

# Mortality Maps based on Spatial Extrapolation Methods

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**Abstract.** Mortality maps display the spatial demographical structure of mortality which is commonly described via death rates. In this paper, mortality maps of the population in Germany are considered over the time horizon from 1996 to 2003. We address regional differences and similarities of the mortality in South, East and West Germany over various age groups. Further, we analyze the time dynamics of the mortality across Germany. The spatial structure of the mortality maps will be investigated by morphological image analysis. The consequences of our observations are discussed for the risk based pricing of life insurances.

**JEL classification:**

**Key words:** Stochastic mortality, Space/time analysis, Extrapolation, Life insurance pricing

## 1 Introduction

The mortality of a population is typically described via death rates depending on age, gender, and year. Death rates form an important input factor for contractual calculations of life insurances or pension plans. For example the insurance industry in Germany uses so-called mortality tables [7] which form a summary of projected current and future death rates. In contrast to the premium calculation of third party liability insurances of motor vehicles which depend on the region the insurant lives, the premium of German life insurances do usually not depend on the regional characteristics of mortality. This paper analyzes the differences and similarities in the spatial demographical structure of mortality in Germany via so-called mortality maps.

The paper is organized as follows. After introducing the data, we construct mortality maps for the population of Germany and carry out the corresponding explorative analysis. In this context, we explain the utilized extrapolation method which is based on an inverse distance method. Our results refer to the regional structure of mortality as well as to its dynamics over time. The implications of our observations are discussed for the risk based pricing of life insurance contracts. Finally, we illustrate a method for the statistical analysis of mortality maps.

## 2 Construction and explorative analysis of mortality maps

### 2.1 Data processing

Our analysis is based on a demographical data set provided by the Federal Statistical Office in Wiesbaden, Germany. It consists of the population sizes and the numbers of deaths per administrative district and non-district town in Germany - we refer to both as districts - over the time horizon from 1995 to 2003. The data are given by gender and age groups. Death rates - per district and year - are calculated as the ratio of the number of deaths with respect to the size of the population in the preceding year, i.e. the death rates  $m_t$  are calculated by

$$m_t = d_t/p_{t-1}, \quad t = 1996, \dots, 2003,$$