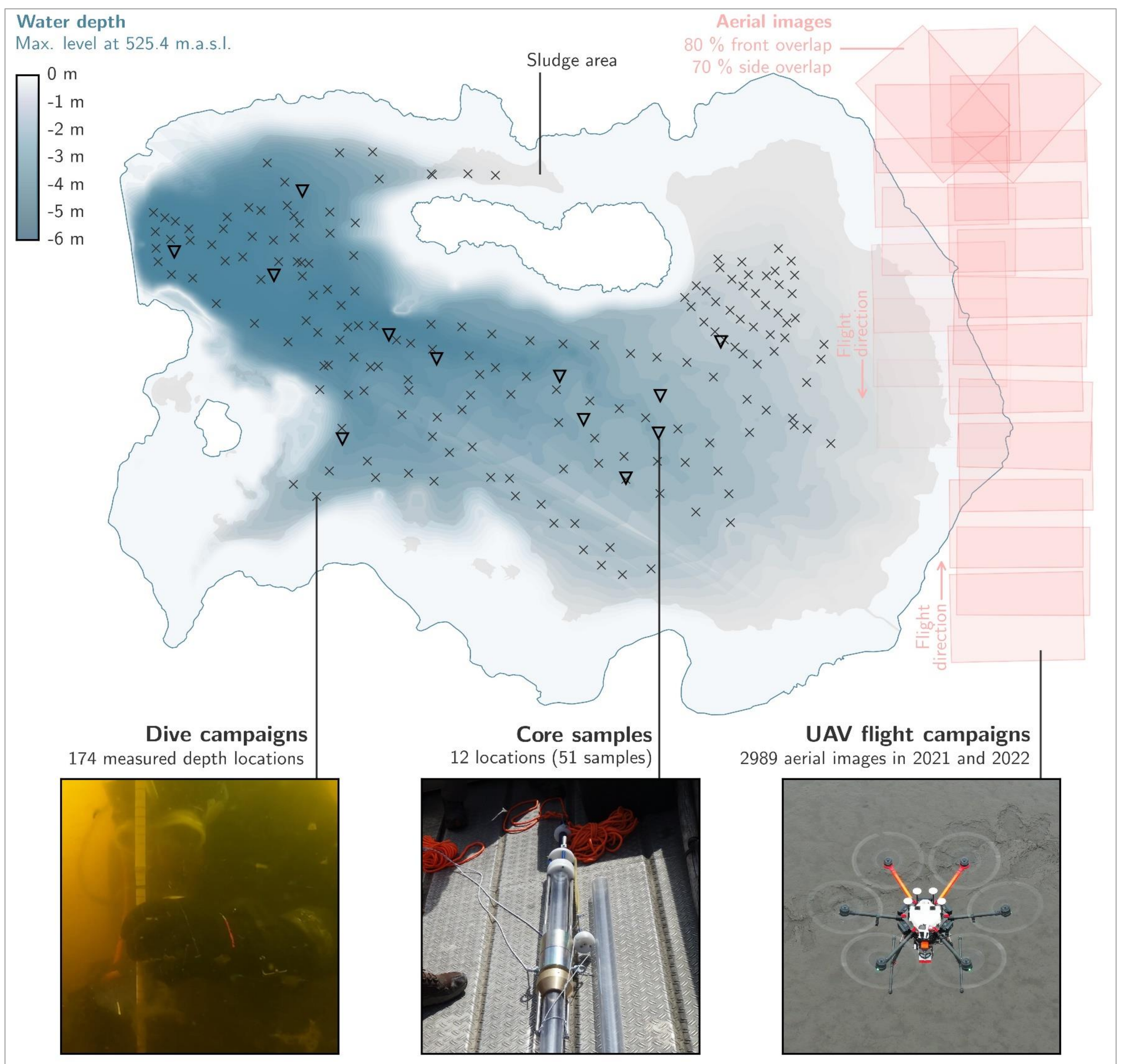

Fig. 2: Shows an overview map with the distribution of the pond sludge with the sample locations and methods used. Two flight campaigns were conducted in the autumn of 2021 and 2022, during which the pond was drained. The investigation of the sludge based on measurements with bamboo rods, to determine depth at spatially distributed locations, and sludge collection using an aquatic sediment corer. This methodology allowed the sampling of sludge cores to a maximum depth of 50 cm.

