# Bachelor Thesis

# TEM at Martenhofer lake (filler title)

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## Abstract

Abstract of the thesis

## 1 Introduction

Introduction including: Objective: Create a model of the subsurface resistivity at Martenhofer Lacke using the transient electromagnetic method.

Hypothesis: An optimal lambda can be found for the TEM data gathered at Martenhofer Lacke by using the L-Curve method.

Research questions:

- How suitable is the transient electromagnetic method for the investigation of the resistivity of the subsurface at the Martenhofer Lacke?
- Which configuration of the TEM method is most suitable for the investigation of the Martenhofer Lacke?
- Is the L-curve method suitable for the determination of the optimal lambda for the TEM data?
- Which conditions are necessary for the L-curve method to be applicable to the TEM data?

## 2 Materials and Methods

### 2.1 State of the Art

[write here]

#### 2.1.1 Common resistivity values

Some common values for resistivities can be found in [1].

#### 2.1.2 TEM method

development...

#### 2.1.3 Application of TEM

different types and fields of application...

#### 2.1.4 Data Inversion

stochacstic and deterministic inversion...different methods...

#### 2.1.5 L-curve method

A common way to solve an ill-posed problem is to use Tikhonov regularization, which is a method that adds a penalty term to the least squares problem. The penalty term is a function of the model parameters and a regularization parameter lambda. ...

One way to determine an optimal values for the regularization parameter $\lambda istheL - curvemethodasintroducedbyHansen[\mathbf{hansen1999curve}].Th$ $curveisagraphoftheresidualnormagainstthesolutionnorm.W$

$shape.The optimal \lambda is the point on the curve where t$ ... $he highest. The L-$
$curve method is widely used in geophysics for the determination of the optimal \lambda for the inversion of geophysical dat$

There are a several methods to automatically determine the optimal lambda as described in[**cultrera2020simple**, **farquharson2004comparison**, **lloyd1997use**]. LLoyd et al. [**lloyd1997use**] proposed a method that computes the $\chi\check{s}, also called error weighted root-mean-square, and the roughness of the model for different \lambda values to obtain the L-curve. In order to find the optimal \lambda a cubic spline function is fitted to the data points and used to find the maximum cu$ $curve.$

Another approach is the iterative golden section search as proposed by Cultrera[**cultrera2020simple**]. After providing an initial range for the optimal lambda

$$\lambda_1, \lambda_4$$

, two more lambda values are calculated using the formula:

$$\lambda_1 = \lambda_0 + \frac{(\lambda_0 - \lambda_2)}{(\chi\check{s}_0 - \chi\check{s}_2)}\chi\check{s}_0 \tag{1}$$

This method is less computationally expensive because for each iteration only four inversion runs are needed. After providing an initial range for the optimal $\lambda, the method iteratively reduces the range until the optimal \lambda is found. Using the golden section formula, new lambd$

# 3 Results

# 4 Conclusion

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

All data and Python routines associated with this study are available open-source to facilitate full reproducibility of the results on github (`https://github.com/pb-tuwien/Geophysics.git`).

# References

[1] E. C. Galazoulas, Y. C. Mertzanides, C. P. Petalas, and E. K. Kargiotis. "Large scale electrical resistivity tomography survey correlated to hydrogeological data for mapping groundwater salinization: a case study from a multilayered coastal aquifer in Rhodope, Northeastern Greece". In: *Environmental processes* 2 (2015), pp. 19–35.