Discussion

The evaluation of TOC, TN, and TP storage indicates that the pond functions primarily as a sink for these nutrients. The accumulation of TOC and other nutrients in the sludge suggests significant retention, preventing an immediate release back into the water column or downstream ecosystems. However, local erosion and displacement can cause temporary nutrient resuspension and redistribution. It seems reasonable to assume that the upper layers of sludge are subject to mixing because of the movement and foraging behavior of carp.

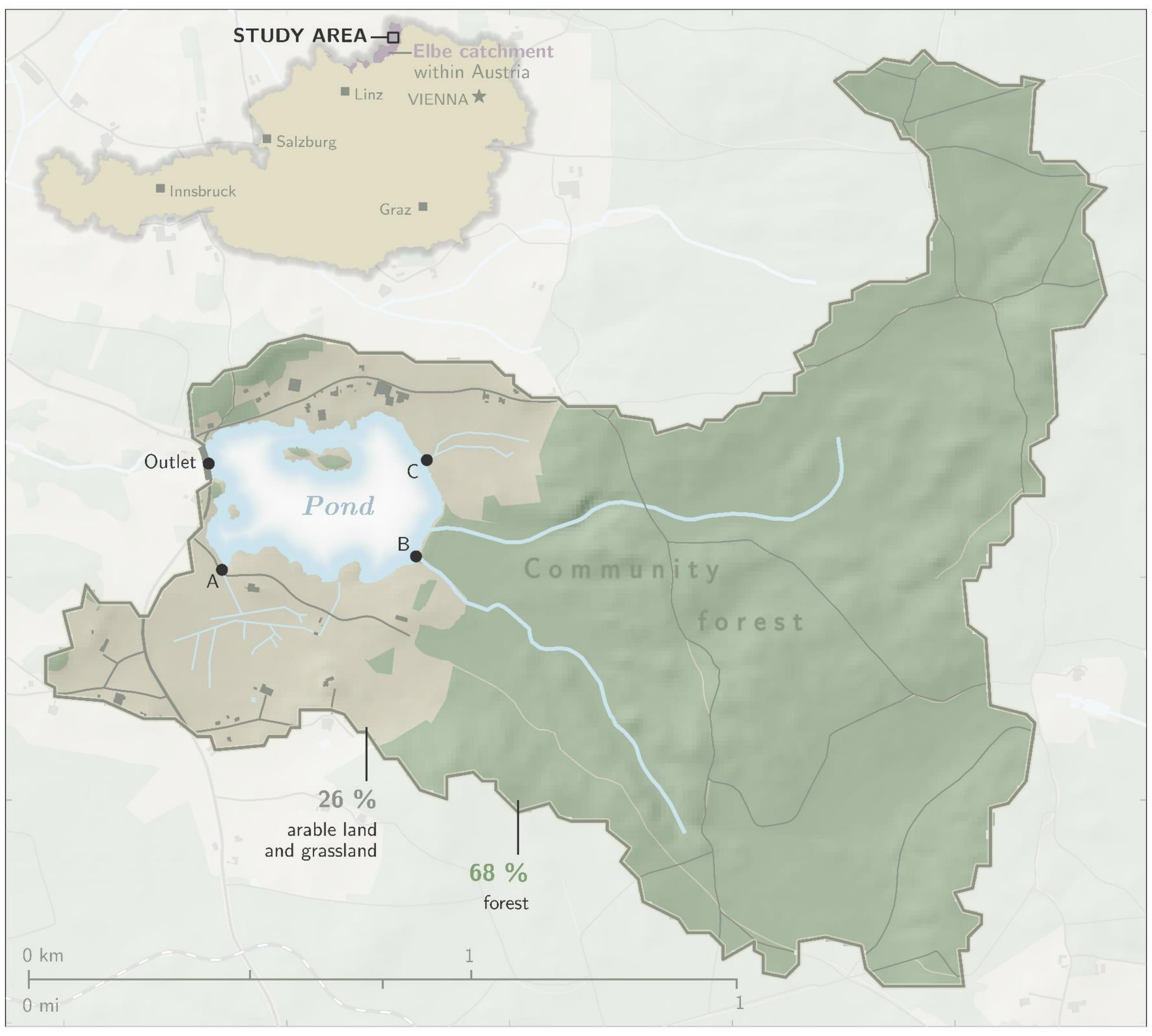

Fig. 1: Shows the location of the study site, the catchment area, the three inlets and the location of the ponds outlet. In addition, the land use is also visible.

Results

- TOC content increased up to a depth of 30-40 cm, declined in deeper layers
- shallow sludge layer with accumulation at pond center
- mass of the entire sludge layer was estimated to be 9,396 Mg (Fig.3)
- sludge contained 2,130 Mg of TOC, 105 Mg of TN, and 5 Mg of TP
- sludge was distributed unevenly, overall mass remained constant between the years
- Erosion channels formed during fish harvest contributed to sediment distribution

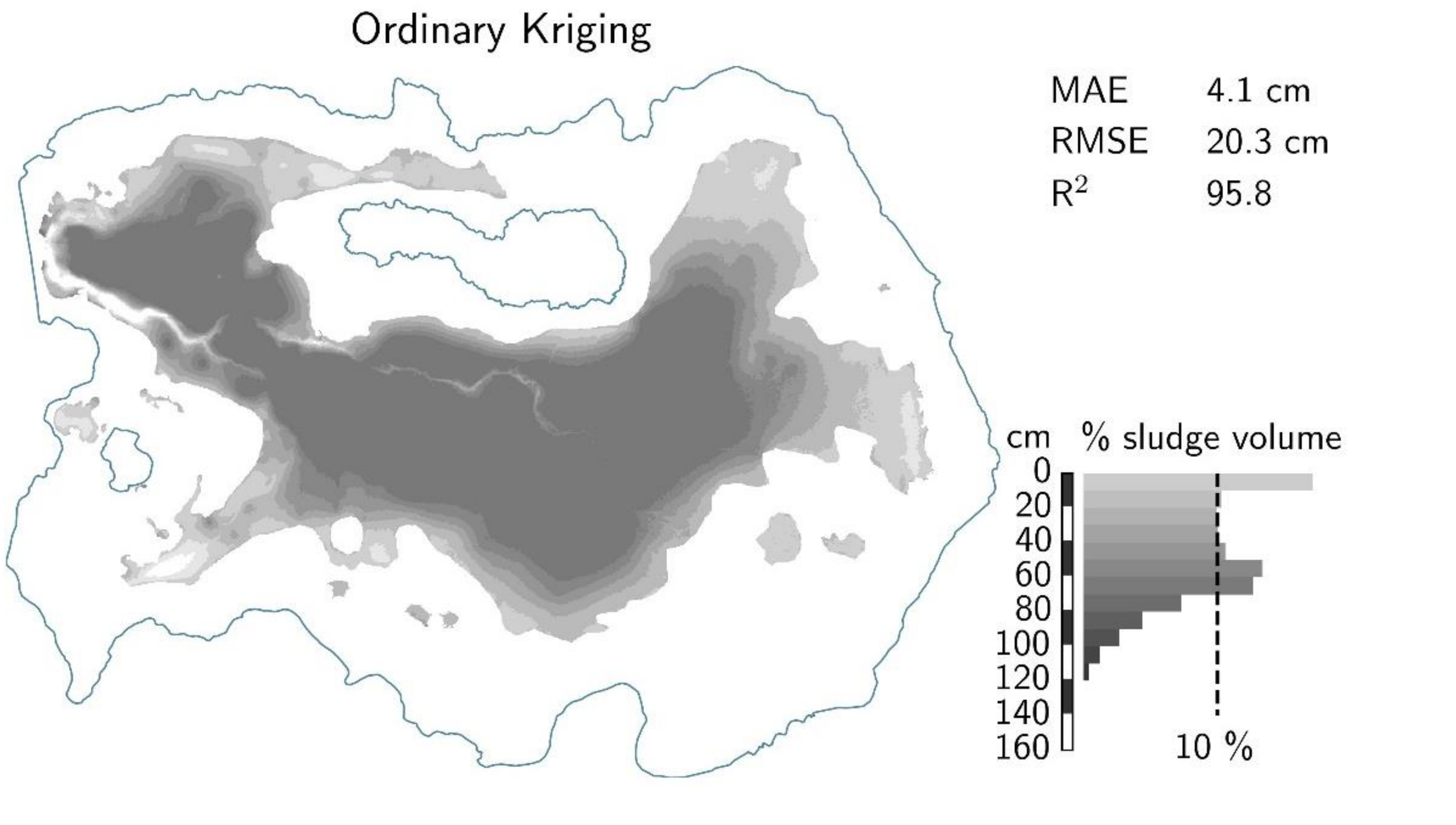

Fig. 3: Mass, depth and distribution of sludge in the pond. Ordinary Kriging emerged within our study as the most accurate interpolation method.